Fostering Historical Knowledge and Thinking Skills Using Hypermedia Learning Environments:

The Role of Self-Regulated Learning

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Abstract

We explored how high school students utilized a hypermedia learning environment (HLE) to acquire declarative understanding of a historical topic, as well as historical thinking skills. In particular, we were interested in whether self-regulated learning (SRL; Winne & Hadwin, 1998; Zimmerman, 2000) processing was related to the acquisition of declarative knowledge and historical conceptual understanding. This study has implications for how educators use HLEs to foster historical thinking skills, and how SRL skills can be scaffolded to support students’ use of computers as cognitive and metacognitive tools for learning (Azevedo, 2005; Lajoie, 2000).
Fostering Historical Knowledge and Thinking Skills Using Hypermedia Learning Environments: The Role of Self-Regulated Learning

Hypermedia learning environments (HLEs) are being deployed in United States classrooms despite a lack of knowledge regarding the best ways to position students to take advantage of their affordances (Lajoie & Azevedo, 2006). The many affordances of HLEs, including their ability to present a vast amount of information in multiple representations, do not seem to foster academic success unless students are effective at self-regulating their learning (Azevedo, 2005). The research of self-regulated learning (SRL) and computers has focused primarily upon science and mathematics topics (e.g., Azevedo, Cromley, & Seibert, 2004; Greene & Azevedo, 2009; Kramarksi & Gutman, 2006), and has shown strong relations between the quality of students’ SRL processing and their acquisition of conceptual understanding of complex topics in these domains. There is a relative paucity of research examining how SRL relates to learning history with HLEs (e.g., Wolters & Pintrich, 1998; Wolters, Yu, & Pintirch, 1996). This gap in the literature is notable because while science and history are different domains, success in each area requires the ability to plan, execute strategies, evaluate sources of information, and construct knowledge; all of which are hallmarks of effective self-regulation (Zimmerman, 2000). Therefore, it is reasonable to investigate whether the findings relating SRL to learning in science also apply to history. In this study, we explored whether the frequency of SRL processing while using an HLE was a predictor of declarative and conceptual knowledge in history, controlling for prior knowledge.

Theoretical Framework

*Historical Thinking*
HLEs that can present multiple primary and secondary sources of historical events are particularly helpful now that schools have moved from treating history education solely as a memorization task. Today, understanding the past requires one to engage in the process of historical thinking. Levstik (1996) defined historical thinking as a:

shift from an emphasis on a 'story well told' (or, the story as told in the textbook), to an emphasis on 'sources well scrutinized'...[Where students] pose questions, collect and analyze sources, struggle with issues of significance, and ultimately build their own historical interpretations (p. 394).

This meaning-making process requires teachers and students to interact with primary and secondary historical documents to reconstruct the past. Unfortunately, there has been relatively little research conducted on high school students’ historical thinking (Bolick et al., 2004; McNeil, 1986; Shaver, Davis & Helburn, 1979). With the proliferation of HLEs, such as digital libraries, it is important to examine how these pedagogical tools influence the development of historical thinking and knowledge.

Hypermedia Learning Environments

HLEs are computer-based tools where information is presented as a series of nodes that can be selected by the user (Dillon & Jobst, 2005). Nodes can include a variety of information and means of representing phenomena including animation, video, audio, diagrams, and text (Jonassen, 1996; Scheiter & Gerjets, 2007). Hyperlinks are used to connect nodes, allowing the user to determine which representations are selected, and in what order. Jacobson and Archodidou (2000) outlined four ways that HLEs benefit students who wish to learn about complex topics. First, students can access information in HLEs in a non-linear manner, allowing them to select the representations they find most helpful at a given moment. Second, HLEs
afford a high degree of user control, allowing students to construct knowledge in ways that best meet their needs and understanding. Third, hypermedia learning environments that include pictures, video, and interactive features in addition to the presentation of content in text or audio format are often more intrinsically interesting than traditional instruction (Jonassen, 1989). Finally, the text, pictures, and videos in HLEs can be used to present users with a rich set of representations of complex systems and ideas that are otherwise hidden from direct observation (Delany & Gilbert, 1991; Mayer, 2005). However, while HLEs are becoming increasingly popular pedagogical tools (Lajoie & Azevedo, 2006), little is known about how high school students utilize history-based HLEs, and how they influence students’ historical thinking and understanding (Kingsley & Boone, 2008).

