QWIZM

Digital Media Design Capstone Project in Partial Fulfillment of the Requirements for a Master of Liberal Arts Degree

Harvard University Extension School

Dave Morgan

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Context

- Teaching introductory engineering courses to adults in a two-year Civil Engineering Technology program at a Canadian polytechnic.
- Students progress through their program in cohorts of 32 students, each cohort taking the same classes at the same time. Students have about 30 hours of instruction or labs each week. Groups within each cohort become tight-knit and study together.

The Problem

- The setting of pertinent take-home assignments that both encourage learning and are efficient to mark.
- Exercise solutions tend to be long and complex, involving many steps, and with a reliance on the mathematical accuracy of numerical answers.
- Some solutions may involve as many as 40 separate calculations before reaching the final answer.

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   - Additionally, students have online access to all major textbook solution manuals making, for many, assignments more a matter of diligent copying than learning. ✗

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   Various LMSs offerings:

   - Moodle has the 'Calculated' question type: https://docs.moodle.org/38/en/Calculated_question_type
   - Canvas has the 'Formula' question type: https://community.canvaslms.com/docs/DOC-26355
   - Blackboard has the 'Calculated Formula' question type: https://help.blackboard.com/Learn/Instructor/Tests_Pools_Surveys/Question_Types/Calculated_Formula_Questions

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   Pros:

   - Individualized inputs, students perform their own calculations. ✓
   - Automatic marking of assignments reduces the instructors' workload. ✓

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   Cons:

   - Students need to perform many calculations, with no feedback, before submitting their final answer. This often leads to significant student frustration if the question is marked incorrect. ✗
   - Instructors do not see students' written work and cannot give feedback on professionalism. ✗
   - These LMS calculated/formula question types match each student's response to a single formula specified when the question was created. It is not practical to combine a series of up to 40 calculations into a single equation. ✗
   - Many problems require more than a single answer. E.g., finding the three angles of a triangle. ✗

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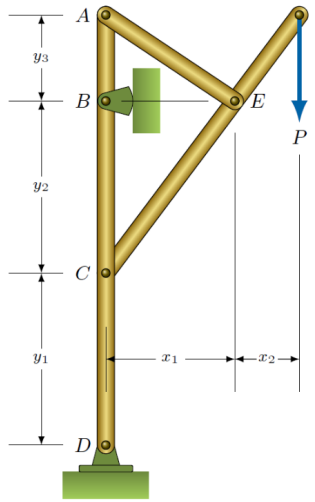

There is a friction-less rocker at B. All the other connections are pinned connections.

The frame dimensions and applied loads are as follows:

- x_1 = 1.75 m,
- x_2 = 0.91 m,
- y_1 = 2.19 m,
- y_2 = 2.15 m,
- y_3 = 1.2 m,
- P = 1.1 kN,

1. Noting that AE is a two-force member with only one unknown, how many unknowns are in this frame? ____ (1 mark)

2. How many unknowns are there in the support reactions at D and B? ____ (1 mark)

3. Determine the magnitude and direction (measured counter-clockwise from the positive x-axis) of the reaction R_B at B.
R_B is ____ kN at ____ ° (3 marks)

4. Determine the components of the reaction at connection D:
D_x is ____ kN, and D_y is ____ kN. (1 mark each)

5. One way to calculate the force in member AE is to split F_{AB} into horizontal and vertical components and then take moments about C of the forces acting on member CE. To do this, we need to find the angle between AE and the horizontal:
$\angle BEA$ = ____ ° (1 mark)

6. Determine the force in AE (Use a positive value for tension, negative for compression)
F_{BE} = ____ kN (1 mark)

7. Determine the rectangular components of the force exerted by member CE on member $ABCE$:
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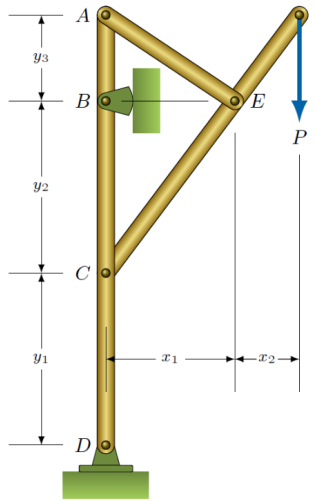

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Pros:

- If you have access to Moodle and the 'Formulas' plug-in, this may be a good route to follow. ✓

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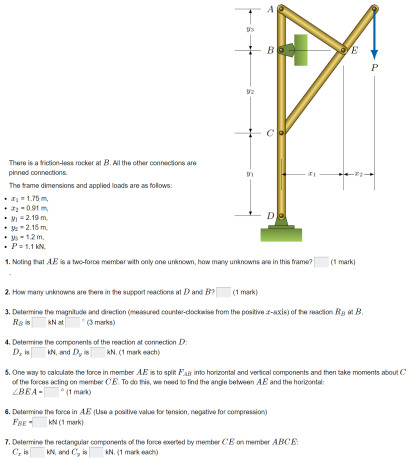


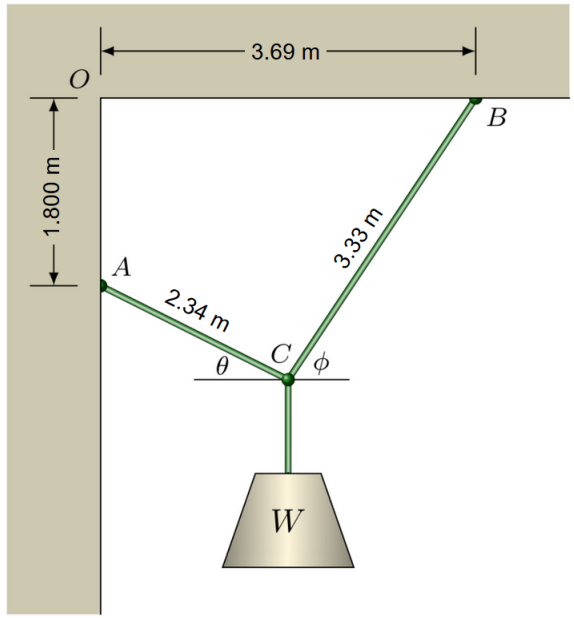
Cons:

