

## Resources for the Lawson Classroom Test of Scientific Reasoning (CTSR).

\* The key is included with the test.

\* For the password, please e-mail [jane.jackson@asu.edu](mailto:jane.jackson@asu.edu), and include a URL or other evidence that you are a TEACHER – not a student. The password to open the free-response versions is the same as for the multiple-choice version.

(Updated August, 2018 by Jane Jackson. Copy/paste the URLs into your browser.)

1) **Two FREE-RESPONSE versions** of Anton (Tony) Lawson's Classroom Test of Scientific Reasoning (CTSR) are on the ASU modeling legacy website, on the webpage called <weblinks for modelers>: [modeling.asu.edu/modeling/weblinks.html](http://modeling.asu.edu/modeling/weblinks.html)

They are in the section called <Assessment.>

**A free-response version makes grading more cumbersome, but you get deeper insights into your students' thinking than if you use the multiple-choice version.**

The two versions are:

a) 12 items, includes combinatorial reasoning. This version is in Tony Lawson's 1995 textbook: SCIENCE TEACHING AND DEVELOPMENT OF THINKING (Appendix F). It includes a 1-page guide to scoring it.

b) 10 items, includes combinatorial reasoning. This version was used in Modeling Instruction as early as 1993, and I think that Malcolm Wells used it in the 1980s, for he took Anton "Tony" Lawson's "methods of science teaching" courses at ASU. (Tony Lawson's test has evolved since he developed it in the 1970's.)

2) HOW TO GET the **Lawson CTSR (multiple choice version)** and answer key:

A) Download it at the ASU modeling legacy website: [modeling.asu.edu](http://modeling.asu.edu) .

Click on <Modeling Instruction in high school sciences>

Then scroll down to <weblinks for modelers> and click.

Direct link: [modeling.asu.edu/modeling/weblinks.html](http://modeling.asu.edu/modeling/weblinks.html) . It is in the section called <Assessment>.

B) Or ask for it at John Demings' website. John Deming, formerly a chemistry professor at Winona State University, and his colleague Jacki O'Donnell, a high school chemistry teacher in Missouri, have an important website, called FRAMEWORKS FOR INQUIRY.

[sites.google.com/site/wsuinquiryinstruction/home](http://sites.google.com/site/wsuinquiryinstruction/home)

They use the Lawson CLASSROOM TEST OF SCIENTIFIC REASONING (CTSR, pre- and post-test). Teachers can request the CTSR at their website.

Direct link: [sites.google.com/site/wsuinquiryinstruction/home/request-ctsr](http://sites.google.com/site/wsuinquiryinstruction/home/request-ctsr)

or [goo.gl/xuWAK](http://goo.gl/xuWAK)

C) Or request it at [www.physport.org/assessments](http://www.physport.org/assessments) . (You need an account. Different password.)

### 3) RECORDING AND SCORING:

a) Free-response versions: Anton Lawson discusses scientific thinking skills in his 1995 textbook: SCIENCE TEACHING AND DEVELOPMENT OF THINKING. (Also 2002.) See pages 444 & 445: scoring the CTSR (1995 free-response version)

I quote: *"To be considered correct, the student should select the correct answer and provide a reasonable explanation. Total scores of 0-4 indicate empirical-inductive thinking. Scores of 5-8 are transitional, and scores of 9-12 indicate use of hypothetical-deductive level thinking."*

b) **Scoring the multiple-choice version:** Maximum score is 13 points (w/ paired scoring). **Questions #1 to 22 are paired, for a total of 11 points. Questions #23 and #24 each stand alone; each is worth 1 point. Total = 13 points.**

(Each pair of questions is worth 1 point; both must be correct. This is called 2-tier scoring, or paired scoring. A 2018 reference that gives evidence for two-tier scoring of the Lawson CTSR being better than single-tier scoring is this:

Xiao, Y., Han, J., Koenig, K., Xiong, J., and Bao, L. (2018). Multilevel Rasch Modeling of Two-Tier Multiple Choice Test: A Case Study Using Lawson's Classroom Test of Scientific Reasoning. Physical Review Physics Education Research 14, 020104. FREE pdf; search for it.)

### 2 EASY WAYS TO RECORD YOUR SCORES (multiple choice version):

A) Physics teachers can record scores, analyze them, and correlate them with the Force Concept Inventory (FCI), by downloading an excellent zipped spreadsheet called assessss.zip at the AMTA website: modelinginstruction.org , under the MODELING WORKS! tab. Prof. James Vesenska (at the University of New England) developed it. The AMTA must charge \$10 for it; pay by Paypal or p-card.

B) Joe Morin, of Minnesota (retired by 2018), had his students take the CTSR using paper copies. They enter their responses online, in google forms. Joe posted on Aug. 13, 2015 to the physics modeling listserv:

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*I use google forms for students to enter their responses on a computer, and then I transfer the google spreadsheet to Excel to do the analysis. They click on a link to the google form and enter their responses there.*

*I use the 13-point system where the grouped questions are counted together, and the spreadsheet gives me the stage (according to the CSTR) of cognitive development of each of my students, and a histogram of all of my students. This is very useful to me in giving one-on-one help to individual students, and in answering questions in class.*

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The URL of the file is [bit.ly/CTSRpretest](https://bit.ly/CTSRpretest)

Go to the right side of the screen and click the OPEN dropdown box and select Excel.

Joe wrote in August 2017 that he posted it to prettygoodphysics to provide broader access.