Recent work has focused upon students’ metacognitive and self-regulatory activities while learning with HLEs (Lajoie & Azevedo, 2006). Students need to build their repertoire of strategies to manage the complexity of HLEs, but they also need the self-knowledge and skills to appropriately implement those strategies, and monitor their efficacy. There is a great deal of theoretical and empirical research indicating that students who enact self-regulated learning processes while using hypermedia are more likely to learn complex topics, such as historical events and thinking (Azevedo, Guthrie, & Seibert, 2004; Greene & Azevedo, 2007).

**Self-regulated Learning**

The numerous SRL models in the literature (e.g., Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000) share a number of common features. First, as Zimmerman (2008) has summarized, “SRL is viewed as proactive processes that students use to acquire academic skill, such as setting goals, selecting and deploying strategies, and self-monitoring one’s effectiveness, rather than as a reactive event that happens to students due to impersonal forces” (pp. 166-167).
Second, students self-regulate their cognition, motivation, behavior, and context to achieve goals. These goals can be distal (i.e., completing an assignment) and proximal (i.e., learning the definition of a new word). Finally, SRL processes are thought to mediate the relations among student characteristics, task characteristics and performance.

Across numerous tasks and in various academic settings, researcher has found that learners with strong SRL skills tend to outperform those who lack these skills (Azevedo, 2005; Pressley & Ghatala, 1990; Pressley & Harris, 2006; White & Frederiksen, 2005). Unfortunately, the research has also shown that most students are not effective regulators of their learning (Paris & Paris, 2001). These findings have spurred a great deal of research into how SRL skills can be taught and prompted in learning environments. Unfortunately, there is little research investigating the relations between SRL and learning in social studies education (VanSledright & Limon, 2006). This study attempts to fill that gap by translating the research methods used to study SRL in science and mathematics to the history context.

Measuring SRL. Wolters and colleagues (Wolters & Pintrich, 1998; Wolters, Yu, & Pintrich, 1996) found relations between SRL processing and learning in history using self-report data. Winne and Perry (2000) argue against measuring SRL using self-report techniques because SRL is not an attribute to can be statically measured, and because self-report data are notoriously unreliable and inaccurate (Winne & Jamieson-Noel, 2002). In an effort both to capture SRL processes more accurately as well as account for how these processes vary over the course of learning, we have chosen to utilize think-aloud protocols (Ericsson, 2006; Ericsson & Simon, 1993) rather than self-report measures. This study builds upon the work of Azevedo and colleagues (2004, 2005, 2008; Greene & Azevedo, 2007, 2009), who have analyzed think-aloud protocol data to investigate relations between SRL and learning in HLEs. Specifically, we used
the measurement techniques outlined in Greene and Azevedo (2009) to examine the degree to which macro-level SRL processes (i.e., planning, strategy use, monitoring) mediated relations between prior knowledge and academic performance, including measures of historical knowledge and thinking.

Azevedo and colleagues’ model of SRL. Azevedo and colleagues’ (2008) model can be used to assess students’ SRL process use while learning. A major contribution of this model is the connection made between observable SRL cognitive and metacognitive processes that students enact while learning and conceptual models of the phases of self-regulation (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). Most models include a similar set of phases that occur during SRL: defining the task, planning, learning, and adaptations to processing (e.g. Winne & Hadwin, 1998). Azevedo and colleagues’ model outlines over 30 specific, observable SRL processes that occur within these phases, including those addressing the areas of cognition, motivation, behavior, and context. For example, the model includes a code for setting subgoals while planning, as well as a code for monitoring progress toward those goals (see Appendix A). Thus, learners’ SRL processing can be categorized according to these codes, and inferred from think-aloud protocol data.

