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Middle Grades Students' Situation Definitions: Development of a Knowledge-Linking Inventory

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Abstract

The purpose of this study was to develop the Student Knowledge Linking Instrument (SKLI), an inventory for middle grades students that seeks to understand student knowledge construction processes. This study included 461 fifth and sixth grade students and follows from a series of qualitative studies that were used as a foundation for development of the SKLI. The SKLI captures student knowledge linking through student responses to brief reading passages and is proposed to capture the students' situation definition (Wertsch, 1985), specifically their initial links with the information. Eight student linking profiles emerged from these students' data, with students on one end of the spectrum drawing on surface characteristics of the text in their linking, while others used more elaborative links that indicated a depth of processing. These profiles were hypothesized to be developmentally ordered, supported by an increase in elaborative links for some sixth grade students in this group.

The purpose of this study was to develop the Student Knowledge Linking Instrument (SKLI), an inventory in which middle grades students demonstrate their level of linking information, presented via a brief text, with what they already know. SKLs are those mental connections that students create between what they are learning in school and personal experiences and understanding from both inside and out of school, which form a key mechanism for educating the middle grades learner. Indeed, developing links, in general, seems a cornerstone of the middle grades learner experience. The integrated curriculum essential to successful middle schools (K. M. Brown, 2001; Jackson & Davis, 2000) demands such linkage among content areas as well as between school and other aspects of students' lives (R. Powell & Allen, 2001). In fact, in order for lasting learning to occur, students must see connections between what they are learning and their own experiences (Center for Collaborative Education, n.d.).

Flexible scheduling allows for time needed to connect prior knowledge with different content areas (D. F. Brown, 2001). These scheduling modifications also increase time for relationship building, allowing for deeper connections between teachers and students and among students, another essential element of the middle school experience (Necochea, Stowell, McDaniel, Lorimer, & Kritzer, 2001). These personal linkages with the content may provide learning relevance for students and prompt links between school and home life experiences (Davis, 2001). As Davis noted, "with relevance, content helps create links, links that students make from one key idea to another and links [that] students discern between what goes on inside the classroom and what is happening outside it" (p. 225).

A series of previous qualitative studies (Schuh, 2003, 2004, 2007; Schuh & Rea, 2001) described the nature of the student knowledge links that fifth and sixth grade learners created in their classrooms, those links between what they were learning and aspects of their personal experiences. As students shared these links via questions or comments, some were viewed by the teachers as off-task, tangential, or inappropriate, given the topic being studied. Yet findings indicated that these student contributions were often instances of their knowledge construction processes where certain content prompted associations with personally relevant information. As middle grades teachers strive to develop the potentially useful links that students share, better descriptions of student knowledge linking efforts may point to better understanding of how students come to understand new content, given prior learning and experiences they bring to their classroom. This student-specific information can then be used to inform scaffolding for understanding of new material that will have idiosyncratic relevance for a particular learner.

Student knowledge links captured via an open-ended writing prompt from these earlier studies were classified as to their potential usefulness in understanding new information (Schuh, 2004; Schuh, Wade, & Knupp, 2005). While examining student writing was useful for understanding the potential types and usefulness of student links, evaluating the open-ended writing was time intensive. The current study sought to develop an instrument with three ideal applications: (a) to capture the types of links the students created in their open-ended writing and their in-class interactions, and (b) to provide efficient administration and scoring. In addition, we hypothesized that the types of links the students made could be developmentally ordered. We describe here the evolution of the SKLI, noting the instrument development process through two pilot studies, followed by the field study of the instrument. First, we provide the theoretical framework for operationalizing student knowledge links.

Theoretical Framework

Constructivism

The study of students' knowledge linking rests principally in constructivism, which is described as an epistemology noting how learners develop understandings of new content and events, given prior understandings (e.g., Bransford, Brown, & Cocking, 1999; Bruning, Schraw, Norby, & Ronning, 2004; Derry, 1992; Jonassen, 1999; von Glasersfeld, 1995), as is recommended for middle grades learners (D. F. Brown, 2001; Center for Collaborative Education, n.d.). At the core of perspectives such as constructivism, whether cognitive- or socio-constructivism, is the individual learner's lens that is developed from prior experiences and used in the interpretation of new events and information encountered (e.g., Cunningham, 1992; von Uexkull, 1957). For this study, the prior experiences of the learner stemmed from environments both in and outside school, while the new information was similar to that typically studied in schools.