He wrote, "*Students who are at the stage of "late transitional" or "formal operational" typically do well in AP Physics. I have found the CTSR to be an excellent predictor of students' cognitive development stage.*"

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#### 4) **HOW TO INTERPRET SCORES ON THE CTSR:**

a) Anton Lawson discusses scientific thinking skills in his 1995 textbook: SCIENCE TEACHING AND DEVELOPMENT OF THINKING. (Also 2002.)

See chapter 2: Patterns of Thinking by Scientists and by Adolescents.

b) Download **Curriculum Analysis Taxonomies (CAT)**, by Shayer & Adey, at the ASU modeling legacy website, at <weblinks for modelers> , in the section: <Research Results for K-14 teachers>. (7 pages, 15 thinking skills, Piagetian).  
Direct link: [modeling.asu.edu/modeling/weblinks.html](http://modeling.asu.edu/modeling/weblinks.html)

It is a rubric of scientific thinking skills and levels; it describes conservation, proportional reasoning, control of variables, probabilistic reasoning, correlational reasoning, etc. for 4 levels of thinking: early concrete, late concrete, early formal, and late formal. Michael Shayer, Philip Adey, and Anton 'Tony' Lawson collaborated on CAT.

c) Download an excerpt from a publication by Anton 'Tony' Lawson: Kinds of Concepts (descriptive, hypothetical, theoretical), at the ASU modeling legacy website, same webpage. (It is also on the <Resources for Modelers> webpage, [modeling.asu.edu/Projects-Resources.html](http://modeling.asu.edu/Projects-Resources.html) Scroll to the bottom of that webpage.)

#### 5) **WHAT TO EXPECT: REASONING LEVELS and GAINS:**

John Deming et. al published in THE SCIENCE EDUCATOR (winter 2012, p.12): "... we assigned students to reasoning levels that correspond to Piagetian thinking stages (i.e., concrete = 0-4 and formal = 11-13), instead of using Lawson's hypothesis-testing levels (Lawson, 2000). We also included two additional categories, early transitional (5-7) and late transitional (8-10), to more accurately reflect students' progression from concrete to formal thinking. These assignments were proposed to Lawson, who acknowledged that they were acceptable and "seem to work in terms of results matching theoretical predictions" (A.E. Lawson, personal communication, September 21, 2009). "

In Anton "Tony" Lawson's BIO100 course for 514 non-science majors at ASU, we estimate the pretest mean to be ~6.8 and post-test to be ~9.7, for a gain of about 3 points. This is huge! (Ref. Lawson, A.E. (2001). Promoting Creative and Critical Thinking Skills in College Biology. Bioscene 27(1) March. Pages 13-24. Download at [modeling.asu.edu/modeling/weblinks.html](http://modeling.asu.edu/modeling/weblinks.html) . ASU MNS degree candidate Scott Gompert did the analysis.)

Prof. Nathan Moore posted to the AMTA & physics modeling listservs in August, 2013: *"Anecdotally, when I grade the CTSR out of 13 points (w/ paired scoring), a 1-semester gain, post-pre, of >1.0 in a college class (N~30) seems typical for a "reformed pedagogy" science content class. Gains of >1.5 in a semester seem to be about as high as I see consistently. Looking at gains without knowing the pre-test average can be tricky though. Graded out of 13, the CTSR maps to Piagetian categories: 0-4, concrete reasoners; 5-7 early transitional; 8-10 late transitional; 11-13, formal. A gain of 1.5 in a class with a pretest score of 5.5 isn't the same as a gain of 1.5 when the pretest score is 7."*

Modelers Anita Schuchardt and Kathy Malone had large CTSR gains in their 9th grade physics course that used Modeling Instruction. Download their paper from Tim Burgess' website, which has many research studies of 9th grade physics. Link to it at <weblinks for modelers> in the section <Modelers' blogs>.

Mirko Marusic and Josip Slisko found a gain of almost 2 points in high school physics using experimentation and discussion (e.g., Observe–Explain–Predict–Test, as in PUM, ISLE, and Modeling Instruction) after 12 weekly 45-minute classes on force, pressure, and heat, supplemental to the obligatory physics syllabus in Croatia. Read my summary at [modeling.asu.edu/Projects-Resources.html](http://modeling.asu.edu/Projects-Resources.html) . Scroll to the bottom.

#### **6) NATIONAL NORMS: WHERE TO SEE STUDENT CTSR SCORES & GAINS:**

John Demings' website has scores (national norms for grades 7 to 12) at [sites.google.com/site/wsuinquiryinstruction/home/thinking-skills-national-norms](http://sites.google.com/site/wsuinquiryinstruction/home/thinking-skills-national-norms) and you can see them in in Jacqueline O'Donnell's Master's degree thesis, which you can download at [modeling.asu.edu/modeling/weblinks.html](http://modeling.asu.edu/modeling/weblinks.html) in the <assessment> section. Insightful!

#### **7) HOW YOU CAN SUBMIT YOUR STUDENTS' SCORES (multiple choice version):**

Teachers can submit classroom data (and be given a comparison with national norms) at [sites.google.com/site/wsuinquiryinstruction/home/ctsr-data-entry-form](http://sites.google.com/site/wsuinquiryinstruction/home/ctsr-data-entry-form) or [goo.gl/xzKBd](http://goo.gl/xzKBd)

The cost was \$1.00 per student (in 2014).

A FINAL NOTE: A teacher wrote me, *"I am trying to get most of my school on board with CTSR, and these write-ups (above) will make my case a lot easier."*