To connect think-aloud protocol data to conceptual models of SRL, the coding scheme developed by Azevedo and colleagues (2008) identifies what Greene and Azevedo (2009) call the micro- and macro-level SRL processes that students enact when learning. Micro-level SRL processes include such cognitive and metacognitive processes as setting sub-goals, judging the adequacy of learning, and using strategies such as drawing or taking notes. Azevedo and colleagues have attempted to create a micro-level SRL code for each cognitive and metacognitive process participants engage in while learning with an HLE, regardless of the
relative efficacy of those processes. Each of these micro-level SRL codes is then categorized as an instance of a macro-level SRL code (see Appendix A for a complete list of micro- and macro-level SRL codes). In Azevedo and colleagues’ model there are 5 macro-level SRL codes or processes: planning, monitoring, strategy use, handling task difficulty and demands, and displaying interest. These macro-level SRL codes align well with the processes that are outlined in conceptual models of SRL, yet often measured using self-report instruments (e.g., Bembenutty, 2007; Bendixen & Hartley, 2003; Kramarski & Gutman, 2006; Sperling, Howard, Staley, & DuBois, 2004). The utility of Azevedo and colleagues’ model is that micro- and macro-level SRL processes can be measured in a more objective manner (i.e., think-aloud protocols) than self-report instruments, and these processes can then be used as indicators of macro-level SRL processes that have been shown to be predictive of learning performance.

The little research that exists on SRL in history contexts (e.g., Wolters & Pintrich, 1998) focused solely upon macro-level measures of SRL strategy use, captured using self-report measures. Greene and Azevedo’s methodology allows for a much more in-depth analysis of planning, monitoring, and strategy use at the macro-level of SRL processing, using think-aloud protocol rather the self-report data. Thus, given the lack of information regarding how students self-regulate while using an HLE to learn about history, and the apparent utility of translating Greene and Azevedo’s methodology to the history context, we chose to determine whether macro-level SRL processing, measured from micro-level SRL data, could predict learning.

Overview of the Current Study

In this study, we sought to address the gap in the literature regarding how high school students use HLEs to learn history content and historical thinking. There is a lack of research on HLEs and history, particularly in terms of how they affect students’ acquisition of historical
thinking skills. Finally, research (Azevedo, 2005; Greene & Azevedo, 2009) suggests that frequent use of SRL processes within an HLE should be a predictor of academic success. Our specific research question was: *What are the relations among student prior knowledge, SRL process use, and performance on measures of historical knowledge and thinking?*

**Methods**

**Participants**

Forty students at a high school in the southeastern United States participated in this study, and 21 (52.5%) of them were female. Their mean age was 16.33 years (SD = .526). Their teacher indicated that they had little to no knowledge of the history content used in this study, and this claim was verified using a pretest, described later.

**Procedure**

Students participated one at a time. First, the participant submitted the necessary consent forms. Then the participant was given as much time as needed to complete a demographic questionnaire. Next, the participant was given 15 minutes to complete a pretest. The participant did not have access to any instructional materials during the pretest.

Participants were told that the learning task involved using the HLE to learn as much as possible about the Regulator Movement in 25 minutes focusing on this learning goal: *“Make sure you learn about who the Regulators were, when the Regulator Movement occurred, and the significance of the Regulation Movement.”* Then the researcher introduced the participant to the navigation functions, the articles, and the images available within the HLE.

Next, the think-aloud process was described in detail to the participant, including instructing the participant to verbalize all thoughts and reading while navigating through the HLE (Ericsson & Simon, 1993). Once the participant was reminded of the learning task and all
final questions were answered, the learning session began. During this time the participant was both audio and video taped. After 25 minutes all recording was terminated, the participant’s notes (if any) were removed from the testing area, and the HLE was closed. Finally, the participant was given 15 minutes to complete a posttest that was identical to the pretest. The participant did not have access to any instructional materials or notes during this time.

Hypermedia Learning Environment

The HLE consisted of documents (five text documents and four images) based upon Documenting the American South (http://docsouth.unc.edu), a digital library collection of more than 1,000 texts, images, and audio files related to southern history, literature, and culture. The text articles used in this study consisted of 528,604 words divided into 42 sections. The participants navigated within the articles and images using a standard search option, as well as hyperlinked titles for each document. Participants were limited to specific text articles, and could not access the rest of the HLE or the Internet.

