Interest, Learning, and the Psychological Processes That Mediate Their Relationship

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Although influences of interest on learning are well documented, mediating processes have not been clarified. The authors investigated how individual and situational interest factors contribute to topic interest and text learning. Traditional self-report measures were combined with novel interactive computerized methods of recording cognitive and affective reactions to science and popular culture texts, monitoring their development in real time. Australian and Canadian students read 4 expository texts. Both individual interest variables and specific text titles influenced topic interest. Examination of processes predictive of text learning indicated that topic interest was related to affective response, affect to persistence, and persistence to learning. Combining self-rating scales with dynamic measures of student activities provided new insight into how interest influences learning.

It has been widely noted in the literature that after decades of neglect, the concept of interest has been revived by investigators (Hidi, 1990; Krapp, 1999; Krapp, Hidi, & Renninger, 1992). Interest has a strong influence on individuals' cognitive and affective functioning (Ainley, 1998; Renninger, 2000; Renninger & Wozniak, 1985; Schiefele, 1996; Schiefele, Krapp, & Winteler, 1992). Whereas some motivational concepts such as task value (e.g., Wigfield & Eccles, 1992), self-efficacy (e.g., Bandura, 1986; Zimmerman, 1989), and achievement goals (e.g., Ames, 1992; Dweck, 1986; Dweck & Leggett, 1988; Harackiewicz & Elliot, 1993) focus on individuals' beliefs and cognitive representations, interest has been conceptualized both as an individual predisposition and as a psychological state. This psychological state is characterized by focused attention, increased cognitive and affective functioning, and persistent effort.

Within the interest literature, the relationship between interest and learning has focused on three types of interest: individual, situational, and topic. *Individual* interest is considered to be an individual's predisposition to attend to certain stimuli, events, and objects. *Situational* interest is elicited by certain aspects of the environment. These include content features such as human activity or life themes, and structural features such as the ways in which tasks are organized and presented. *Topic* interest, the level of interest triggered when a specific topic is presented, seems to have both individual and situational aspects (Ainley, Hidi, & Berndorff,

1999). How the three types of interests interact and through what processes they influence learning has not been clearly established (Rheinberg, 1998; Schiefele, 1998).

New ways of accessing the processes that link interest and learning are required. Alexander (1997) suggested that in addition to more standard quantitative and qualitative methodologies, the complexity of academic development in specific domains requires the creation of alternative techniques that can document and describe the nature of interest, shifts in interest over time, and the influence of interest on student learning. The present study investigated relationships between individual, situational, and topic interest and specific aspects of the affective and cognitive processes through which they influence learning. We examined how the interest triggered by text titles influenced affective responses, persistence, and scores on a test of text comprehension and recall. In addition to traditional self-report ratings, a novel interactive computer task was used to monitor students' reactions as they read the four texts.

First we consider some of the issues that are important for distinguishing individual, situational, and topic interest and review some of the methodological difficulties that have limited understanding of the ways interest influences learning.

Individual Interest

Individual interest has been described as a relatively enduring predisposition to attend to certain objects and events and to engage in certain activities (e.g., Krapp et al., 1992; Renninger, 1992, 2000). This behavior is associated with a psychological state of positive affect and persistence and tends to result in increased learning. For example, the reader with an individual interest in ecology and conservation seeks opportunities to engage in associated activities and while so engaged experiences enjoyment and expands his or her knowledge.

Within the broader domain of schooling, students have not just one individual interest but a network or system of individual interests, some closely related to the goals of classroom learning,

others antithetical to classroom learning. Specific patterns of individual interests and how they influence student engagement with learning have not been well researched. As well as the need to identify students' specific patterns of individual interests, it is important to determine how individual interests at different levels of generality might differentially influence student learning. Pintrich (2000) argued that achievement goals should be seen as representing goals that are between task-specific goals and general life goals. In a similar way, there are different levels of generality implicit in different conceptualizations of individual interest. Individual interests can be defined in terms of specific domains such as school subjects (e.g., literature, history, mathematics) or specific activities within popular culture (e.g., music, sports, movies). In addition to having individual interest in specific domains and activities, students may have a more general individual interest in learning. General individual interest in learning is expressed as a desire to acquire new information, to find out about new objects, events, and ideas not restricted to any narrow domain. This may involve approaching and acquiring information about something novel or it may involve seeking new information concerning something the student already knows about. As Ainley (1998) argued, general interest in learning represents a characteristic way of approaching novel, uncertain, or puzzling phenomena with the goal or purpose of understanding those phenomena. This type of interest may involve both seeking new knowledge and expanding existing knowledge. Ainley has found that general individual interest in learning was associated with a range of positive attitudes to schooling.

From another perspective, Bergin (1999) suggested that group identification based on social categories such as culture and gender can function as a set of individual interests that influence classroom behavior. Thus, culture and gender influence what is valued and practiced by specific groups. Fivush (1998) also argued that gender represents a system of valuing certain activities and behaviors and making judgments about new experiences. From these perspectives, culture and gender operate as self-schema and represent broad sets of individual interests that have developed through experience.

In addition to the interests related to culture and gender, students may bring to their learning in specific school subjects their own well-developed individual interests. Once a student has a well-developed individual interest in a specific domain, various topics from that domain may draw on that interest. For example, having an individual interest in ecology and conservation means that specific topics, such as global warming, are likely to arouse interest and school texts on this topic will be given increased attention and processed accordingly. To assess individual interest and the complex role that it may play in the arousal of topic interest, in the present study we have included various measures of individual interest at different levels of generality, such as general individual interest in learning and individual interest in specific domains.

Situational Interest

The psychological state of interest can also be generated by specific environmental stimuli and is referred to as situational interest (Hidi & Baird, 1988). Whereas the state is characterized by focused attention that is similar to the outcome of individual interest, the immediate affective reaction may include a broader range of emotions. Situational interest may also involve some negative feelings (Hidi & Harackiewicz, 2000; Iran-Nejad, 1987). Once triggered, this reaction may or may not be maintained (Hidi & Baird, 1986; Mitchell, 1993). Certain texts are sources of this interest, and high-interest text segments are associated with increased comprehension and recall (e.g., Anderson, Shirey, Wilson, & Fielding, 1987; Benton, Corkill, Sharp, Downey, & Khramtsova, 1995; Harp & Mayer, 1997; Hidi & Anderson, 1992; Schraw, Bruning, & Svoboda, 1995; Wade, Buxton, & Kelly, 1999).

Hidi (1990) distinguished two types of factors that contribute to situational interest. The first group includes formal structural characteristics such as novelty, intensity, and ambiguity, what Berlyne (1960) called "collative variability." The second group consists of content features such as human activity, intensity factors, and life themes. Investigators have argued that situational sources of interest may be particularly important for educators dealing with students who do not have preexisting individual interests in their school activities (Bergin, 1999; Folling-Albers & Hartinger, 1998; Hidi, 1990; Hidi & Berndorff, 1998; Hidi & Harackiewicz, 2000; Mitchell, 1993; Schraw & Dennison, 1994). For example, a reader who has no previous interest in ecological issues may have his or her interest aroused when confronted with a novel and personally relevant text on the topic of global warming. Furthermore, the aroused interest may be maintained if the text is well written. The present study investigated how situational interest, in the form of varied human activity themes, and individual interests combine to influence topic interest triggered by texts drawn from the areas of science and popular culture.

Topic Interest as an Outcome of Individual and Situational Factors

Topic interest refers to the interest elicited by a word or paragraph that presents the reader with a topic. This form of interest is particularly relevant for educators, because students are often given topics about which they will be expected to learn or to write. Some of the earliest references in the literature to topic interest appeared in a study by Hidi and McLaren (1990). The focus of this investigation was fourth- and fifth-grade students' interest in topics and themes taken from social science textbooks. One group of students rated their interest in studying the topics and themes, and another group of students rated their interest in writing about those topics and themes. The researchers considered the elicited interest to be situational as the ratings were reactions to the characterization of the topics, most of which were not among students' individual interests. Furthermore, the responses elicited were anticipatory, because students were making judgments about what they expected to experience when studying or writing about the topics and themes.