From a cognitive-constructivist perspective, learners apply an individually constructed scheme*—essentially a lens—through which they make sense of the world. Through a spontaneous assimilation process, learners apply their most salient lens to the new situation or learning opportunity. While this lens may or may not be useful in understanding the new situation, it may be the best interpretation the learner can make at that moment. The scheme that guides these initial interactions is the starting point for the integration of new learning with an existing scheme, potentially resulting in revisions to the scheme as the learner develops new understandings (von Glasersfeld, 1995).

From a socio-constructivist perspective, the primary theoretical lens for this study, all learning is socially/culturally mediated. Through mediators (located on an interpsychological or intermental plane), learners may potentially internalize new information.

* We intentionally use the word "scheme" as Piaget did (Eckblad, 1981; von Glasersfeld, 1995) to keep it distinct from "schema" and "schema theory" as defined from more information-processing perspectives.

Developing through a socially-mediated process, individuals' constructions are not mere copies of those interpsychological functions, though influenced by them, but are new individual constructions (Wertsch, 1985). A situation definition (i.e., how a situation is viewed by an individual in it (Wertsch, 1984)) captures this notion that learners bring personal meanings to a learning situation. To help the learner grasp understandings of information, the mediating agent/event (e.g., a teacher) needs to be responsive to the learner's perspective or lens—essentially being attuned to what the learner is seeing in the new information or event. A learner's situation definition is his or her prior learning in action, reflecting the personal characteristics of the learner and how that individual views a new learning opportunity. A learner's situation definition is where the learner meets the content.

While the process of how a learner comes to know something differs between these two constructivist perspectives (cognitive and socio), they are complementary (Cobb, 2005). Whether one views a learner as equipped with a scheme as he or she approaches a situation, or whether one posits a degree of enculturation from which further interactions may stem, the learner encounters most new information or tasks with an initial understanding. From a cognitive-constructivist perspective, understanding a learner's initial scheme allows facilitation of new knowledge construction by providing opportunities for cognitive dissonance that may prompt accommodation. From the socio-constructivist perspective, the learner's situation definition points to the zone of proximal development, the area in which effective scaffolding may be beneficial.

While prior learning is viewed, in this study, as providing an initial link to new content, the role of prior learning in the comprehension of reading and in developing new understandings has a long history stemming from a variety of theoretical perspectives (e.g., Bartlett, 1932; Caillies, Denhière, & Kintsch, 2002). In studies of elementary children and prior knowledge, prior knowledge was related to time spent searching for information in a book for third grade students, with the prior knowledge mediating the efforts and contributing to decreased search time and increased accuracy (Reynolds & Symons, 2001). High-ability fifth grade students seem better able to make sense of potentially unsensible text, given their prior knowledge; they are also better able to determine the sensibility of a text (Owings, Peterson, Bransford, Morris, & Stein, 1980). Likewise, higher-ability fifth and sixth grade students more frequently use specific strategies for learning that include linking information with their prior knowledge (Peterson, Swing, Braverman, & Buss, 1982) and these strategies were also linked with positive achievement and associated scores earned for independent work completed during class time. In a study of question asking and generating, fifth grade students with greater prior knowledge on a topic asked more necessary questions (meaning, they needed the information to respond correctly to a word meaning task), while lower prior knowledge students asked more global questions when provided with prompts for the questions (Van der Meij, 1990). The current study of knowledge linking processes considers the initial aspects of students' links with their prior knowledge as they make sense of text similar to that they will encounter in school. These initial aspects of the students' lenses are captured through the student knowledge links.

Student Knowledge Links

This concept occurs as cue and trajectory-dimension pairs (Schuh, 2003, 2007). Cues are a feature of the new content/event that that are aligned with with the prior learning. Discussions of transfer (see Marton's (2006) summary, for example) have sought shared commonalities between one task and another. These commonalities may be identical elements (Thorndike & Woodworth, 1901), identical functions (Judd, 1908), or identical representations (Gick & Holyoak, 1980). While the cue may, indeed, seem like an identical element, in that something in a new situation is similar to something in a prior situation, cues in student knowledge links more accurately align with Greeno, Moore, and Smith's (1993) definition of transfer, in that the cue captures something similar between the relation a learner has "to one situation and the learner's relation to another situation" (Marton, 2006, p. 505)—an invariant interaction (Greeno et al., 1993). Information in an environment are cues because of relationships between a learner and the two different situations—a connection the learner sees between something occurring in the classroom and some other aspect of his or her life. For example, consider a sixth grade student in a science lesson that introduces the biomes using a textbook map noting biome locations. Given his experiences of watching football on television, he questioned why Green Bay, Wisconsin, was called the "frozen tundra" when Green Bay was not in the tundra biome marked on the map (Schuh, 2003). His question illustrated his relation between two different situations as he tried to make sense of the new content. This link prompted an insightful question that moved beyond the content, thereby exemplifying ideal foundational learning

opportunities found in effective middle grades classrooms (Center for Collaborative Education, n.d.). Cues may be intentionally imbedded in the learning environment (e.g., cuing particular learned responses). However, cues used as a component of SKLs are those identified by the learner, as this boy identified his previous exposure to the concept of tundra. Learners selectively attend to a cue because of familiarity; something is the same in the new learning opportunity as something else they already know. The SKL is a student-developed relationship.