Measures

Declerative measure. The multiple-choice/true-false portion of each student’s pretest and posttest were scored for accuracy by a trained graduate or undergraduate student.

Mental models. We adapted Azevedo and colleagues’ (Azevedo & Cromley, 2004; Greene et al., 2008) method for evaluating science content to history as a means of scoring participants’ mental model pretest and posttest essays. We identified 10 mental models that progressed from no understanding of the Regulator Movement to the most complete understanding (see Appendix B). One trained graduate student and one trained undergraduate student individually scored each mental-model essay by assigning one of the 10 model values
Historical thinking and SRL  

(inter-rater agreement was .988; agreement on 79/80 essays). The disagreement was resolved by the first author.

SRL Coding. All participant sessions were transcribed and coded using a version of Azevedo and colleagues’ (Azevedo et al., 2005; Azevedo & Cromley, 2004) SRL coding scheme that we adapted for this study. The scheme includes 35 micro-level self-regulatory processes used by learners to regulate their learning of historical topics with hypermedia (see Azevedo et al., 2005, pp. 394-397). Each of the micro-level codes is further categorized into one of five macro-level processes: planning (e.g., activating prior knowledge), monitoring activities (e.g., judgment of learning), and strategy use (e.g., drawing, coordinating informational sources, knowledge elaboration).

The above mentioned coding scheme was used to group participants’ think-aloud verbalizations into segments. To qualify as a codeable segment, a word or group of words had to represent one of the 35 micro-level SRL processes. Audio tape from each participants’ think-aloud process was transcribed by trained students. Each transcript was coded using both the transcription and the video recording, to ensure accuracy. A total of 950 minutes (15.83 hours) of audio tape was transcribed and coded. The total number of codeable segments for all participants was 3,539 ($M = 93.13$ per participant). Two researchers coded each transcript, independently, and then came together to compare their coding. Differences were resolved through discussion between the two coders. All transcriptions were coded twice. Using this process of coding, there is no need to calculate interrater reliability because every codeable segment was evaluated by two separate researchers.

Results

Micro-level SRL process data were aggregated into five macro-level SRL process
variables (see Appendix A). This aggregation was a simple summation of the number of each participant’s micro-level codes, resulting in a score for the associated macro-level variable. In this study we focused upon the planning, monitoring, and strategy use macro-level variables. Descriptive information for all variables can be found in Table 1. Our hypothesis was that macro-level SRL process use mediated the relations between pretest and posttest declarative and historical thinking measures. To do test this, we performed a path analysis using Mplus 5.2 (Muthén & Muthén, 2008). All variables were treated as measured, and the MLR estimator was used to account for non-normality. There was little missing data, and it was treated as missing at random (Little & Rubin, 2002), allowing for the use of full information maximum likelihood estimation for the analyses. Both the multiple choice and mental model essay posttest scores were regressed onto the three macro-level SRL variables (i.e., planning, monitoring, and strategy use) as well as the pretest scores. The three macro-level SRL variables were also regressed onto the pretest scores.

The chi-square test of model fit was statistically non-significant \([\chi^2 (3, N = 40) = 6.952, p = \text{n.s.}]\) indicating that that model had good fit to the data and the estimates of the regression coefficients could be interpreted. As can be seen in Table 2, participants’ posttest scores on the declarative knowledge measure were statistically significantly related to their use of planning SRL processes, with those who planned more having higher predicted posttest scores than those who planned less. No other predictors had a statistically significantly relationship with declarative knowledge posttest score.

Participants’ scores on the historical thinking posttest measures were statistically significantly related to their pretest scores. No other predictors were related to posttest historical thinking. However, there was a sizable but statistically non-significant effect \((b = .228, p = .209)\)
that showed planning SRL processes related to historical thinking posttest scores. The r-squared values for the declarative knowledge and historical thinking posttest measures were .221 and .206, respectively, both medium effects according to Cohen’s (1992) standards.