In subsequent investigations, Schiefele (1996, 1998) and Schiefele and Krapp (1996) have used the term *topic interest* to mean a relatively enduring evaluative orientation toward certain topics, a form of individual interest. In their studies, topic interest was assessed by asking students to rate how they felt about a given topic (feeling-related valence) and how valuable the topic was to them personally (value-related valence), with the two valence measures highly correlated. They contrasted topic interest with

text-based interest, which they defined as an emotional state aroused by specific text features, a form of situational interest. The methodology used in the current investigation allowed us to reexamine these relationships.

We propose that topic interest is not necessarily the same as either situational or individual interest. A strong existing individual interest in the content of a text will increase the likelihood that individual interest factors are contributing to topic interest. A weak or nonexistent individual interest will increase the likelihood that situational factors are paramount. Most topics, whether a three-word title or a paragraph, will have both sources contributing to the measured topic interest. As Bergin (1999) suggested, "It is important to recognize that personal or individual factors always interact with situational factors to create interest, or lack of interest. It is not useful or accurate to claim that a particular factor is purely personal or purely situational" (p. 89). A similar view has been presented by a number of other researchers. Renninger (2000) treats topic interest as having both individual and situational components, and Wade, Buxton, and Kelly (1999) have adopted a similar stance when suggesting that more research is needed to define the relationship between the constructs of situational and individual interest. In summary, given the basic interactive nature of interest, both the characteristics of the person (individual factors) and the features of the environment (situational factors) can potentially influence topic interest.

In the present study, topic interest was measured prior to presentation of the texts. That is, a number of text topics such as Body Image and X-rays were presented as titles consisting of one or a few words, and topic interest was measured as a rating of how interesting students expected each text to be. The procedures were designed to assess the different levels of topic interest created by situational factors such as the content of the separate text titles, as well as to determine the contribution of individual interest to variability in the topic interest triggered by these titles.

Methodological Issues in Examining Processes Mediating Interest and Learning

There has been general agreement in the interest research literature that heightened attention, concentration, and affect characterize the psychological state of interest (e.g., Krapp et al., 1992; Pekrun, 2000). Although interest has been shown to contribute to student learning, the path from the arousal of interest to learning is not well documented. Almost 10 years ago, Lepper and Cordova (1992) reviewed studies dealing with the relationship between interest and learning and concluded that the main paradigm involved correlating ratings of interest given by one group of subjects with measures of learning from another group. Use of this paradigm limits the possibility of exploring the critical mediating variables. More recently, Schiefele and colleagues (Rheinberg, 1998; Schiefele, 1996, 1998; Schiefele & Rheinberg, 1997) drew attention to this deficiency in the literature and argued that we know very little of the processes that mediate between interest and learning. Schiefele (1996) examined how aspects of subjective experience mediated the relation between arousal of topic interest and learning. During the reading phase of his study, high school seniors were asked a number of times to make ratings on three subjective experience dimensions: activation, affect, and concentration. Ratings were aggregated on the basis that they were highly

correlated ($>.74$). Schiefele reported that subjective experience was significantly related to topic interest but unrelated to any of the measures of cognitive processing of the texts. He concluded that quality of experience did not mediate the effects of interest on text learning, that quality of experience seems to be an "epiphenomenon of interest" (Schiefele, 1996, p. 13). We further address this interpretation in our conclusion.

One of the major difficulties facing interest researchers concerned with investigating the way interest influences learning is how to measure mediating processes. Interest researchers have generally relied on self-report questions administered either before or after a critical task. For example, Schraw, Flowerday, and Reisetter (1998) investigated the role of choice in relation to both affective and cognitive engagement with text materials. The task required college students to read one text passage, and choice was made salient through task instructions. All of the measures, such as interest and attitude toward the task, were recorded along with the measures of learning after reading the text.

The timing of questionnaires and rating scales is an important consideration when interpreting their meaning as measures of the psychological state of interest. For example, a rating of interest prior to reading a text is an expectancy measure. It represents the participants' estimation of their likely psychological state. A rating administered after the event requires participants to reflect back, to remember what they felt as they were reading the text. In this case, knowledge of the whole text and its outcomes may then intrude and color participants' recollections of their psychological state while reading. Even if participants are instructed to respond how they felt at some defined point, for example, when they first started reading a text, the intervening experience may influence their judgment. Thus, measurement of the psychological state of interest either before or after reading a text does not necessarily indicate what is happening during the reading process. In particular, such ratings are not sensitive to changes in interest levels that might occur during the course of reading a text.

In the present study, in addition to measuring interest prior to the reading task and subsequent learning, we also focused on behavioral measures during task performance. That is, we designed an interactive computer task that recorded in real time sequence behavioral reactions indicative of student involvement or disengagement with a text. This approach has been adopted because it provides a way of accessing affective and cognitive variables that are the consequence of arousal of topic interest. Important variables occurring before, during, and after reading have been recorded in a form that preserved their real-time occurrence (Ainley & Hidi, 2002).

The Current Investigation

The above considerations pointed to a need for a methodology that, in addition to measuring expected interest in the traditional self-report mode, would allow the monitoring of the dynamics of students' subjective experience while engaged in reading a text. To this end, the current study, in addition to rating scales, used computerized online recording of students' behavior as they interacted with a set of texts. Following participants' signaling of how interesting they expected the texts on certain topics to be (measurement of topic interest), each text was presented in a form that recorded students' choices, affective responses, and persistence

with each text. Tracking these behavioral variables enabled us to examine the set of psychological processes that may mediate between arousal of interest and learning outcomes. By having the advantage of recording behavioral decisions in real time rather than only recording reflections in response to a questionnaire before or after the fact, we were able to analyze the temporal contingencies between responses.

Our main research questions concerned identification of the contribution of individual interests to the arousal of topic interest, how situational factors (variation in text topics) affect topic interest, and the processes mediating between arousal of topic interest and learning. A two-level hierarchical model of interest processes was used to address these questions. At the primary process level, responses initiated by arousal of topic interest (response variables model) were considered. The response variables model included topic interest, affect, persistence, and test scores. At the secondary level, personal characteristics such as individual interest and gender that potentially affect what happens in each specific learning situation (personal characteristics model) were investigated. By adopting multivariate, multilevel modeling procedures (see Rowe, 2000), we were able to investigate the responses initiated by triggering topic interest independently of the effects of personal characteristics. The main advantage of this technique is that the matrix used to test the relationships between the key response variables has been adjusted to allow for the effect of associations with the personal characteristics. Hence, the first step in the analysis deals with the secondary process level, the influence of personal characteristics on topic interest and the subsequent responses. The second step in the analysis deals with the primary process level, the model of relationships between topic interest and the responses that followed. Thus the model allowed us to develop information about psychological processes on the basis of the behavioral level of student responses.

Method

Participants

Participants were 117 Australian Grade 8 students (mean age 14 years 3 months) and 104 Grade 9 Canadian students (mean age 14 years 7 months). Each sample consisted of approximately equal numbers of boys and girls. Both schools catered to children from predominantly lower middle-class and middle-class backgrounds.

Materials and Procedures

The Between the Lines (BTL; Ainley, Hidi, & Tran, 1997) computer program presented first a number of interest measures online. These measures were followed by presentation of a set of four texts. Students' responses, more specifically their choice of the order they accessed texts, how long they spent with each text, their feelings (affect) about the texts, and how many parts of each text were accessed, were all recorded automatically. After students finished reading each text, a multiple-choice test provided a measure of learning.

