

The Impact of Text Genre on Science Learning in an Authentic Science Learning Environment

Steven McGee, The Learning Partnership
Amanda M Durik, Northern Illinois University
Jess K. Zimmerman, University of Puerto Rico

Abstract: A gap exists between research on learning and research on interest. Cognitive researchers rarely consider motivational processes, and interest researchers rarely consider cognitive process. However, it is essential to consider both since achievement and interest are in fact intertwined. In this paper we (1) discuss a theoretical model that intertwines cognitive and interest development, (2) describe how that model informed the development of educational materials, and (3) report on the results of the cognitive components of a randomized research study examining the impact of text genre on learning and interest. In our prior analyses, we examined the effects of text characteristics (i.e., narrative or expository genre) on situational interest. We found that students with higher levels of prior individual interest preferred the narrative versions of text whereas students with lower levels of prior individual interest preferred the expository versions of text. In this paper, we examine the impact of text characteristics on student learning. The results of this research showed that contrary to prior research, there was no significant difference in comprehension based on text characteristics. These results provide evidence that is possible to differentiate instruction based students' prior interest without sacrificing learning outcomes.

Significance of the Project

Numerous national reports call for increasing the number of students who pursue careers in science (Robelen, 2010), and often recommend ways to increase either student achievement in science or interest in pursuing a career in science. These recommendations often sidestep the reality that achievement and interest are in fact intertwined (Hidi, 1990), such that as student achievement in science increases, students tend to value science more. Moreover, the development of interest in science increases the selection of opportunities to further develop skills (e.g., Easton, Ponisciak, & Luppescu, 2008; Simpkins, Davis-Kean, & Eccles, 2006),.

In this paper we (1) discuss a theoretical model of interest development that intertwines learning and interest, (2) describe how that model informed the development of educational materials about the life history of a variety of consumer species in the El Yunque rainforest in Puerto Rico, and (3) report on the preliminary results of the cognitive components of a randomized research study examining the impact of those materials on students' learning and interest in science. In a prior report, we found that students' situational interest in the task depended on both students' prior interest and the characteristics of the task (Authors, 2014). In this paper, we examine the extent to which the same task characteristics impact student comprehension.

Four-Phase Model of Interest

Hidi and Renninger (2006) articulated a phase-based model of interest development describing how instructional elements interact with both interest and cognitive development. They make a distinction between *situational* interest, which is supported primarily by the environment, and *individual* interest, which is driven by internal characteristics. A key element of the model is that the educational supports for situational and individual interests are not the same. Therefore, instructional enhancements will only promote interest if they are customized to learners' existing levels of individual interest.

In the case of situational interest, it is primarily the characteristics of instructional materials that trigger interest. Situations that are rich in novelty, surprise, and incongruity as well as group work, hands-on activities, fantasy contexts, and narrative texts can trigger situational interest, which is the first, and more short-term phase of situational interest (see Schraw & Lehman, 2001 for a review). If individuals become sufficiently involved in the

material and find the content meaningful, they might experience maintained situational interest, the second phase of situational interest, and continue to engage in the material or choose to enter very similar situations in the future.

On the other hand, the phases of individual interest are supported more by factors inside the person. Individuals with individual interest have some stored knowledge of the content area and value that knowledge. However, individual interest still requires some external support, and the presence of factors such as expert models, challenging goals, and opportunities for knowledge building can promote the development of individual interest.

Given this framework and the variability between instructional supports that enhance situational versus individual interest, a critical question is how to design instructional materials to maximize learning and interest for the most number of students. In most of the prior experimental research testing the effects of situational factors on interest, pre-existing individual interest, if measured, is not tested as a moderator of the effects of situational factors (e.g., Harp & Mayer, 1997). In other words, there is an assumption that learners will respond to situational enhancements with greater interest regardless of their level of individual interest.

Consistent with the four-phase model, evidence is beginning to accumulate that the effects of situational enhancements work differently depending on individuals' pre-existing orientations towards the task (Hulleman & Harackiewicz, 2009). For example, learners with low individual interest in math, showed higher situational interest after learning the material with colorful versus plain instructional materials, whereas learners with high individual interest in math showed the opposite pattern. In addition, learners with high individual interest in math showed higher task interest after learning how a new math technique could be personally useful to their lives (Author, 2007). In other words, the effect of situational enhancements designed to raise interest in educational contexts seem to work best if the type of enhancement is paired with learners' existing level of individual interest.

Implication of Four-Phase Model of Interest on the Design of Instructional Texts

The four-phase model of interest development suggests that students' interest in any given learning task is a function of the task characteristics and students' prior individual interest in the subject of study. The genre of a reading passage is a task characteristic that has been shown to influence interest. Research in which both expository and narrative texts are included often shows that readers find narrative texts more interesting than expository texts (Dai & Wang, 2007). Several characteristics of narrative texts have been identified to increase text interest (see Schraw & Lehman, 2001), such as, rich detail about concepts and ideas (Schraw, 1997), as well as suspense and resolution (Iran-Nejad, 1987). Coherence is also a critical variable related to text interest because texts that readers perceive to be coherent are more interesting (Sadoski, Goetz, & Rodriguez, 2000).

