Discussion of Projectile Lesson: What and Why

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I've adapted Section 12.6 on Motion of a Projectile from the classic Hibbler text "Engineering Mechanics Dynamnics, 10th edition." I selected this topic because it is one of the first topics typically taught when students are introduced to the study of dynamics is projectile motion. Projectile motion is a good starting point for two reasons:

- The model developed is relatively simple because it only involves kinematic quantities, not kinetics. Kinematics focuses on the geometrics aspects of motion, while kinetics introduces the concept of forces.
- Projectile motion has practical applications for tracking the motion of launched or thrown objects.

To take into account that Section 12.6 builds on the previous sections, I've added an initial section that simply provides a summary of the equations that were previously derived. The derivation of these equations is fairly similar to how they are derived in the current Projectile example in Drasil. I've made an effort to change the symbols and notation to match what is currently in Drasil.

Comments have been incorporated into the text using square brackets [].

I've tried to write the parts using the simplest possible markdown. Equations are added using LaTeX. To get cross-references to equations to work I had to add the LaTeX extensions to my local installation of Jupyter. Maybe there is a better way to do cross-references?

For the code part, I tried to leave the variabilities in code (as opposed to in the markdown), so that they can be changed easily. The figure is "hardcoded" with specific values for the variable inputs.

For projectile motion, there are 5 equations (4 independent equations), but Hibbler doesn't include the one about velocity in the horizontal direction being constant in his list of 4 equations. He mentions it, but doesn't consider it a separate equation.

The general view of projecile problems has 10 variables: $p_x, p_y, v_x, v_y, p_x^i, p_y^i, v_x^i, v_y^i, a, t$. There are 4 independent equations (we don't need the equation that eliminated time, since it is derived from the other equations). However, solving projectile motion problems isn't as simple as solving for 4 unknowns from 4 equations, since the equations aren't all coupled. For instance, if there are three unknowns of p_x, v_x^i and v_x, there is no way to solve for the unknowns, despite having 4 equations. For completeness of the presentation, it doesn't seem to be an option to exhaustively go through all cases, since there are 10 choose 4, or 210 cases. Some of the 210 aren't solvable. The textbooks tend to focus on problems inspired by real engineering problems, so a is usually set to g or 0. Even in this case there are 9 choose 4, or 126 combinations.

The Drasil viewpoint of the family can be that everything up to the instance model is mostly common to all examples. The instance model selects the specific equations, which are then rearranged to solve for the unknowns.

The kinematic equation where time has been eliminated is not used in the Projectile SRS, because it isn't necessary.

Incorporating the results of the code into the markdown is possible by using the python-markdown

1 Discussion

The Projectile example should be updated to use the modern approach to textbook writing. The knowledge should be classified and divided so that the generic patterns emerge. By classifying the knowledge, we'll be able to generalize to other lessons. This could also help us find the mapping between knowledge in the SRS and knowledge in a typical lesson.

Information on templates for textbook chapters can be found on-line:

- Developing a Textbook Structure
- Textbook Writing Tutorial
- Textbook Design Rules
- Textbook Genres and Examples

The elements of a textbook chapter have been categorized by the above resources. The presentation in the resources provide an overview of the "program family" of textbooks. The commonalities and variabilities are:

- Openers: Express "subject, theme, aims, topics, and organization of a chapter [... readers should] know at the outset what they are reading and why or to what end" (Lepionka 2003:117). E.g. if you follow Gagné's nine events of instruction then you should include something to motivate and gain attention (step 1), something to help the frame and organize (step 2) and something to recall prior knowledge (step 3).
  - overviews (previews)
  - introductions
  - outlines (text, bullets or graphics)
  - focus questions (knowledge and comprehension questions)
  - learning goals / objectives / outcomes / competences / skills
  - A case problem
  - In addition one may use the "special features" used inside chapters, e.g. vignettes, photos, quotations, ...
- Closers: Give students opportunities to review, reinforce, or extend their learning, i.e. help with transfer of learning (Lepionka 2003:118)
  - conclusions and summaries (may include diagrams)
  - list of definitions
  - reference boxes (e.g. computer instructions)
  - review questions
  - self-assessment (usually simple quizzes)
  - small exercises
  - substantial exercises and problem cases
  - fill-in tables (for "learning-in-action" books) to prepare a real world task
  - ideas for projects (academic or real world)
  - bibliographies and links (that can be annotated)

- Integrated Pedagogical Devices: These elements aid the learning process in several ways, e.g. by giving advice on how to understand / interpret or navigate, by engaging the learner in some reflection, by pointing out important elements, or to summarize key elements treated in previous text.
  - Emphasis (bold face) of words
  - Marginalia that summarize paragraphs
  - Lists that highlight main points
  - Summary tables and graphics
  - Cross-references that link backwards (or sometimes forwards) to important concepts
  - Markers to identify embedded subjects (e.g. an "external" term used and that needs explanation)
  - Study and review questions
  - Pedagogical illustrations (concepts rendered graphically)
  - Tips (to insure that the learner doesn't get caught in misconceptions or procedural errors)
  - Reminders (e.g. make sure that something that was previously introduced is remembered)
- Interior Feature Strands: "Intext features, whether boxes or portions of text set off through design, function pedagogically to attract attention; arouse curiosity; increase motivation to read; stimulate critical thinking; and provide opportunities for reflection, application, or problem solving" (Lepionka, 2003: 118).
  - Case studies
  - Problem descriptions
  - Debates and reflections
  - Profiles (case descriptions)
  - Primary sources and data
  - Models

To the last category of elements we could likely add "historical notes, or autobiographies of important figures". However, this may be covered under "Profiles."

If an entire book is treated as a sequence of Chapters, a tool like Drasil can verify that all of the required sections are present and that the same sections are used in each chapter. There are textbook design principles in the links above, like the principle that the format and structure of the textbook should be obvious after reading the first chapter and that there won't be surprises in later chapters. These principles can be enforced by Drasil, or at least when they are violated warnings could be provide.

The lists of elements for book chapters seem very complete, although I didn't see any items corresponding to the following:

- Pre-conditions - assumed prior knowledge for the lesson