Interest Measures

The first two of the three measures of self-reported interest investigated in this study were given online prior to the reading task, and the third was given after the reading task (see pencil-and-paper measures).

Individual interest in five specific domains. Following Renninger's (1992) definition that individual interest involves knowledge and value components, students were asked to rate their individual interest in five domains. Four of these domains (personal health, animals and pets, TV and movies, and science) were related to the content of the text passages that students were subsequently asked to read. Two ratings on 5-point Likert-type scales were made online by the students for each domain. The first was a rating of knowledge ("how much I know about it": 1 = *a little*; 5 = *a lot*), and the second a rating of value ("how important it is to me": 1 = *a little*; 5 = *a lot*). The two ratings for each domain were summed to give participants an individual interest score for each of the specific domains. We included popular music as a fifth domain because popular music has been shown to be a marker in adolescent psychosocial development (e.g., Arnett, 1995; Larson, Kubey, & Colletti, 1989; Larson & Verma, 2000). Analysis of specific findings involving this individual interest domain are not reported here.

Topic interest measure. Because we assumed that both individual and situational factors contribute to topic interest, separate ratings of topic interest were made for four titles used in the reading tasks (Body Image, Chameleons, Star Trek/X-Files, X-rays). Topic interest was measured online by having students complete a 5-point Likert-type rating (1 = *a little*; 5 = *a lot*) assessing how interesting they expected each title to be.

Texts

The materials consisted of four short expository texts. These were two science-based texts (Chameleons and X-rays) and two popular culture texts that researchers had determined to be topics of interest for young adolescents (Body Image and Star Trek/X-Files). Each text was approximately 750 words in length. The choice of topics involved gender-balanced considerations. Two topics (Chameleons and Body Image) were expected to be of greater interest for girls, and the other two topics (X-rays and Star Trek/X-Files) were expected to be of greater interest to boys. These decisions were based on piloting the topics as well as on findings in the literature on interest and gender (Hoffmann & Haussler, 1998; Hoffmann, Krapp, Renninger, & Baumert, 1998).

Online Task Response Measures

After completing the two online interest measures, students were required to read the four text passages. While they read the text, we recorded a number of variables to monitor the way that students engaged with these four texts. The structure of the software recorded students' responses in temporal sequence, thereby allowing assessment of the critical contingencies between the processes that followed recording of topic interest ratings.

Text choice. Students were able to choose in which order to read the four texts. The topics were presented simultaneously across the screen in the following order: Body Image, Chameleons, Star Trek/X-Files, and X-rays. To the extent that topic selection was based on participants' comparisons and preferences between the texts, text choice provided an indicator of the situational aspect of topic interest.

Affect. Each text was made up of three 250-word parts, and students could choose to continue or quit after reading each part. Affect and its intensity were measured through responses to a panel of faces (see Appendix) presented online at the end of each part of all four texts. The panel included 11 faces representing common basic emotions such as happy, angry, bored, sad, interested, and sorry. These emotions covered the range of basic emotions defined by Izard (1972) and included what Pekrun (2000) has described as activating and deactivating achievement emotions. An expressionless neutral face was also included. Participants were asked to choose a face that reflected how they were feeling. If students wished to report more than one emotion, they were able to do so. In addition, 5-point Likert scales (1 = *a little*; 5 = *a lot*) were used to measure the intensity of the chosen emotion(s). Practice trials showed that students used the emo-

tion panel in a way that discriminated appropriately between situations in which they would be expected to feel differently.

Persistence. Each text was divided into three parts of approximately 250 words. As they progressed through the texts, students were able to choose how much they read, indexed by how long they spent with the text on the screen. A *NEXT* button in the bottom righthand corner of the screen allowed them to move on whenever they chose. This could be as soon as the text appeared on the screen or after an extended interval of time. When participants chose to move on they were presented with the emotion panel. Following this they were given the choice of reading more of that text or quitting. This pattern was repeated if they chose to go to the second part of the text, and again if they chose to go on to the third part. Persistence was defined in terms of students' engagement with each text and took into account both the amount of time they spent with each part of the text and how many parts they accessed.

Test score. Text comprehension and recall were measured by a set of three multiple-choice items presented as soon as the participant indicated he or she had finished with a text, whether this was after one part, two parts, or three. All students were presented with the test for their chosen text before they were able to choose another text. The items were designed to be a test of what students had read. The specific three items presented to each participant covered content only from those sections of a text that the participant had accessed. A student who accessed only the first part of a text was required to answer three questions on that part. A student who had accessed all three parts was presented with three questions that covered material from the whole text. Potentially, a student could score three correct responses whether he or she had accessed one, two, or three parts of the text.

Pencil-and-Paper Measures

On completion of the BTL computer task, students were administered a pencil-and-paper questionnaire (Two Factor Curiosity Scale; Ainley, 1986). The depth-of-interest subscale of this test was used to provide a measure of participants' general individual interest in learning. This subscale measures students' general orientation toward wanting to find out about and investigate novel, uncertain, or puzzling phenomena (see Ainley, 1998) and has strong psychometric properties ($\alpha = .89$; test–retest over 1 week, $r = .90$; Ainley, 1986).

The final measure consisted of an estimate of students' prior knowledge of the content of the texts. Using 5-point Likert-type scales (1 = *very little*; 5 = *a lot*), students were asked to indicate how much they knew about each specific topic prior to reading the texts.

Results

The results are presented in four sections. First, the construction of various measures included in the analyses is outlined. In the second section, the analysis of relationships between topic interest for the four text titles and individual interest factors is presented. In the third section the order of text choice as an outcome of topic interest is considered. In the final section, a multivariate, multilevel modeling of the relationships between individual interest, topic interest, and the processes that mediate the effects of interest on learning is described.

Measure Construction

Measures for a number of the variables for the analyses were constructed by combining responses recorded online. These included the individual interest for the specific domains, affect, and persistence.

Individual Interest for the Specific Domains

Following Renninger's (1992) conceptualization, we measured individual interest by having students rate how much they knew about each domain (personal health, animals and pets, TV and movies, science, and popular music) and how important it was for them. Principal-components analysis of the 10 ratings (knowledge and importance ratings for each of 5 domains) indicated that five factors accounted for 76% of the variance. After varimax rotation, each factor was defined by strong loadings (>.80) for the knowledge and importance ratings from one of the individual interest domains. There were no substantial cross-loadings between the domains. Subsequently, a single individual interest score for each domain was calculated by summing the knowledge and importance ratings.

Affect

The analyses reported in this study deal with the first emotion chosen at the end of the first part of the text for each topic. The most commonly chosen emotions were interested, neutral, and bored. These three emotions accounted for more than 80% of all responses. A 5-point index of affect was calculated from the specific emotion and associated intensity rating and ranged from 1 (*very bored*), through 3 (*neutral*), to 5 (*very interested*). The relatively small number of students who chose emotions other than interested, neutral, or bored were not included in the analysis.

Persistence

An index of persistence was developed that considered the automatically recorded reading times distinguishing between two levels of text engagement, brief and more substantial. On the basis of the results of a pilot study, less than 35 s was taken as a cutoff point to identify students who had accessed a section of a text only briefly and had quit before spending enough time to read any substantial part of the text. The extent of this brief engagement can be seen in the mean times spent with the first 250-word segment of the texts. Mean times ranged from 11.14 s for the Chameleon text to 12.95 s for the Body Image text. Students who had spent 35 s or longer reading a text segment were considered to have spent sufficient time with the text to be able to read at least a part of it. Mean times for the first 250-word segment of each of the four texts for this group ranged from 96.14 s for the Body Image text to 107.39 s for the X-rays text.

Persistence with the reading task was measured by calculating the number of parts students had accessed and read for longer than 35 s from the three sections each text contained. The final categories on this index of persistence were 1 = *no parts read*, 2 = *one part read*, and 3 = *more than one part read*.

