Using Learning Progressions to Map High School Student Understandings of Molecular Genetics

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Using Learning Progressions to Map High School Student Understandings of Molecular Genetics

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What Do We Already Know?
- Concepts in molecular genetics are difficult to teach and learn (e.g., Stewart, Carter, & Fixammon, 2000; Stewart & Van Kirk, 1990; Venville & Treagust, 1998).
- Two learning progressions (LPs) have been produced (Duncan, Rogal & Yerdan, 2008; Wigfield, Chinnix, & Yerdan, 2008) in molecular genetics.
- Both LPs are theoretical as neither have been fully empirically tested.
- Mobile school (portions of the Duncan et al. (2009) progression tested in one context (Fischeliskam, Duncan & Shek, 2011).
- Group refined constructs B & C with this data (Shek, & Duncan, 2013).
- Empirical studies of the progression led to revisions and refinement of progression based on classroom data obtained.
- Makes LPs more practical and useful for teachers and researchers to support students.

What Did We Do?
- Theoretical framework for study is based on:
  - Duncan et al., 2009 (molecular genetics LP).
  - Stewart et al., 2009 (molecular genetics literacy being ability to understand and integrate three inter-related conceptual models).

Three different 10th grade biology courses in 2011-2012 school year:
- Suburban public school (A, B, C) with a STCOS focus (Content A)
- Two classrooms in urban public school with arts focus (Contents B & C).

Three molecular genetics intervention units created:
- Different from normal classroom instruction.
  - Teacher A taught three units in their entirety.
  - Teacher B taught the first unit and shortened version of second unit.
  - Teacher C did not teach any of the units.

- Pre/post written assessments (n = 121) were administered to all the students.
- Interviews conducted (n = 54) with students in contexts A & B.

Student ideas mapped to the Duncan et al. (2009) LP.
- Coding scheme based on the LP empirically developed for each of the eight target ideas.
- Data shown in this poster is preliminary, reliability has not yet been established.

RQ1: Where do students align with the Duncan et al. (2009) LP?
RQ2: How can the Duncan et al. (2009) LP be revised and refined?

What do students think genes do?
- Revised levels 1 & 2 can be combined.
- Few students thought that genes were non-informational in nature (proposed level 1).
- Passive versus active distinction removed, very fine distinction between two.

New level added to progression:
- Students were told that proteins, made of amino acids.
- Several students understood genes code only for proteins and that the proteins are made of amino acids.
- Questions did not probe how descriptions in DNA are translated into a sequence of amino acids which make up the protein (proposed level 8).

Dramatic shift to higher levels after instruction:
- Seen especially in context A interviews (highlighted in red box).

How are alleles related to traits?
New levels added to progression:
- Data supports the three original levels of the construct.
- Also supports addition of these new levels.

Molecular model introduced to genetic model at this level:
- Students have firm grasp of the molecular model (Construct B) and genetic model (Construct F), proposed level 3 after instruction.
- Students did not differentiate integrating the two models.
- “Stuck” at level 3 because unable to add in molecular model.

Dramatic shift to higher levels after instruction:
- Seen especially in context A interviews (highlighted in red box).

How different are humans and fruit flies?

Ideas about genes changing and evolution moved to Construct H.
- Modified to include genetic changes through recombination, mutations, environmental factors.
- Or creation of new construct for molecular evolution ideas.

Ideas from original levels combined:
- Ideas about the genetic similarities/differences between individuals found in all levels of original LP.
- Ideas combined into one level (proposed level 3).

New lower and higher levels added to progression:
- Data supports addition of four levels.
- Lower levels added for more basic ideas.
- More students held these ideas (proposed levels 0-2).
- Higher level added to the progression.
- Ideas discussed in the original LP, not included in the progression.
- Many students able to achieve proposed level 4; some students may be able to achieve this higher level.