The Diagnoser Project: Using Online Tools to Support Assessment for Learning

Eric Magi, Spokane School District
Stamatis Vokos, Seattle Pacific University
Pamela Kraus, James E. Minstrell, Ruth Anderson, and
Jim Minstrell, FACET Innovations

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Cognitive Validity

Facet Cluster

00 The student understands that all forces arise out of an interaction between two objects and that these forces are equal in magnitude and opposite in direction.

01 All forces arise out of an interaction between two objects.

02 The force pairs are equal in magnitude.

03 The force pairs are opposite in direction.

40 The student identifies equal force pairs, but indicates that both forces act on the same object. (For the example of a book at rest on a table, the gravitational force down on the book and the normal force up by the table on the book are identified as an action-reaction pair.)

50 The student uses the effects of a force as an indication of the relative magnitudes of the forces in an interaction.

51 More damage indicates one of the interacting objects exerted a larger force.

52 If an object is at rest, the interaction forces must be balanced.

53 If an object moves, the interaction forces must be unbalanced.

54 If an object accelerates, the interaction forces must be unbalanced.

60 The student indicates that the forces in a force pair do not have equal magnitude because the objects are dissimilar in some property (e.g., bigger, stronger, faster).

61 The 'stronger' object exerts a greater force.

62 The moving object or a faster moving object exerts a greater force.

63 The more active or energetic object exerts more force.

64 The bigger or heavier object exerts more force.

90 The student believes that inanimate/passive objects cannot exert a force.
Instructional Validity

Integrating the Diagnoser Tools with Your Curriculum

Planning Your Curriculum Unit/Cycle

Learning Goals → Engagement → Developing Ideas → Applying Ideas → Reflection

Diagnoser Instructional tools
> click on each to explore <
Jennifer and Katie stand and lean on each other. Jennifer weighs 150 pounds and Katie weighs 120 pounds. Which one pushes harder on the other?

- Katie must push harder because she weighs less and has to compensate for having less weight.
- Jennifer and Katie push on each other with the same size force because force pairs are always equal.
- Jennifer pushes harder because she weighs more.
- It depends on whether Jennifer or Katie moves.
Facets for each Choice

Question 1.
Jennifer and Katie stand and lean on each other. Jennifer weighs 150 pounds and Katie weighs 120 pounds. Which one pushes harder on the other?

(a) Katie must push harder because she weighs less and has to compensate for having less weight. [63]
(b) Jennifer and Katie push on each other with the same size force because force pairs are always equal. [02]
(c) Jennifer pushes harder because she weighs more. [64]
(d) It depends on whether Jennifer or Katie moves. [50]
## Toward Inferential Validity

### Summary Statistics for Forces as Interactions Set 1

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*Explanation for Facets and notes, Text of questions, Prescriptive activities*
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A form of Criterion Validity

- If Diagnoser is assigned to students, will students do better on outside measures of achievement?
The more question sets a grade 8 or grade 10 teacher assigned and students used, the better the student test scores.
Users outperform non-users

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Consequential Validity

- For Whom?
- According to who’s theories of
  - Assessment
  - Learning
  - teaching

What will it do for my teaching?

Will it give me information on whether they “got it”?
Perspective: Teaching focus

- **Gather**
  How much have my students learned of what I have taught?

- **Evaluate**
  How many have “got it”? Did enough of them get it so I can move on or do I need to slow down?

- **React**
  Do I re-teach to the entire class or assign a review to a few? How can I teach more effectively next time?

Perspective: Learning focus

- **Collect**
  What and how are my students learning in relation to the learning goal?

- **Interpret**
  What are the strengths & problematic aspects of their thinking? What do they need next to deepen their learning?

- **Act**
  What learning experience, or feedback will address the needs I just identified?
Pre-1985: Action research
- Shifted instruction to focus on paying close attention to what students were really understanding and in the process deepened his own understanding.
- Initially, Minstrell tried to correct the misconceptions he was seeing, “Don’t think that way”
- Recognized that this approach was not as effective as he would like, he began to develop cycles of assessment and instruction.

1987: The term *facets* was introduced to describe the sorts of ideas and thinking students use in the classroom
- Influenced by diSessa’s “Knowledge in Pieces” perspective
- Constructivist theory of learning
- Not all problematic student ideas are “misconceptions”
- Initially built around big ideas in HS physics
- Lists of facet clusters were created to connect the research on student ideas to Minstrell’s classroom practice for each unit
History of Diagnoser: Part 2

1988: The first Diagnoser computer program was built (E. Hunt, B. Levidow, D. Aiken, C. Traynor and J. Minstrell)
- Programmed in HyperCard for the Mac
- Students answered groups of questions
- Scored based on correct/incorrect and consistent/inconsistent.
- Last version built in 1994

1989: Physics pedagogy program
- Desire to replicate success beyond Minstrell’s classroom
- Use facets of student thinking as the framework to develop instructional resources and assessment practices
Results from 12 HSs

- $X$ Before adopting perspective
- $X + 15\%$ Next cohort of students
  - Teacher using perspective for one year
- $X + 19\%$ Next cohort of students
  - Teacher using perspective for a second year

$X$ represents mean for first cohort of students
History of Diagnoser: Part 3

1998: Began identifying facets in middle-level physical science

2001: First web-based version of the Diagnoser Project tools
- U. of Washington and WA state collaboration
- Aligned with WA science standards for middle and high school in force, motion, and waves topics
- Used by teachers from 2001-2004

2004: Most recent web version of the Diagnoser Project tools
- Content aligned with National Science Education Standards (NRC, 1997) and Benchmarks for Science Literacy (AAAS, 1993)
- Technology built by FACET Innovations in collaboration with UCLA-CRESST