The means and standard deviations for all of the measures used in the analyses are presented in Table 1.

Topic Interest and Individual Interest

There were strong differences in topic interest in response to the specific text titles. The Body Image title was rated as the most interesting ($M = 3.41$, $SD = 1.03$) and the X-rays title as the least ($M = 2.46$, $SD = 1.17$), whereas Chameleons ($M = 2.84$, $SD = 1.22$) and Star Trek/X-Files ($M = 2.78$, $SD = 1.37$) aroused

Table 1

Descriptive Statistics for Personal Characteristics and Response Variables (N = 221)

Variable	M	SD
Personal characteristics		
General individual interest in learning (average item score: 1–4)	2.35	0.62
Specific individual interest domains (1–10)		
Personal health	8.23	1.34
Animals and pets	7.22	2.19
TV and movies	7.50	1.65
Science	6.10	1.62
Popular music[a]	7.47	1.90
Prior knowledge (1–5)		
Body Image	3.49	0.90
Chameleons	2.46	1.07
Star Trek/X-Files	3.06	1.10
X-rays	2.55	0.95
Response variables		
Topic interest (1–5)		
Body Image	3.41	1.03
Chameleons	2.84	1.22
Star Trek/X-Files	2.78	1.37
X-rays	2.46	1.17
Affect (1–5)[b]		
Body Image	2.96	1.30
Chameleons	3.08	1.27
Star Trek/X-Files	2.77	1.24
X-rays	2.87	1.34
Persistence (1–3)		
Body Image	2.05	0.60
Chameleons	1.88	0.61
Star Trek/X-Files	1.95	0.65
X-rays	1.82	0.57
Test score (1–3)		
Body Image	2.05	0.91
Chameleons	1.54	1.00
Star Trek/X-Files	1.64	0.82
X-rays	1.88	0.88

[a] Not included in further analyses.   [b] Includes only those participants choosing the emotions interested, neutral, or bored; Body Image, N = 172; Chameleons, N = 190; Star Trek/X-Files, N = 190; X-rays, N = 174.

similar medium levels of interest. Repeated measures multivariate analyses of variance (MANOVA) indicated that there was significant within-subject variation in topic interest scores (multivariate $F(3, 218) = 28.59$, $p < .01$, $\eta = .28$). The Chameleons and Star Trek/X-Files pair of text titles was the only paired comparison for which the mean topic interest scores were not significantly different. In summary, text titles tended to trigger different levels of topic interest.

The contributions of individual interest factors to differences in levels of topic interest were tested by examining the effects of specific individual interest domains and general individual interest in learning. Multivariate repeated measures analysis of covariance (MANCOVA) was used with general individual interest in learning and the four specific interest domains related to the four texts entered as covariates. Gender was included as a between-subjects factor. Zero-order correlations between all of the main variables

considered in the analyses in this section are presented in Table 2. The multivariate F results are presented in Table 3, demonstrating that significant within-subject variability across the set of text titles was associated with general individual interest in learning and two of the four specific individual interest domains. These were the domains of personal health, and animals and pets.

Reference to the correlations presented in Table 2 shows that general individual interest in learning was correlated with topic interest for all of the texts except Body Image. The strongest of these associations was with topic interest for the X-rays title. The specific individual interest domain of personal health was significantly associated with topic interest for the Body Image title, whereas individual interest in animals and pets was associated most strongly with Chameleons and less strongly with Body Image. Although significant, these patterns of association accounted for only a part of the within-subject variation. After allowing for the effects of these covariates, gender was not significantly related to topic interest ratings. This is shown in the covariate-adjusted estimates of the mean topic interest scores for the total sample and separately for boys and girls presented in Table 4.

In summary, different levels of topic interest were triggered by the four text titles. The Body Image title triggered stronger topic interest than the X-rays title. Whether individual interest was measured at the general level represented by general individual interest in learning scores or at the more specific domain level, individual interest did account for a part of the variation in topic interest. The contribution of gender over and above the effects of the specific individual interest domains was not significant.

Topic Interest and Text Choice

It was our expectation that the order in which students selected topics would be primarily a measure of the situational aspects of topic interest and would be significantly related to topic interest. Unexpectedly, approximately 50% of the students chose the texts in the order that matched the left to right layout of the topics as they were presented on the computer screen. To separate the effect of screen order on topic choice from the effect of interest on topic choice, the following classification was made. Topics were presented across the screen in the order of Body Image, Chameleons, Star Trek/X-Files, and X-rays. Where students selected a topic in the order that matched its position on the screen, the selection was classified as a *screen order* choice. A topic chosen earlier than its screen order was classified as a *positive interest* choice. A topic chosen later than its screen order was classified as a *negative interest* choice. We expected that topic interest would have an influence on order of selection. More specifically, for each of the four texts, the mean topic interest scores were expected to be the highest for positive interest choices. Negative interest choices were expected to have the lowest topic interest. Screen order choices were expected to be in the middle. The results (shown in Table 5) confirmed these expectations. The pattern of means was in the predicted direction, and for three of the four topics the differences were statistically significant. Thus, topic interest triggered by text titles was associated with some students choosing specific texts ahead of other texts, and lack of such interest resulted in some students delaying the selection of texts.

Table 2
Correlation Matrix for Personal Characteristics and Topic Interest

| | Personal characteristics | | | | | | | Topic interest | | | |
| | | | Specific individual interest domains | | | | | | | | |
Variable	1	2	3	4	5	6	7	8	9	10	11
Personal characteristics											
1. Gender[a]	—										
2. General individual interest in learning	.15*	—									
Individual interest domains											
3. Personal health	−.15*	.02	—								
4. Animals and pets	−.23***	.11	.10	—							
5. TV and movies	.01	−.10	.10	.13	—						
6. Science	.10	.37***	.13	−.01	−.01	—					
7. Popular music	−.22***	−.16*	.30***	.17	.34***	−.01	—				
Topic interest											
8. Body Image	−.23***	−.04	.32***	.18***	.10	−.03	.30***	—			
9. Chameleons	.05	.27***	.06	.32***	.15*	.19***	−.04	.16*	—		
10. Star Trek/X-Files	.18***	.28***	−.06	−.03	.10	.20***	−.08	−.19*	.24***	—	
11. X-rays	.21***	.34***	.05	.05	.01	.31***	−.05	.04	.35***	.23***	—

[a] Female = 0; male = 1.
* $p < .05$. *** $p < .001$.

Individual Interest, Topic Interest, and Processes Mediating the Effects of Interest on Learning

The multivariate, multilevel modeling procedures used in this analysis generated a two-level hierarchical model of interest processes (see Rowe, 2000). The first step in the analysis dealt with the secondary process level, the influence of personal characteristics on topic interest and the responses that followed. The second step in the analysis dealt with the primary process level, the model of relationships between topic interest and the responses that followed.

Means and standard deviations for the scores on the personal characteristics (gender, general individual interest in learning, specific interest domains, and prior knowledge) and all of the response variables (topic interest, affect, persistence, and test score) used in the modeling procedures were presented in Table 1. Correlations within the set of personal characteristics and with topic interest were presented in Table 2, whereas Table 6 presents the correlations between personal characteristics and response variables as well as correlations within the set of response variables.

The personal characteristics showed some significant correlations with the response variables. Gender was significantly related to all of the Body Image text measures, with girls scoring higher than boys. Gender was also correlated with topic interest for two of the other three texts. Boys reported higher topic interest than girls on the Star Trek/X-Files and on the X-rays texts. General individual interest in learning scores correlated significantly with a number of the response measures for all texts except Body Image. Specific individual interest domain scores correlated with topic

Table 3
The Effect of Specific Individual Interest Domains on Topic Interest for Four Text Titles: Statistical Significance, Effect Size, and Power (MANCOVA)

Effect	$F(3, 204)$	p	η^2	Power
Within-subject				
Covariate: General individual interest in learning	3.58	.02	.05	.79
Specific individual interest domains				
Personal health	3.07	.03	.04	.71
Animals and pets	4.84	.01	.07	.90
TV and movies	2.55	*ns*		
Science	2.48	*ns*		
Between-subjects: Gender	2.28	*ns*		

Note. MANCOVA = multivariate analysis of covariance.