Briefly, a number of cues in the data from the fifth and sixth grade students are elaborated elsewhere (Schuh, 2003, 2004, 2007; Schuh & Rea, 2001). Sensory cues include those that seemed to draw on surface characteristics (e.g., that the new information looked like or sounded like something with which the learner was familiar). Concept cues and their associated variations capture conceptual similarities or differences between new information and prior experiences. For example, an idea in the new information in a particular class might be similar to an idea the student encountered previously outside school, such as the frozen tundra.

Trajectory dimensions capture characteristics of the prior learning—descriptions of where and with whom the cue had been previously encountered. These trajectory dimensions, or the contexts in which the prior learning occurred, reflected the expanding world of the early adolescent, pointing to events and influences important to her or him. Links included encounters with family, friends, school, society, and media (Schuh, 2003, 2004, 2007). In addition, affect played a role in many of the links these students created (Schuh & Rea, 2001). These trajectory dimensions, given they were developed from data from fifth and sixth grade students, are particularly sensitive to young adolescent learners and denote potential values and interests. The links between the student and the school content may prompt relevance, in that the students note a common characteristic, yet some of the links may be more useful than others in prompting deeper understanding of the content.

The links students make vary in terms of potential for learning the new information; some may foster or inhibit further understanding. Earlier work noted three classifications of KCLs in the data: surface or simple links, links of similar ideas that could be potentially useful, and elaborated links that exhibited greater depth of processing (Schuh, 2004; Schuh et al., 2005). Simple links drew on only surface elements shared between the information being learned and prior learning. These simple links noted shallow, surface details that did not capture critical characteristics of the new information and seemed to have little value for developing further understanding of the content. Given this type of cue, a learner's situation definition (i.e., how a learner initially views the learning opportunity) may seem limited, given the learning goal. For example, noting that an orca is black and white as is a newspaper is a simple link that is limited in its usefulness in understanding the orca in a deep way. This type of surface knowledge is often aligned with traditional school scheduling practices (D. F. Brown, 2001). However, even these simple links are useful in the instructional process, in that they may portray the most salient characteristics of the new content for a particular learner at a particular time. These characteristics, although limited, help clarify the learner's situation definition, and capture how the learner may initially approach the content using surface features. It is his or her starting point, albeit limited, for his or her learning.

In contrast, students who make links for understanding and who elaborate upon useful links actually then integrate what they bring with them to the new learning experience. These links potentially foster deeper understanding of the new content (Schuh, 2004; Schuh et al., 2005). Focusing on deeper characteristics of the content may indicate an understanding or an intention to understand (Biggs, 1999).

Between these two levels are instances in which learners may identify links among similar elements of two concepts (new and prior) that provide the potential to foster understanding of a particular topic, and thereby foster the potential for deeper engagement with the content. With this mid-level classification, the learners bring relevance with them, but they do not elaborate the links (Wittrock, 1985). As with simple links, the value of these links may lie in the potential they provide by identifying the learners' initial situation definition and prompting appropriate scaffolding.

This instrument, the SKLI, was developed concurrently with the Student Knowledge Linking Instrument—Perception (SKLIP, Kuo, Schuh, & Knupp, 2010), in which students indicate their belief of their use of particular linking strategies via a 5-point Likert scale. With this pair of instruments, we captured processes of how students link (SKLIP) as well as how those links might play out, given typical types of content being learned (SKLI). To

our knowledge, no instrument has assessed linking between prior knowledge and current learning opportunity in this way. Our purpose was to develop the SKLI instrument, and we were guided by these questions: (a) Can the levels of sophistication of student knowledge links be described developmentally? (b) How does the sophistication of students' knowledge links compare to the attributes on which students claim to link? Before we address these two questions, we describe the development of the SKLI through two pilot studies and a field study, noting the challenges of developing forced-response items and coding themes to capture the diversity of students' links in an ecologically valid way.