On the other hand, narrative texts can be more challenging than expository texts in supporting reading to learn (Lee & Spratley, 2010). Expository texts tend to be organized around the structure of the subject matter to be learned, whereas narrative texts can lead readers astray from the main ideas conveyed in a text (Kintsch, 1998). Consistent with this, Harp and Mayer (1997) measured two kinds of self-reported situational interest following a reading activity in order to separate the affective and cognitive value of texts. They found that seductive details, which are common in narrative texts, increased affective interest (enjoyment) but decreased cognitive interest (utility). In our prior analyses, we also examined the effects of text characteristics (i.e., narrative or expository genre) on cognitive and affective situational interest (Authors, 2014). We found that the impact of text characteristics on situational interest also depended on initial levels of individual interest. Students with higher levels of prior individual interest preferred the narrative versions of text

whereas students with lower levels of prior individual interest preferred the expository versions of text. In this paper, we extend our prior results to examine the impact of these text characteristics on student learning.

Design of Instructional Texts

The four-phase model of interest development and the empirical research on text characteristics provide a framework for the design of instructional materials that may enhance interest and learning at different phases of interest. For students who are low in science interest, it is important to maximize the instructional enhancements that will promote interest and engagement. For students who are high in individual science interest, it is important to provide students with challenging material.

In this paper, we test the effects of two parallel forms (narrative and expository) of the background reading materials within a middle school, inquiry-based ecology curriculum unit. The narrative form describes the life history of targeted species by presenting anthropomorphic characters that show students key limiting factors through vivid imagery and rich descriptions. In contrast, the expository versions present the same key limiting factors as in the narrative form, but the information is conveyed as a general description. These are situated within the context of a rainforest in Puerto Rico.

The web-based curriculum program aims to improve middle school students' understanding of the dynamic interrelationships among organisms and the environment. The units expose students to authentic research practices at a research site in the El Yunque rainforest in Puerto Rico. El Yunque has been struck by two severe hurricanes (Hurricane Hugo in 1989 and Hurricane Georges in 1998). The research surrounding the recovery of species from these disturbances provides a rich example of basic ecosystem processes at work.

The program engages students in the same problems that researchers in El Yunque are investigating. The program consists of four modules that support the overarching goal of investigating what will happen to the rainforest if severe hurricanes end up striking the rainforest more frequently, as suggested by climate models. In the program, students learn about the historical patterns of hurricane frequency and damage in El Yunque, investigate what happens to the producers and consumers in El Yunque after a hurricane, and explore the impact of a hurricane on an entire food chain.

The background readings in this study come from the module on consumers. Prior to engaging in modeling activities, students are presented with background readings about the life history of each species. The program introduces students to six consumer species that are representative of the types of hurricane responses researchers have found in El Yunque. There are two decomposers, two primary consumers, and two secondary consumers. As part of the investigation cycle, students read about the life history of their assigned consumer, make a prediction about the population dynamics after hurricane Hugo, and explore a model of population dynamics to explain what happened to their species after hurricane Hugo.

When investigating population dynamics after a disturbance, scientists in El Yunque typically consider changes to five primary limiting factors for a given species: access to prey, avoidance of predators, direct mortality from the hurricane, and suitability to changes in environmental conditions, in particular drought conditions and the influx of forest debris from the hurricane. Each species has five background readings focused on providing the life history of each limiting factor. During the modeling activities, students manipulate parameters related to these limiting factors and examine the impact on population dynamics.

Parallel Readings

We developed background readings (narrative or expository) for each of the five limiting factors for each of the six species. The narrative and expository versions were designed to be

parallel in reading complexity, word length, and idea units. Details on how we achieved this parallelism has been reported elsewhere (Authors, 2014). Each version was developed from a common outline of the main idea units related to each limiting factor.

Method

The study was conducted during the 2012-13 school year in 20 seventh and eighth grade classrooms from 7 different middle schools in the Midwest. In five of the schools, greater than 90% of the students were eligible for free or reduced lunch. One school was an urban Catholic elementary school with a 20% poverty rate, and the other was a suburban junior high school with 0% of the students eligible for free or reduced lunch. A total of 488 students participated in the intervention, although only those who gave informed consent and were present on at least one intervention day ($n = 308$) were included in analyses.

The intervention took place over five class periods. On Day 1, students completed pre-surveys and on Day 5 students completed post-surveys. During the middle three days of the intervention, students studied three of the six species—one species on each day (randomly assigned at the classroom level to ensure generalizability across species). Students within classrooms were randomly assigned to read either narrative or expository versions of the readings. In order to ensure that levels of prior individual knowledge and interest in ecology were evenly distributed across conditions, we did blocked random assignment on students' prior knowledge and individual interest.

The delivery of the educational materials was conducted through a web-based system. Once a student was assigned to a treatment condition, an account was created for the student and associated with the assigned experimental condition. The students were told that they had 20 minutes to read the articles associated with the species. Once the students completed the reading and note-taking task, they completed a comprehension task by summarizing the main factors that affect the survival of the species. The system then presented students with a prediction activity, which was an application of their reading comprehension. The students repeated the same protocol on Days 3 and 4 for the second and third species they were assigned respectively.