Table 4

Topic Interest Scores for Four Text Titles: Covariate-Adjusted Estimated Means and Standard Deviations for Gender

	Text title			
Gender	Body Image	Chameleons	Star Trek/X-Files	X-rays
Overall				
M	3.39	2.82	2.79	2.46
SD	0.07	0.08	0.09	0.74
Female				
M	3.56	2.71	2.63	2.29
SD	0.10	0.11	0.13	0.11
Male				
M	3.23	2.94	2.94	2.64
SD	0.10	0.11	0.13	0.11

interest scores for all except the Star Trek text. In addition, students' prior knowledge ratings correlated significantly with some of the process measures for each text. Correlations within the response variables for each text (Table 6) showed a clear pattern of significant coefficients between the adjacent processing variables: topic interest with affect, affect with persistence, and persistence with test score. The only exception to this pattern was the correlation between persistence and test score for the Star Trek/X-Files text. As was indicated earlier, the structure of the task allowed students freedom to determine their own level of interaction with each text. The persistence measure based on both time spent with each section of text and how many sections were accessed clearly indicated that given the opportunity, a significant number of students disengaged. For example, just over half of the students stayed with at least one part of each of the four texts (Persistence Category 2), whereas less than one quarter continued with two or more sections of text (e.g., 23% for the Body Image text, 9% for the X-rays text). When the positive correlation between affect and persistence was examined to establish the pattern of this association, significant differences in the affect scores were found between all three persistence categories. However, when the association between persistence and test score was examined, the significant effects were between the students who had quit without engaging with the text and those who had engaged with at least one section.

Multivariate, multilevel modeling (Lisrel 8.30; Jöreskog & Sörbom, 1999) was then used to identify the contribution of individual interest and other personal characteristics to topic interest, and to identify the processes mediating between arousal of topic interest and learning. This procedure allows testing of the relationships between the response variables independently of the associations between personal characteristics and response variables. All cases with no missing data were included, and the analysis was implemented in a series of steps for each of the four texts. The first step involved application of a multivariate, multilevel modeling procedure to determine the independent fixed effects of the personal characteristics (gender, general individual interest in learning, and the related specific individual interest domain) on the response variables (topic interest, affect, persistence, and test score) for each text. The students' estimate of their prior knowledge of text content was also included as one of these fixed effects. The second step involved fitting a structural equation model to the covariance matrix of the response variables. This step identifies the relationships between the response variables after allowing for any effects of the personal characteristics.

Individual Interest and Topic Interest: The Personal Characteristics Model

A separate analysis was performed for the data from each of the four texts. The personal characteristics of gender, general individual interest in learning, the related specific individual interest domain (Personal Health, Animals and Pets, TV and Movies, and Science), and prior knowledge ratings were entered as fixed effects in a multivariate, multilevel model. Topic interest, affect, persistence, and test score were entered as the response level variables. The output from these analyses indicated the independent direct effects of each of the personal characteristics on each of the response variables. Figure 1 displays the significant paths and coefficients for these variables for each text separately.

The primary interest of these analyses concerned the relationships between personal characteristics and topic interest ratings for the four texts, and the processes following from topic interest. Gender did not have any significant independent effects on the response variables except for the Body Image text. For this text, gender was significantly related to the affect response, with boys more likely to report being bored and girls more likely to report more positive affect. For most of the response variables, the significant correlations with gender (see Table 6) were not independent of the other personal characteristics in these models. The significant relationships shown in Figure 1 suggest that associations between gender and topic interest may operate through

Table 5

Mean Topic Interest Scores by Topic and Order of Reading Choices

	Text			
Choice indication	Body Image[a]	Chameleons	Star Trek/X-Files	X-rays[b]
Positive interest		3.83	3.26	2.59
Screen order	3.55	2.96	2.50	2.35
Negative interest	3.11	2.40	2.49	
	$F(1, 219) = 9.06**$	$F(2, 218) = 16.01***$	$F(2, 218) = 8.44**$	$F(1, 219) = 2.36†$

[a] Body Image was the first topic on the screen, and therefore there could be no positive interest choices for this topic.   [b] X-rays was the last topic on the screen, and therefore there were no negative interest choices possible.
$** p < .01.$ $*** p < .001.$ $† p < .10$ (marginally significant).

Table 6
Correlation Matrix for Personal Characteristics and Response Variables

Variable	Body Image				Chameleons				Star Trek/X-Files				X-rays			
	TI	A	P	TS	TI	A	P	TS	TI	A	P	TS	TI	A	P	TS
Personal characteristics																
Gender	.23**	.20**	−.14*	−.14*	.05	.05	.01	−.03	.18**	.05	.01	−.07	.21**	−.02	−.00	.06
General individual interest in learning	−.04	.10	.08	.04	.27**	.30**	.25**	.07	.28**	.21**	.14*	−.05	.34**	.20**	.13	.11
Individual interest domains																
Personal health	.32**	.23**	.10	.15*												
Animals and pets					.32**	.17*	.08	.03								
TV and movies									.10	.01	−.14*	−.04				
Science													.38**	.04	.00	−.01
Prior knowledge																
Body Image	.27**	.27**	.21**	.10												
Chameleons					.36**	.20**	.10	.11								
Star Trek/X-Files									.56**	.29**	.24**	.13				
X-rays													.19**	.05	−.02	−.04
Response variables																
Topic interest (TI)	—				—				—				—			
Affect (A)	.42**	—			.34**	—			.44**	—			.26**	—		
Persistence (P)	.19**	.41**	—		.28**	.32**	—		.33**	.33**	—		.19**	.30**	—	
Test score (TS)	−.02	.10	.21**	—	.18**	.18**	.34**	—	.05	.05	.09	—	−.03	.16**	.33**	—

* $p < .05$. ** $p < .01$.

