**An introductory type paragraph:**

Educational standards in the United States have increased considerably in accordance with the Common Core standards and Next-Gen science standards (Achieve, 2013; Council of Chief State School Officers, 2010). These standards call for a focus on comprehending and evaluating science models, theories, explanations, and evidence, and learning from multiple documents and multiple representation formats. However, middle and high school students and even many undergraduates have difficulty learning from multiple documents in science or history (Britt, & Aglinskas, 2002; Millis, Morgan, & Graesser, 1990; Wiley, Goldman, Graesser, Sanchez, Ash, & Hemmerich, 2009). As part of a much larger project (cite READI), we are examining students’ comprehension of scientific explanations (e.g., “explain how and why coral bleaching rates vary at different times”) from multiple documents of a variety of types (e.g., descriptive texts, images, graphs and maps) as measured primarily from an essay written with the documents available. A complete and coherent explanation requires integration of information from the entire set of documents to form a causal model of the phenomena (see Figure 1 for a coral bleaching causal model).

This causal model is a coherent series of claims connecting initiating factors (e.g., increased trade winds, warmer waters in east, increased salinity) to the to-be-explained outcome (TBEO) (e.g., coral bleaching).

**Paragraph about human scoring**

The essays were first scored for number of core concept mentioned (e.g., increased trade winds”, “rain storms”). The next step was to identify causal chains where students explicitly link these factors to the TBEO with either a rhetorical connector or causal verbs. The following student example would receive credit for mentioning 4 concepts connected into a causal chain with an initiating cause (increased water temps), 2 intervening factors (e.g., decreased CO2, threatened balance) all connected to the to-be-explained outcome.

“It happens at different rates and times.

Because when the water temperature increases the carbon dioxide in the water decreases and very little carbon dioxide and it ruins the balance that corals need to be healthy.” (S3252)

Or can show an entire student essay. This one has 6 concepts and 3 distinct causal chains, one of which has 2 intervening factors.

Table 1. Scoring of a student essay for concept codes and causal chains.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Student sentence** | | **Concepts codes scoring** |
| 1. | Coral bleaching happens when the coral has no algae or sugar. | | Vague - 50 |
| 2. | Then it becomes bleached white. | | 50 |
| 3. | This can cause death. | |  |
| 4. | It can spread across the coral reef and destroy the coral reef. | |  |
| 5. | It happens at different rates and times. | | 50 |
| 6. | **Because** when the water temperature increases the carbon dioxide in the water decreases and very little carbon dioxide and it ruins the balance that corals need to be healthy. | | 3 -> 4 -> 14 -> 50 |
| 7. | Then when the coral runs out of it algae and starts to bleach and dies slowly it does not get it's nutrients and bleaches. | | 7 -> 50; 5b -> 50 |
| 8. | The rates change because (sic) at different times **because** the water temperature changes and the coral can't produce food or things that the need healthy and alive. | | V3 -> 50 |
| 9. | **Also** the wind affects the water and food change since the coral is sensitive on temperatures and can't produce any food. | | Vague 1 -> Vague 3, Vague 4 |
| 10. | So that's it that's my answer. | |  |
| 11. | Hopefully that answers your question. | |  |
|  | **Causal chain scoring:** | 1. 7 – 50  2. 5b – 50  3. 3 - 4 - 14 - 50 | |

**Paragraph about 4 categories**

In prior work, we have used tools to automatically identify core concepts (SCIP, 2013 and peter/goldman papers) and, from human scoring of core concepts, automatically identify causal chains (ITS, 2014). As next step, we created four categories of essay responses that based on the criteria for an explanation (e.g., accuracy, completeness, coherence). When reading, especially multiple documents, readers’ goals influence what is deemed relevant which, in turn, influences how information is processed (McCruden & Schraw, 2007; Rouet & Britt, 2011; van den Broek, Rapp, & Kendeou, 2005). We selected categories that could point to feedback that would that could be used to help students refine the goals for the task.