**Scientific and Scholarly Significance**

This study is the first to use think-aloud protocol data and Greene and Azevedo’s (2009) method of capturing SRL processing to examine how SRL processing relates to the acquisition of historical knowledge and thinking skills using an HLE. As such, it represents a first step toward the design of HLEs that foster both conceptual understanding and the skills necessary to be a critical consumer of historical information. The main finding was that students who engaged in frequent planning of their learning were more likely to be successful in acquiring historical knowledge and thinking skills, above and beyond the influence of their prior knowledge. This finding is not necessarily surprising given the depth and breadth of the content in the history HLE we used. However, it underscores that students who do not initiate planning processing on their own are at a serious disadvantage when presented with HLEs. Therefore, well-intended educational initiatives that introduce computers in classrooms without preparing students to use them effectively are unlikely to be successful. In the future, research should be conducted to explore how SRL planning skills, and other SRL skills can be taught to students before they interact with an HLE. A next step would be to create adaptive HLEs that provide scaffolding for students who lack the knowledge or ability to effectively enact SRL processes on their own. Such HLEs would serve two important purposes: they would teach content as well as the learning skills necessary to thoughtfully and adaptively work with sophisticated tools such as computers.
References


## Appendix A

### Classes, Descriptions and Examples of the Macro- and Micro-Level Processes Used to Code Students’ Regulatory Behavior (based upon Azevedo, Moos, Greene, Winters, & Cromley, 2008)

#### Macro-Level Process: Planning

<table>
<thead>
<tr>
<th>Micro-Level Processes</th>
<th>Description</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning (Plan)</td>
<td>Stating two or more sub-goals simultaneously or stating a sub-goal and combining it with a time requirement.</td>
<td>&quot;First I'll look around to see the structure of environment and then I'll go to specific sections of the Regulator Movement&quot;</td>
</tr>
<tr>
<td>Sub-Goal (SG)</td>
<td>Learner articulates a specific sub-goal that is relevant to the experiment provided overall goal. Must verbalize the goal immediately before taking action.</td>
<td>&quot;I'm looking for something that's going to discuss the role of Governor Martin&quot;</td>
</tr>
<tr>
<td>Recycle Goal in Working Memory (RGWM)</td>
<td>Restating the goal (e.g., question or parts of a question) in working memory</td>
<td>&quot;…who the Regulators were, when the movement occurred, and the significance of the movement&quot;</td>
</tr>
</tbody>
</table>

#### Macro-Level Process: Monitoring

<table>
<thead>
<tr>
<th>Micro-Level Processes</th>
<th>Description</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Evaluation (Plus and Minus)</td>
<td>Monitoring content relative to goals. Learner states content is or is not useful toward reaching the goal.</td>
<td>&quot;The Regulators were in Hillsborough, I need to know that.&quot;</td>
</tr>
<tr>
<td>Expectation of Adequacy of Content (Plus and Minus)</td>
<td>Expecting that a certain type of representation will prove either adequate or inadequate given the current goal</td>
<td>&quot;…the image will probably give me the info I need to answer this question&quot; or “I don’t think the Journal of a Lady of Quality will answer my question”</td>
</tr>
<tr>
<td>Emotion Monitoring (EM)</td>
<td>Learner realizes that he/she is having an emotional response due to some aspect of the learning task.</td>
<td>“This text is frustrating me because it is so long.”</td>
</tr>
<tr>
<td>Feeling of Knowing (Plus and Minus)</td>
<td>Learner is aware of having read something in the past and having some understanding of it, but not being able to recall it on demand or learner states this is information not seen before</td>
<td>&quot;… I recognize that from the pretest…&quot; or “Governor Tryon - I never heard of him before.”</td>
</tr>
<tr>
<td>Judgment of Learning (Plus and Minus)</td>
<td>Learner makes a statement that they understand what they’ve read or becomes aware that they don’t know or understand everything they read</td>
<td>“I get it” or &quot;I don't know this stuff, it's difficult for me&quot;</td>
</tr>
<tr>
<td>Monitor Progress Toward Goals (MPG)</td>
<td>Assessing whether previously-set goal has been met. Participant comments on how useful a strategy was</td>
<td>“Those were our goals, we accomplished them”</td>
</tr>
<tr>
<td>Monitor Use of Strategies (MUS)</td>
<td>The learner asks a question relevant to the task, but does not articulate a specific plan to investigate the answer. Indicates that the learner has recognized a gap in understanding</td>
<td>“Yeah, taking notes really helped me understand the grievances of the Regulators”</td>
</tr>
<tr>
<td>Self-Questioning (SQ)</td>
<td></td>
<td>“Was Governor Tryon for or against the Regulators?”</td>
</tr>
</tbody>
</table>