Body Image Text

Chameleons Text
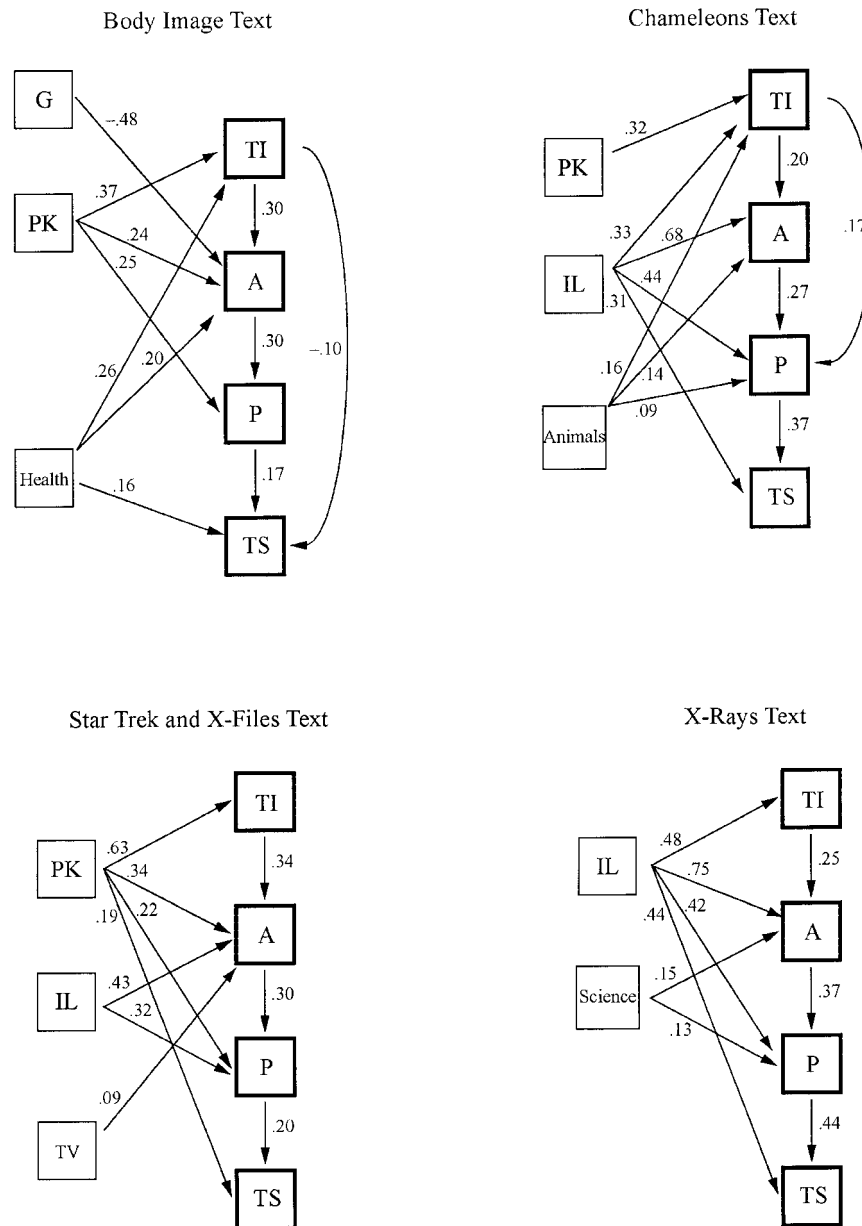
Star Trek and X-Files Text

X-Rays Text

Figure 1. Standardized solutions to multilevel, structural equation models for effects of personal characteristics (on left) and response variables (in boldface boxes on right). G = gender; PK = prior knowledge; IL = general individual interest in learning; TI = topic interest; A = affect; P = persistence; TS = test score.

general individual interest in learning, the pertinent specific interest domain, and prior knowledge. These variables were all significantly correlated with gender.

The general individual interest in learning measure showed consistently strong relationships with the response variables for the two science texts, Chameleons and X-rays. All of the possible paths linking general interest in learning and the response variables for these texts had the largest significant coefficients. Students' general individual interest in learning about new, uncertain, or puzzling phenomena was clearly an important influence on the processes triggered by the science expository texts. General indi-

vidual interest in learning was less important as a factor contributing to the response variables for the two popular culture texts, Body Image and Star Trek/X-Files.

Scores on the specific individual interest domain for each text topic showed different patterns of relationships with the response variables. For all four texts there was a significant effect of individual interest on affect. These effects, although significant, were generally small. Students' ratings of their prior knowledge for the content of the science texts were less predictive of the response variables than was the general individual interest in learning variable. On the other hand, for the popular culture texts,

students' ratings of prior knowledge showed some substantial associations with the response variables.

In summary, there were some important differences between the science and popular culture texts in terms of the predictive relationship between the personal variables and the response variables. Students' general individual interest in learning was significantly related to all of the response variables for the science texts, whereas prior knowledge was a more important factor for the popular culture texts.

From Topic Interest to Test Score: The Response Variables Model

After allowing for the effects of the personal characteristics (gender, general individual interest in learning, specific individual interest domain, and prior knowledge) on the response variables (topic interest, affect, persistence, and test score), the covariance matrix for the set of response variables was analyzed (Lisrel 8.30; Jöreskog & Sörbom, 1999). The best fit for both direct and indirect effects of topic interest on the response measures for each of the texts was determined. The results can be seen in the models presented in Figure 1, where the response variables are shown in boldface boxes. The significant coefficients displayed in Figure 1 are the standardized direct effects between the response variables. Goodness-of-fit indices for each of the four text models are presented in Table 7, indicating that for all four texts, fit indices are in excess of 0.90, considered to be the lower boundary for an acceptable model fit. These models accounted for most of the variance in the response variables.

The best fitting model for each of the four texts showed a significant influence of topic interest on affect, affect on persistence, and then persistence on test score. The coefficients for the effect of topic interest on affect, the emotion response reported when the student had finished with the first section of the text, suggest that the interest triggered by presentation of the text topic influenced level of involvement with the text. For two of the texts, Body Image and Chameleons, there was an additional direct effect of topic interest on later processing. Although smaller than the coefficients for the path to test score through affect and persistence, these effects were significant. For the Body Image text this additional effect was a negative effect of topic interest on test score, suggesting that for some, the initial expectations about the topic were not fulfilled. For the Chameleons text there was a significant direct effect on persistence whereby students who had higher levels of topic interest were more likely to persist further with the text.

To interpret the substantive significance of these models, refer to the standardized total effects and squared multiple correlations presented in Table 8. Reference to the entries in Table 8 shows that for the two science texts these models accounted for slightly more than 10% of the variance in test score. This is in keeping with the size of effects reported more widely in the interest literature (see Schiefele, 1998). For the popular culture texts the level of variance explained was lower.

In summary, using interactive computer presentation of short expository texts, we have been able to inspect some of the complex paths whereby individual interest variables combine with the content of text titles to influence levels of topic interest triggered by those text titles. Simultaneously we have identified how these factors influence the processes that intervene between the initial triggering of interest in the text topics and scores on a test of text content.

Table 7

Goodness-of-Fit Indices for Best Fitting Model of the Response Variables for Each Text: Topic Interest to Test Score

Goodness-of-fit index	Text			
	Body Image ($n = 172$)	Chameleons ($n = 190$)	Star Trek/X-Files ($n = 190$)	X-rays ($n = 174$)
χ^2	2.758	7.942	2.003	3.633
p	.252	.019	.572	.304
RMSEA	0.024	0.062	0.000	0.035
SRMR	0.011	0.036	0.022	0.031
GFI	0.998	0.995	0.995	0.990
AGFI	0.990	0.974	0.982	0.965
NFI	0.981	0.969	0.960	0.953
CFI	0.995	0.976	1.000	0.991
IFI	0.995	0.977	1.021	0.991
RFI	0.944	0.907	0.921	0.906

Note. RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed-fit index; CFI = comparative-fit index; IFI = incremental-fit index; RFI = relative-fit index.

Discussion

We analyzed the responses of young adolescent students to a set of four expository texts to address two important issues in interest research. The first of these concerned the contribution of individual and situational factors to levels of topic interest, and the second examined processes mediating the effects of topic interest on learning.

Relationships Between Individual Interest, Situational Interest, and Topic Interest

Individual Interest and Topic Interest

A number of variables that reflect different perspectives of individual interest and its influence were represented in the study. General individual interest in learning, an orientation or predisposition toward wanting to know, wanting to find out about and understand novel, uncertain, or puzzling phenomena (see Ainley, 1998) was one of these variables. In addition, students' individual interest was assessed for a number of specific domains that might be expected to relate to the specific titles of the four texts students were given to read. Gender was included to represent the broad sets of interests and values that differentiate males and females within social and cultural groups (Bergin, 1999; Fivush, 1998; Hoffmann et al., 1998).