The 4 type of response categories were (1) No core content, (2) No causal chains, (3) Causal chain with no intervening factors, (4) Chain with intervening. The *No core content* essays did not have any core concepts other than the To-be-explained-outcome that was given. Students who receive no credit for core concepts generally selected statements that were supporting but not part of the explanation or were too vague (e.g., see sentence 9 in Table 1). Feedback for these students could encourage them to begin to identify elements of the explanation and to make their statement of the concept more explicit and complete. For example, merely saying that “wind affects the water” does not help the reader distinguish wind conditions that would lead to bleaching from those that would lead to healthy coral. Students may not understand the importance of attending to directional modifiers. The *No causal chains* essays selecting at least one important element of the causal model but did not explicitly connect this information to the TBEO. These students are selecting some accurate content but could be instructed to attend how the factors connect to the TBEO. The final two types of essays actually have some degree of structure that is required of the inquiry question. The difference is whether there is some success in connecting factors. Students writing *Causal chain with no intervening factors* could be encouraged to examine whether factors across documents could be connected as intermediate causes.

Here are the refs (except van den Broek, P., Rapp, D. N., & Kendeou   
which I would delete). Patty should read over for grammar at the end. I can read also  
thanks  
--britt  
  
Achieve, Inc. (2013). Next Generation Science Standards. Achieve, Inc.  
  
Britt, M.A. & Aglinskas, C. (2002). Improving student's ability to   
use source information. Cognition and Instruction, 20, 485-522. doi:   
<[http://dx.doi.org/10.1207/S1532690XCI2004\_2](http://dx.doi.org/10.1207/S1532690XCI2004_2" \t "_blank)>[http://dx.doi.org/10.1207/S1532690XCI2004\_2](http://dx.doi.org/10.1207/S1532690XCI2004_2" \t "_blank)  
  
Council of Chief State School Officers. (2010). The common core   
standards for English language arts and literacy in history/social   
studies and science and technical subjects. Washington, DC: National   
Governors Association for Best Practices. Retrieved from   
<[http://www.corestandards.org](http://www.corestandards.org/" \t "_blank)>[http://www.corestandards.org](http://www.corestandards.org/" \t "_blank)  
  
McCrudden, M.T., & Schraw, G. (2007). Relevance and goal-focusing in   
text processing. Educational Psychology Review, 19, 113-139. doi:   
<[http://dx.doi.org/10.1007/s10648-006-9010-7](http://dx.doi.org/10.1007/s10648-006-9010-7" \t "_blank)>[http://dx.doi.org/10.1007/s10648-006-9010-7](http://dx.doi.org/10.1007/s10648-006-9010-7" \t "_blank)  
  
Millis, K.K., Morgan, D., & Graesser, A.C. (1990). The influence of   
knowledge-based inferences on the reading time of expository text.   
Psychology of Learning and Motivation, 25, 197-212. doi:   
<[http://dx.doi.org/10.1016/S0079-7421](http://dx.doi.org/10.1016/S0079-7421" \t "_blank)(08)60256-X>[http://dx.doi.org/10.1016/S0079-7421](http://dx.doi.org/10.1016/S0079-7421" \t "_blank)(08)60256-X  
  
Rouet, J-F., & Britt, M.A. (2011). Relevance processes in multiple   
document comprehension. In M.T. McCrudden, J.P. Magliano, & G. Schraw   
(Eds.), Relevance Instructions and Goal-focusing in Text Learning (pp   
19 - 52 ). Greenwich, CT: Information Age Publishing.  
  
Wiley, J., Goldman, S., Graesser, A., Sanchez. C., Ash, I. &   
Hemmerich, J. (2009) Source evaluation, comprehension, and learning   
in internet science inquiry tasks. American Educational Research   
Journal, 46, 1060-1106. doi: [http://dx.doi.org/10.3102/0002831209333183](http://dx.doi.org/10.3102/0002831209333183" \t "_blank)