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1 All codes refer to what was recorded in the verbal protocols (i.e., read, seen, or heard in the environment and/or during discussions).

2 Plus and minus indicates that there are two separate codes. Plus is used when a participant notes the presence of the attribute and minus is used when the participant notes the absence of the attribute i.e., Content Evaluation (-) when the content is deemed not helpful by the participant.
<table>
<thead>
<tr>
<th>Time Monitoring (TM)</th>
<th>Participant refers to the number of minutes remaining</th>
<th>“I only have 3 minutes left”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Difficulty (TD)</td>
<td>Learner indicates the task is hard or easy.</td>
<td>“This is harder than reading a book.”</td>
</tr>
</tbody>
</table>

### Macro-Level Process: Strategy Use

<table>
<thead>
<tr>
<th>Micro-Level Processes</th>
<th>Description</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinating Informational Sources</td>
<td>Coordinating multiple representations, e.g., drawing and notes.</td>
<td>“I’m going to put that [text] with the image”</td>
</tr>
<tr>
<td>(COIS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draw (DRAW)</td>
<td>Making a drawing or diagram to assist in learning</td>
<td>“…I’m trying to imitate the image as best as possible”</td>
</tr>
<tr>
<td>Emotion Regulation (ER)</td>
<td>Learner actively attempts to control emotional response to some aspect of the learning task.</td>
<td>“Okay, I’m going to count to ten to calm down.”</td>
</tr>
<tr>
<td>Inferences (INF)</td>
<td>Making inferences based on what was read, seen, or heard in the hypermedia environment</td>
<td>“I see in this image some people who look poor. Since the Regulators had issu with unfair taxes, maybe they’re the Regulators.”</td>
</tr>
<tr>
<td>Knowledge Elaboration (KE)</td>
<td>Elaborating on what was just read, seen, or heard with prior knowledge</td>
<td>[Learner sees the image of Governor Tryon and the Regulators] and states “So I gather from this picture that…”</td>
</tr>
<tr>
<td>Memorization (MEM)</td>
<td>Learner tries to memorize text, diagram, etc.</td>
<td>“I’m going to try to memorize this picture”</td>
</tr>
<tr>
<td>Prior Knowledge Activation (PKA)</td>
<td>Searching memory for relevant prior knowledge either before beginning performance of a task or during task performance</td>
<td>&quot;It's hard for me to understand, but I vaguely remember learning about the role of the Regulation Movement in 10th grade&quot;</td>
</tr>
<tr>
<td>Read Notes (RN)</td>
<td>Reviewing learner’s notes.</td>
<td>“Grievances of the Regulators were unfair taxes – unfair taxes.”</td>
</tr>
<tr>
<td>Re-reading (RR)</td>
<td>Re-reading or revisiting a section of the hypermedia environment</td>
<td>“I’m reading this again.”</td>
</tr>
<tr>
<td>Search (SEARCH)</td>
<td>Searching the hypermedia environment with or without the Encarta search feature</td>
<td>“I’m going to type grievances in the search box”</td>
</tr>
<tr>
<td>Selecting a New Informational Source</td>
<td>The selection and use of various cognitive strategies for memory, learning, reasoning, problem solving, and thinking. May include selecting a new representation, coordinating multiple representations, etc.</td>
<td>[Learner reads about the petition to Governor Tryon] then switches to looking at the image of the state seal of North Carolina.</td>
</tr>
<tr>
<td>(SNIS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Knowledge Activation (SKA)</td>
<td>The learner verbalizes that he or she is (or is not) going to invoke a strategy because it is helpful (or not helpful) to him/her personally.</td>
<td>“I’m gonna take notes because that helps me remember things better.”</td>
</tr>
<tr>
<td>Summarization (SUM)</td>
<td>Summarizing what was just read, inspected, or heard in the hypermedia environment</td>
<td>&quot;So James Moore was against the Regulators.&quot;</td>
</tr>
<tr>
<td>Taking Notes (TN)</td>
<td>Copying text from the hypermedia environment</td>
<td>“I’m going to write that under grievances”</td>
</tr>
</tbody>
</table>