There were significant influences of individual interest variables on both intra- and interindividual differences in topic interest. Students' general individual interest in learning and their pattern of individual interest for the specific domains made significant contributions to the level of topic interest triggered by the specific titles of these four expository texts. General individual interest in learning also made a contribution to the psychological state trig-

Table 8
Standardized Total Effects and R^2 Values: Fitted Multilevel Structural Equation Models for Response Variables: Four Texts

Variable	Texts			
	Body Image	Chameleons	Star Trek/X-Files	X-rays
Standardized total effects for fitted multilevel structural equation models				
Effect of topic interest				
Affect	.30	.25	.34	.35
Persistence	.09	.22	.10	.09
Test score	.09	.08	.02	.04
Effect of affect				
Persistence	.30	.31	.30	.37
Test score	.02	.11	.06	.16
Effect of persistence test score	.16	.37	.20	.44
R^2 for structural equations				
Topic interest				
Affect	.09	.06	.12	.06
Persistence	.09	.09	.09	.14
Test score	.04	.13	.04	.19

gered by three of the four text topics. For the physical science text (X-rays) this was a substantial effect. Students with a strong individual interest in the specific domain of personal health were more likely to report that their interest was triggered by the text title Body Image. In the same way, students with a strong individual interest in animals and pets were more likely to report higher topic interest for the Chameleons text. Associations between gender and topic interest were not independent of the individual interest in the specific domains and general individual interest in learning. This finding supports the position that gender operates through associated sets of values and self-schema (see Bergin, 1999; Fivush, 1998). It should be pointed out that although the students in the present study represented only a narrow age range, the association between individual interest and gender is also likely to be age related.

The psychological state triggered by specific text titles is affected by the patterns of individual interest that students bring with them to a text. On one hand, a well-developed individual interest in a particular domain means that when students are presented with a text on a topic connected with that domain, their interests are likely to be triggered. On the other hand, a strong general orientation toward finding out about novel, uncertain, or puzzling phenomena means that text titles may be perceived to be opportunities to find out about something new or to acquire new information on a well-known topic and thus trigger topic interest. This perspective on general individual interest in learning has its origins in research that investigated the structure of curiosity (Ainley, 1998; Berlyne, 1962; Beswick, 1971; Hunt, 1971; Loewenstein, 1994) and emphasizes behavior whereby novel, uncertain, or puzzling stimuli are approached in order to acquire further information and knowledge. What has been measured in this study as a general individual interest in learning involves seeking knowledge and understanding through approaching what holds the promise of new or novel information extending what is already known. General individual interest in learning also has strong conceptual links with mastery or learning achievement goals, although it has a broader

range of referents. Items of the scale focus on novel, uncertain, and puzzling phenomena that are not specifically tied to school achievement.

Text Title, Situational Factors, and Topic Interest

The four texts used in this study generated significantly different levels of topic interest. Not surprisingly, the highest level of interest was triggered by the popular culture topic of Body Image. The biological science topic, Chameleons, generated a level of interest comparable with the other popular culture topic, Star Trek and the X-Files, whereas the physical science topic, X-rays, aroused the least interest of the four topics. The intraindividual variation in response to these topics clearly indicates that text title was an important situational source of topic interest. For example, the different levels of topic interest reported to the text titles Body Image and X-rays supports Hidi's (1990) assertion that topics vary in the degree that they touch on human activity and life issues, text characteristics with almost universal appeal and significance. The text title Body Image immediately triggers issues of concern to most young adolescents. Similar patterns of variation in topic interest were reported from a study of 10th-grade students' responses to literary texts (Ainley, Hillman, & Hidi, 2002). In that study, topic information consisted of title, author, and a one-line introduction to the story. Not surprisingly, the text title "The Blooding" triggered significantly higher topic interest than did "Follow Your Heart." Variations in topic interest triggered by different text titles support the usefulness of considering the content of text titles as a source of situational interest. Making use of this situational source of interest can assist students to get started on the path to learning (see also Shraw & Dennison, 1994).

Interest triggered by a text title is not solely dependent on students' individual interests. Text titles that suggest themes of personal or universal significance can trigger interest even when students have no well-developed individual interest in the domain. Our findings have shown considerable variation in the levels of

topic interest triggered by our four expository text titles. Some of that variation could be attributed to individual interest factors, as shown by the significant effects in our analyses. The size of these effects suggests that topic interest is likely to be the outcome of both individual and situational factors, operating separately or in combination. Further investigation is needed to identify how both individual and situational interest factors operate for different students and different learning tasks.

Order of Choice

Because the four text titles triggered different levels of topic interest, the effects of topic interest on subsequent behavior were examined. Topic interest had a significant influence on the order in which some students chose to read the texts. Higher topic-interest texts tended to be chosen ahead of lower topic-interest texts. To the extent that topic selection may result from comparisons between the text titles by the participants, text choice provided an indicator of situational aspects of topic interest. However, topic interest was not the only factor influencing choice, as unexpectedly many of the students chose to read the texts in an order that matched the normal left–right reading orientation. This effect has been reduced in subsequent studies by presenting text titles in an irregular arrangement on the screen (e.g., Andrews, Hoey, & Ainley, 2001).

Prior Knowledge

Schiefele (1998) stated that interest research generally has not included prior achievement or knowledge as predictor variables when determining the effects of interest on learning. Our study included students' estimates of their prior knowledge of the content of the texts completed after they read texts. Prior knowledge was then included in the models to take into account the well-documented relationship between knowledge and individual interest (e.g., Alexander & Murphy, 1998; Renninger, 2000; Renninger, Hoffmann, & Krapp, 1998), a relationship that was confirmed here for three of the four texts. We found that the contribution of prior knowledge to topic interest varied substantially across the different texts. Estimates of students' prior knowledge were strongly related to topic interest for the Star Trek/X-Files text and not at all for the X-rays text. Although there was a significant correlation between students' estimates of their prior knowledge of the X-ray text content and their topic interest, the stronger correlations between general individual interest in learning and prior knowledge and between general individual interest in learning and topic interest for the X-rays text absorbed this association. A more formal assessment of knowledge of the content of the texts could be a more appropriate alternative to the rating measure used here. However, the timing of such a measure in the research design is critical for ensuring that there is no priming for content that might influence students' reporting of topic interest, and thus a knowledge test administered on a separate occasion may be least disturbing. Even though our measure of prior knowledge was limited, it allowed us to assess something of the relationship between prior knowledge and topic interest.

The Processes Mediating Interest and Learning

The second main focus of our study was to investigate some of the processes initiated when topic interest is triggered and to identify those processes mediating the effects of interest on learning. In particular we examined the variables of affect and persistence in relation to both topic interest and answers to questions concerning text content. The influence of personal characteristics of individual interests, general individual interest in learning, gender, and prior knowledge of text content on the processes that follow triggering of topic interest were determined. These personal characteristics not only contributed to topic interest but also had small but significant effects on what happened in the course of text processing. The relationships between topic interest, affect, persistence, and test scores were identified after statistically controlling for the effects of the personal characteristics.

For all four texts the strongest relationships within the set of process variables were consistent with a model having a path from topic interest through affect and persistence to test score. As might be predicted from our knowledge of the importance of domain specificity in learning processes (Alexander, 1997; Alexander, Jetton, & Kulikowich, 1995), there were variations in the size of these effects across the four texts. However, the pattern of similarities across texts supports the conclusion that topic interest influenced students' affective response at the end of the first part of the text. Affect influenced the degree that students persisted with each text, and persistence was related to scores on the test at the end of each text.

Personal Characteristics, Topic Interest, and Learning

General individual interest in learning, individual interest for specific text-related domains and prior knowledge all contributed to the variance in text processing that followed triggering of topic interest. Student gender was related to each of these personal characteristics, and where it was associated with topic interest and further processing variables, these associations operated through students' general individual interest in learning, individual interest in related specific domains, and prior knowledge. The only exception to this pattern was the Body Image text, for which gender did have a direct effect on the affective response recorded when students quit from the first part of this text. Girls were more likely to report more positive affect and boys more likely to report less positive or negative affect. Several features of these relationships stand out. First, the personal characteristics included in our design did have direct effects on all levels of processing. Second, the general individual interest in learning variable had stronger associations with the affective responses than was the case for any of the other personal characteristics. This relationship is consistent with other studies that have shown elevated levels of the emotion interest–excitement associated with a measure of students' general individual interest in learning (see Ainley, 1998).

