Rubric Design for Separating the Roles of Open-Ended Assessments

Leanne Doughty*, Anna Turnbull†, Vashti Sawtelle‡, and Marcos D. Caballero**

1Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824
2Lyman Briggs College, Michigan State University, East Lansing, MI 48824
*CREATE for STEM Institute, Michigan State University, East Lansing, MI 48824

Background and Motivation

Assessments
- Identify student difficulties
- Measure student performance
- Central to course transformations

Colorado Classical Mechanics/ Math Methods Inventory (CMI)
- Designed to inform and assess a Classical Mechanics/Math Methods course transformation at University of Colorado
- Consists of open-ended questions that investigate student skills.
- Administered at three universities (N=123)

Open-Ended Questions
- Written work shows variety of approaches
- Errors indicate specific student difficulties

Our solution
- A difficulties rubric for trained users
- A grading rubric for untrained users

Sample CCMI Question
A particle (mass, m) is confined to move on the x-axis between two objects that attract it. The particle does not leave the region between the two attractive objects.
- One object is located at x=0 and the attractive force between the object and the particle is proportional to the square of the distance between them with proportionality constant c.
- The second object is located at x=10 and the attractive force between the object and the particle is inversely proportional to the distance between them with proportionality constant c.
Write down a differential equation that describes the position of the particle as a function of time, x(t).

Difficulties Rubric
- Presents claims about student difficulties based on evidence from their written work
- Claims are categorized by steps from a task analysis and categories are not mutually exclusive

Grading Rubric
- Uses a mastery approach where only the final answer is considered and points are taken away for errors in that answer.
- Describes how points are deducted for different errors and gives examples where necessary.
- Illustrative errors are those commonly seen in student answers.
- Graders can score based on obvious features.

Inter-rater reliability
- Random sample of 25 student answers
- Three untrained graders
- Scores agreed for 24 of the 25 answers
- Cohen’s kappa of 0.95, ‘almost perfect’ agreement

Future Work
- Refine and verify the claims made in the difficulties rubric through the use of targeted student interviews
- Investigate the outcomes of applying both rubrics to student work

Distribution of student scores (N=123)
- 24% of students gave no answer
- Students who translate the force description into a force expression but do not write a differential equation get a score of zero (~15%)

References

Acknowledgements
The authors would like to thank the members of PERL@MSU and PERC@UC for their useful comments and suggestions at various stages of this work. We would especially like to thank Steven Pollock for his valuable feedback.