In order to assess the impact of cognitive demand on learning, we also varied the number of readings available to students across the days. Each of the six species had two primary limiting factors. In the first of four conditions, the students only had access to the articles associated with these two influential limiting factors (all easy condition). In the second condition, the students had access to the all of the readings associated with all five limiting factors (all difficult). In the increasing condition, students started with access to two readings, then three, and then all five. In the decreasing condition, the students started with access to all five, then three, and then two. Regardless of condition, students always had access to the two readings about the two main limiting factors. In this paper, we will examine the impact of text genre and sequencing condition on students' comprehension of the two most important limiting factors for each species.

Measures

The pre- and post-surveys contain measures of individual interest and general ecology knowledge. The pre-survey also measures students' reading fluency and collects demographic information. Since this study focuses on student learning, the ecology pretest and comprehension measures are described below.

General Ecology Knowledge. A measure of general ecology knowledge was developed during the summative evaluation of the program (Author, 2006). This assessment was comprised of publicly released state test questions in ecology that would mimic the kinds of performance expected of students on state exams. The assessment contained 14 multiple-choice questions and one constructed response task. The assessment was scaled using Rasch

modeling. Using latent variable modeling, the reliability was determined to be 0.87.

Limiting Factors Idea Units. We scored students' comprehension summary of the main factors that affect the survival of the species. The outline of idea units used to develop the background readings was converted to a scoring rubric. Two independent scorers coded for the presence or absence of idea units related to each main limiting factor for each species. Students received a score of 1 if they mentioned an idea unit related to one of the two main limiting factors and a score of 2 if they mentioned an idea unit related to each of the two main limiting factors. Coding discrepancies were identified and discussed with a third rater to reach consensus. The overall interrater reliability of the two independent ratings prior to discussion was 92% agreement and 0.82 using Kohen's Kappa, which adjusts for chance agreement.

Results

In the final paper, we will present the full analyses of the impact of prior knowledge, sequence and genre on students' summarization of the main limiting factors and post ecology knowledge. Here, we present key findings. Students' prior knowledge of ecology was a significant predictor of students' summarization of each of the 3 days of the intervention. The genre of the background readings was not a significant predictor of students' summarization on any of the three days. The assigned sequence was not a significant predictor on the first two days of the intervention. On the third day, students in the two conditions that presented just two readings had significantly higher summarization scores than the students in the two conditions that presented all five readings. After controlling for prior knowledge in ecology, the students' quality of summarization predicted students' post ecology knowledge.

Conclusion

Based on our prior analyses, narrative texts increased situational interest in the readings for students with high prior interest in ecology (Authors, 2014). Yet, contrary to prior research indicating that narrative texts could lead to decreased learning, we found no significant difference in performance based on the genre of text. However, the presentation of ancillary information decreased students' ability to summarize the main limiting factors and did not increase interest. These results provide evidence that it is possible to differentiate instruction based on students' prior interest without sacrificing learning outcomes.

References

- Dai, D. Y., & Wang, X. (2007). The role of need for cognition and reader beliefs in text comprehension and interest development. *Contemporary Educational Psychology*, 32(3), 332-347.
- Easton, J., Ponisciak, S., & Luppescu, S. (2008). *From High School to the Future: The Pathway to 20*. Chicago: Consortium on Chicago School Research at the University of Chicago. Retrieved March 23, 2011 from http://ccsr.uchicago.edu/content/publications.php?pub_id=126.
- Harp, S. F., & Mayer, R. E. (1997). The role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology*, 89, 92-102.
- Hidi, S. (1990). Interest and Its Contribution as a Mental Resource for Learning. *Review of Educational Research*, 60(4), 549-571.
- Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41(2), 111-127.
- Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, 326, 1410-1412.

- Iran-Nejad, A. (1987). Cognitive and Affective Causes of Interest and Liking. *Journal of Educational Psychology*, 79(2), 120-130.
- Kintsch, W. (1998). *Comprehension: A Paradigm for Cognition*. New York: Cambridge University Press.
- Lee, C. D., & Spratley, A. (2010). *Reading in the Disciplines: The Challenges of Adolescent Literacy*. New York: Carnegie Corporation. Retrieved March 18, 2011 from http://carnegie.org/fileadmin/Media/Publications/PDF/tta_Lee.pdf.
- Robelen, E. (2010, September 14). Advisory Panel to Offer Obama Ideas for Advancing STEM Education. http://blogs.edweek.org/edweek/curriculum/2010/09/stem_ed_conference.html
- Sadoski, M., Goetz, E. T., & Rodriguez, M. (2000). Engaging tests: Effects of concreteness on comprehensibility, interest, and recall in four text types. *Journal of Educational Psychology*, 92, 85-95.
- Schraw, G. (1997). Situational interest in literary text. *Contemporary Educational Psychology*, 22, 436-456.
- Schraw, G., & Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review*, 13, 23-52.
- Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. L. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, 42, 70-83.