From Topic Interest to Learning

The size of the relationship between interest and learning across a wide variety of studies has been documented as accounting for approximately 10% of the variance. The findings for the science texts in the present study were of the same order of magnitude. Schiefele (1998) reported that studies of individual interest and its effects on learning that used achievement grades as the measure of learning typically have found correlations of about .30. The smaller number of studies using specific text recall measures

reported correlations of about .27. However, as Schiefele pointed out, these studies have not simultaneously accounted for the influence of prior knowledge on the learning measures. Our study looked at the relation between topic interest triggered by a set of text titles, statistically controlling for the effects of prior knowledge and individual interests, and has modeled the process that links topic interest and learning. What is clear from our analyses is that the influence of the psychological state triggered when a topic was presented consisted of a sequence of processes. We measured affect and persistence and modeled the relationships between the four variables, topic interest, affect, persistence, and test score.

The strongest model for these texts was a pattern whereby topic interest influenced affective responses, affect influenced persistence with the text, and persistence was related to the test score obtained at the end of each text. The level of topic interest triggered by the title influenced the feelings students reported when they chose to leave the first part of each text. The specific responses included both positive and negative emotions, or as Pekrun (2000) has referred to them, activating and deactivating achievement emotions. Students who reported feeling interested were more likely to engage further with a text, whereas those reporting feeling bored were more likely to discontinue reading the text. Online recording of these affective reactions has allowed identification of the psychological state at points in their reading of a text where decisions were being made about further engagement. When given the opportunity to disengage from these texts, large numbers of the students chose to do so, and this limited our opportunity to identify contingencies between affective responses across the sequence of processing all three parts of each text. The level of interest triggered by the text topics was not maintained. Application of the same methodology to processing of texts known to both trigger and maintain students' interest could provide further insight into the contribution of affective responses in the influence of interest on learning. In particular, this approach would allow further identification of specific achievement activating emotions and combinations of emotions that support further engagement with learning texts.

The role of affective reactions identified in this study does not suggest that quality of experience is an "epiphenomenon of interest," as suggested by Schiefele (1996, p. 13), who examined the relationship between reported subjective experience and measures of cognitive processing of texts. Our focus has been on relating subjective experience to the process of persisting with a text and, through persistence, achievement of higher test scores. The index of persistence we used incorporated both the number of parts of a text students chose to access and a global indicator of how much time was spent with part of a text. Hence, persistence as used in this study was an index of students' engagement with the texts. A similar measure was reported by Vollmeyer and Rheinberg (2000), who measured persistence as the number of "rounds" students spent finding out about a biology-lab system and the number of rounds to achieve a specific goal state. Vollmeyer and Rheinberg reported that students' initial motivation influenced persistence, but the relationship between persistence and achievement was complicated by the use of a mastery measure of performance rather than an indicator of the amount of learning that had occurred. Their analysis of "intra-individual gains in knowledge acquisition and application" (p. 306) showed a positive effect of persistence on learning.

Clearly student persistence with a text is an important factor in learning. Interest plays a role in learning through its contribution to students' connecting with the content and maintaining that connection for sufficient time to be able to learn.

Measuring the Dynamics of the Relation Between Interest and Learning

Whether the focus of research is individual, situational, or topic interest, features of the dynamic set of processes that connect the initial triggering of interest with learning outcomes are critical for educators who wish to understand how to motivate students' learning. To be able to observe something of that dynamic set, we have developed a methodology that measures students' reactivity to texts in real-time sequence. The methodology is not limited to analyzing text processing, and a variety of studies using the same methodology are now being conducted. For example, one investigation focuses on the ways in which students learn physics using interactive models of specific physical phenomena (Ainley & Hidi, 2002). The critical feature of our methodology is that students are making responses that reflect how involved they are with the task, and these responses are being monitored in their real-time sequence. Through analyses of the contingencies in this real-time sequence of reactions, the dynamic properties of student interest being triggered, maintained, or dissipated can be explored.

Unfortunately, students were not highly engaged with the texts presented in the current investigation. This lack of involvement limited our opportunity to model the full set of contingencies, such as the sequence of affective responses across all three sections of each text. Future studies using a variety of learning materials should be able to achieve this goal and identify how successive affective responses relate to maintaining interest and continued engagement with learning tasks. In addition, the significant relationship between persistence and learning observed in this study was largely a function of the difference between those who disengaged quickly and those who read some of the text. One of the advantages of our methodology is that it allows one to distinguish these types of differences in students' responses to the learning material. This is a discrimination generally not available through more conventional pencil-and-paper measures.

Summary and Conclusion

In this investigation we examined processes mediating the influence of interest on learning using an interactive computer task that recorded students' responses in their real-time sequence. The contributions of individual and situational interest factors to variability in the psychological state triggered by four expository text titles were identified. After allowing for the effects of individual interest factors, we still found substantial intraindividual variation in the topic interest triggered by the specific text titles. The strongest model linking topic interest and learning suggested that topic interest was related to affective response, affect was then related to persistence with the text, and persistence was related to learning.

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Appendix

Panel of Faces
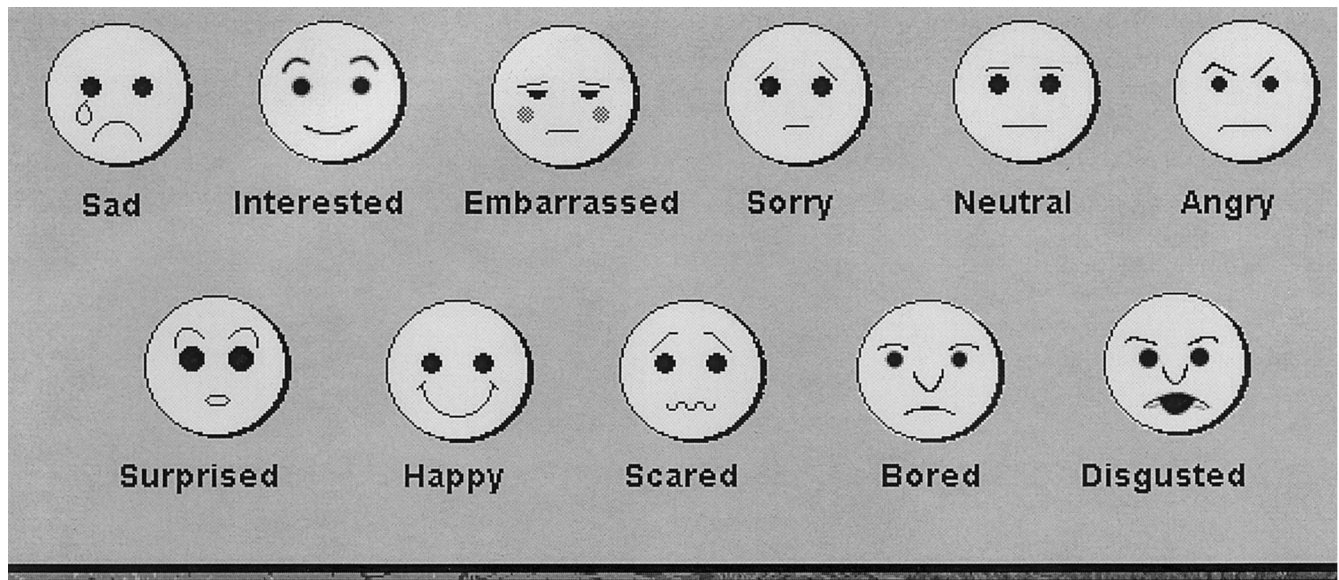
Select from the set of faces to show how you are feeling NOW.