### Macro-Level Process: Handling Task Difficulty and Demands

<table>
<thead>
<tr>
<th>Micro-Level Processes</th>
<th>Description</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help Seeking Behavior (HSB)</td>
<td>Learner seeks assistance regarding either the adequateness of their answer or their instructional behavior</td>
<td>&quot;Do you want me to give you a more detailed answer?&quot;</td>
</tr>
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</table>

### Macro-Level Process: Interest

<table>
<thead>
<tr>
<th>Micro-Level Processes</th>
<th>Description</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Statement (Plus and Minus)</td>
<td>Learner has a certain level of interest in the task or in the content domain of the task</td>
<td>&quot;Interesting&quot;, &quot;This stuff is interesting&quot;</td>
</tr>
</tbody>
</table>
Appendix B

*Necessary Features for Each Level of Conceptual Understanding and Historical Thinking Skills (based on Azevedo & Cromley, 2004)*

1. No understanding

2. Lists one of the following
   - NC colonists
   - Herman Husband
   - Governor Tryon
   - Orange and/or surrounding counties
   - Late 1760s – 1771 (pre-Revolutionary War)

3. Lists more than one of the following
   - NC colonists
   - Herman Husband
   - Governor Tryon
   - Orange and/or surrounding counties
   - Late 1760s – 1771 (pre-Revolutionary War)

4. Grievances of Regulators - general
   - 1-3 above
   - Lists that the Regulators had *some* kind of grievance or issue

5. Grievances of Regulators – one specific
   - 1-4 above
   - Lists one specific grievance of the Regulators:
     - Excessive taxes (or extortionate fees)
     - Dishonest sheriffs
     - Wanted better economic conditions
     - Wanted a system that did not benefit only colonial officials
     - Wanted to make the colony’s political process more equal

6. Grievances of Regulators – more than one specific
   - 1-5 above
   - Lists more than one specific grievance of the Regulators:
     - Excessive taxes (or extortionate fees)
     - Dishonest sheriffs
     - Wanted better economic conditions
     - Wanted a system that did not benefit only colonial officials
     - Wanted to make the colony’s political process more equal

7. Grievances of Regulators, Purpose of Movement, and Results of Movement (basic)
   - 1-6 above
   - Lists one of the following:
     - Movement itself was considered to be unsuccessful
     - Some (approximately 6-7) of the Regulators were hanged; majority pardoned in exchange for their allegiance to the crown

8. Grievances of Regulators, Purpose of Movement, and Results of Movement (advanced)
   - 1-7 above
• Lists more than one of the following:
  o Movement itself was considered to be unsuccessful
  o Some (approximately 6-7) of the Regulators were hanged; majority pardoned in exchange for their allegiance to the crown

9. Historical Context
• 1-8 above
• Catalyst to the American Revolutionary War

10. Historical Context and Significance of the Movement
• 1-9 above
• Provide contextual information about other historical activities during this period (any or all of the following)
  o Following the French and Indian War, the Treaty of Paris was signed.
  o Great Britain begins a series of rulings to tax the colonists, including the Stamp Act and Townshend Acts.
  o Protests occurred in Wilmington, NC.
  o Orange County Farmers organize as the Regulators.
  o The movement spreads until the Regulators are defeated by Governor Tryon and his militia.
Table 1