- Access limited to Moodle platform users. ✗
- Plug-ins, not part of the Moodle core, may break when Moodle is updated. ✗
- Moodle is open source and plug-ins are maintained by volunteers. Due to retirement, there is no current maintainer of the 'Formula' plug-in. ✗
- 'Instant' feedback for each part has to be 'gamed': After each answer is entered, you must submit the whole question for marking and then look for a checkmark indicating your last entry is correct. ✗

Enter Qwizm!

- qwizm.org is an existing web-site containing containing an early proof-of-concept for this current version of Qwizm. Although limited in content, it has proved useful for over ten years and is still in use by former colleagues.
- The existing site will be replaced by the new application as questions are converted to the new format.
- All the code from the original app has been refactored. Features that are new to this current version are indicated.

Q5: A typical question in Statics is to determine the tension in rods AC, BC and CW.To solve this, we need to find the angles θ and ϕ. Follow the steps outlined below in order, starting with the length of AB, to find these angles:



$\lvert AB\rvert$:	4.11	m	Enter	✓ 3/3
$\angle ACB$:	42	°	Enter	✗ Try again. (0/4)
$\angle ABC$:		°	Enter	(4 marks)
$\angle OBA$:		°	Enter	(3 marks)
ϕ:		°	Enter	(3 marks)
θ:		°	Enter	(3 marks)

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Client-side?

Pros:

- No need to manage user data on the server. (I'm not looking for a long term commitment here, just the ability to add quizzes and questions when the urge strikes.) ✓

Cons:

- No automatic entry of student marks or attempts to an LMS gradebook. ✗
  - This is less of a problem for instructors than might first seem obvious. There is more paper handling, of course, with a summary printout and written work attached but marking is very quick. It is the work of a moment to scan the written work for professionalism and that some (or all) work matches the submitted answers. Then, assign to mark to the student in the gradebook. It takes about a minute to 'mark' a student Qwizm assignment. And, commonly, you are marking long complex problems.

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  4. Each assignment is worth about 1% of the final course work so there is not a lot at stake.

     The stated purpose is assessment but, in reality, it's more about guided learning, encouraging a student through a long problem towards a final answer. It is formative assessment rather than summative assessment.

Technologies Used

- The core of the application is HTML5, CSS3 and ES6 (Javascript)
- jQuery is used to facilitate DOM manipulation and reduce browser compatibility issues.
- The katex (https://katex.org/) javascipt library is used for math typesetting in the LaTeXlanguage
- The ES6 is compiled into ES5 so that current browsers can read it. Babel (https://babeljs.io/) is run to perform the compilation.
- VSCode is the editor used for development. I made regular use of its live server.
- CSS styles were automatically compiled when SASS files were saved using the Live Sass Compiler extension for VSCode.
- All development was on a Windows 10 laptop.
- Code is open source and available at https://github.com/dmorgorg/nuQwizm

Going Live!

Let's see it in action:
https://qwizm.org/nuQwizm/statics/quizzes/quiz00MR01/

Why not host the app within an LMS?

- It is not simple, or even possible in many cases, to insert a functioning .html site containing JavaScript into an LMS.
  - The LMS with which I have most experience, D2L Brightspace, automatically strips all JavaScript to the extent that it is not possible to include simple JavaScript libraries in pages. Other LMSs may do the same.
  - There is a plug-in (https://github.com/ricoshae/ricoshaejs) for inserting 'JavaScript activities' into Moodle. The LMS interface for entering code into Moodle – without the intellisense, syntax highlighting and live browser updating available in modern text-editors – complicates content creation and makes debugging difficult.
- Having a relatively lightweight application, hosted on a openly available site, ensures free access for all who are interested.

Future Plans

1. Improve marking options:
   - Allow a specified tolerance in the last digit of an answer. E.g., if the correct answer to a question is 1.234, also allow 1.233 and 1.235 as correct answers. This may be useful in the case of questions with many calculations that allow rounding errors to accumulate.
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2. Introduce the concept of 'question sets'. Currently, each student gets the same question but with individualized inputs. With questions sets, two or more questions of equal difficulty and testing equivalent concepts may be chosen at random for display in the quiz. In this case, not all students get the same questions; their question is chosen 'randomly' from an array of equivalent questions.

Future Plans

3. Masking of correct solutions:
   - A user who knows their way around their browser's debugger can readily find 'correctSoln' in a stored variable.[1]
   - Encoding and decoding functions are under development (not quite ready yet!). Instead of 'correctSoln' containing 1.234, it will contain something like 'VM`VDCG.EA9'.
     https://codepen.io/dmorgorg/pen/dyPJbLQ

[1] In more than 10 years using a prototype of Qwizm, I was never aware of any of my students finding correct answers in this way. Given the tight-knit nature of my student cohorts, I feel that if one student knew how to do this then all would soon know. The queries I received from students having difficulties getting thie correct answers indicated that they were unaware of the debuggers capabilities.

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- Qwizard will be written in HTML, CSS and JavaScript and will use Electron to convert it into a desktop application.

The Elevator Pitch!