*Descriptive Statistics*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness (SE)</th>
<th>Kurtosis (SE)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declarative knowledge</td>
<td>2.120</td>
<td>1.977</td>
<td>.635(.374)</td>
<td>-.542(.733)</td>
<td>7</td>
</tr>
<tr>
<td>Declarative knowledge</td>
<td>5.850</td>
<td>1.027</td>
<td>-.433(.374)</td>
<td>-.929(.733)</td>
<td>3</td>
</tr>
<tr>
<td>Conceptual knowledge</td>
<td>2.150</td>
<td>2.167</td>
<td>2.392(.374)</td>
<td>5.339(.733)</td>
<td>9</td>
</tr>
<tr>
<td>Conceptual knowledge</td>
<td>6.380</td>
<td>2.272</td>
<td>.005(.374)</td>
<td>-1.055(.733)</td>
<td>8</td>
</tr>
<tr>
<td>Planning</td>
<td>1.711</td>
<td>1.769</td>
<td>1.023(.383)</td>
<td>.096(.750)</td>
<td>6</td>
</tr>
<tr>
<td>Monitoring</td>
<td>17.553</td>
<td>12.787</td>
<td>1.026(.383)</td>
<td>.516(.750)</td>
<td>53</td>
</tr>
<tr>
<td>Strategy Use</td>
<td>46.000</td>
<td>21.206</td>
<td>.240(.383)</td>
<td>-.355(.750)</td>
<td>89</td>
</tr>
</tbody>
</table>
Table 2

*Path Analysis Results*

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Predictor</th>
<th>Estimate*(Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declarative knowledge posttest</td>
<td>Declarative knowledge pretest</td>
<td>-.031(.184)</td>
</tr>
<tr>
<td></td>
<td>Historical thinking pretest</td>
<td>.248(.151)</td>
</tr>
<tr>
<td></td>
<td>Planning macro-level SRL process use</td>
<td>.374(.114)**</td>
</tr>
<tr>
<td></td>
<td>Monitoring macro-level SRL process use</td>
<td>.017(.170)</td>
</tr>
<tr>
<td></td>
<td>Strategy use macro-level SRL process use</td>
<td>.190(.118)</td>
</tr>
<tr>
<td>Historical thinking posttest</td>
<td>Declarative knowledge pretest</td>
<td>-.133(.178)</td>
</tr>
<tr>
<td></td>
<td>Historical thinking pretest</td>
<td>.459(.162)**</td>
</tr>
<tr>
<td></td>
<td>Planning macro-level SRL process use</td>
<td>.228(.181)</td>
</tr>
<tr>
<td></td>
<td>Monitoring macro-level SRL process use</td>
<td>-.011(.157)</td>
</tr>
<tr>
<td></td>
<td>Strategy use macro-level SRL process use</td>
<td>.070(.166)</td>
</tr>
<tr>
<td>Planning macro-level SRL process use</td>
<td>Declarative knowledge pretest</td>
<td>-.236(.268)</td>
</tr>
<tr>
<td></td>
<td>Historical thinking pretest</td>
<td>.111(.148)</td>
</tr>
<tr>
<td>Monitoring macro-level SRL process use</td>
<td>Declarative knowledge pretest</td>
<td>-.047(.209)</td>
</tr>
<tr>
<td>Process use</td>
<td>Historical thinking pretest</td>
<td>.059 (.189)</td>
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<tr>
<td>------------------------------------</td>
<td>-----------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Strategy use macro-level SRL</td>
<td>Declarative knowledge pretest</td>
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<tr>
<td>Declarative knowledge pretest</td>
<td>Historical thinking pretest</td>
<td>-0.047 (.218)</td>
</tr>
<tr>
<td>Declarative knowledge posttest</td>
<td>Historical thinking posttest</td>
<td>.266 (.037)*</td>
</tr>
</tbody>
</table>

\( \text{a All estimates are standardized coefficients.} \)

\( \text{b This estimate is the correlation between both pretest measures.} \)

\( \text{c This estimate is the correlation between the residual variances of these measures.} \)

\( \text{* } p < .05 \)

\( \text{** } p < .01 \)

\( \text{*** } p < .001 \)