Methods

SKLI Item Development and Format

In previous qualitative studies in which the construct of student knowledge links was developed (Schuh, 2003, 2007), students completed an open-ended writing activity that captured ideas and topics that came to mind while studying a topic in their classrooms. Although the students' writing was extremely useful in understanding how students linked what they were learning with what they knew (i.e., an aspect of their situation definition), the process of scoring for surface or deep learning was laborious and time intensive. Therefore, we set out to create an instrument that would prompt the students to make explicit the types of links they made when encountering information.

Question content for the SKLI was gathered from children's books, including textbooks and novels, selecting two- to three-sentence passages. Fourth grade sources were used to reduce the reading comprehension burden for these fifth and sixth graders. For each text excerpt, a list of potential links was developed, using the kinds of links students created in the earlier qualitative study as a model (Schuh, 2003, 2004, 2007; Schuh & Rea, 2001). In other words, we tried to anticipate potential cues in the text, given the kinds of links other fifth and sixth grade students had made in the earlier studies. The trajectory-dimension was captured more narrowly in the SKLI as the reason why the cue had come to mind.

The question format prompted students to read the short text passage, mark what the passage reminded them of, and then indicate why they linked the item in the passage with that particular mental association. As students read each item, they used a cover-up sheet, which they moved down the page until they encountered a stop sign. At the first stop sign, they read the text above and were asked to think about that text. Then, they moved the sheet to the next stop sign, indicated what had come to mind (the link), then moved the sheet again. Last, they indicated a reason they believed their choice linked with the text excerpt. See Appendix A for an example.

Participants and Data Collection Procedure

We conducted two pilot studies, both in combined fifth-sixth grade classrooms in the same Midwestern city. The first pilot took place in a K–6 elementary school that included a 33.7% minority population (with 2.5% of the school population being Asian), and, in the study year, reported 11.9% of the 522 students in the school eligible for free/reduced-price lunches. Five fifth-sixth grade combined classrooms were invited to participate, and of these 143 students, 27 students completed the SKLI (see Table 1) in this end-of-school-year study. Our second pilot took place in two elementary schools the following spring. One classroom was housed in a school with 13.18% minority population and 3.9% of the 493 students in the school eligible for free/reduced-price lunches. The second K–6 elementary school, with three participating classrooms, had a 21.24% minority population and, in the study year, reported 17.3% of the 306 students in the school eligible for free/reduced-price lunches. Ninety-two students participated in Pilot 2.

The purpose of the pilot studies was to update the questions and begin the development of a coding system for student responses. Pilot 1 included 20 questions and was administered as two non-parallel forms, while Pilot 2 was reduced to 15 questions in one form. Both pilots included an "other" write-in option for each link-reason pair. These write-in responses were used to expand or replace choices in the question development. The final SKLI used for the field study included the 15 items from Pilot 2, with all forced responses (no "other" write-in option) (see Appendix A). The write-in response option was removed to ease others' use of the instrument and to enhance reliability of the scoring.

The participants for the final stage of SKLI development, the field study, included 476 middle grades students (grades 5 and 6) and their teachers in 26 classrooms, in 10 school buildings, in 7 school districts, in the same Midwestern state in which the pilot studies were conducted. These seven school districts were generally rural, with three in communities of fewer than 3,000 people, three with fewer than 11,000, and one in a community of approximately 26,000. All these communities

Table 1
Demographic information of SKLI Pilot 1, Pilot 2, and the Field Study

Demographic information	Pilot 1	Pilot 2	Field Study
Number of students	27[a]	92	461[b]
Number of schools	1	2	10
Number of classes	5	4	26
Grade			
5th	33.3%	47.8%	78.3%
6th	66.7%	52.2%	21.7%
Sex			
Boy	50%	50%	51.7%
Girl	50%	50%	48.3%
Race			
NHW	72%	68.5%	84.6%
Other	28%	31.5%	15.4%

Note. NHW = Non-Hispanic White; Other = Includes American Indian, Hawaiian or Other Pacific Islander, Asian or Asian American, Black or African American, and Hispanic or Latino.

[a] The effective $N = 26$ for presenting demographic information, given existing missing data.

[b] The effective $N = 460$ for presenting demographic information, given existing missing data.

were smaller than the community of the pilot study schools. Of the nine school buildings providing school/community demographic information, minority population ranged from 4% to 20% ($M = 13.9\%$) and students receiving free/reduced school lunch rates ranged from 33% to 86% ($M = 53.8\%$). Participating classrooms from 43 solicited rural school districts were recruited via e-mail to a random selection of school buildings stratified by larger educational areas within the state. Interested building principals forwarded the e-mail to their teachers, who, in turn, decided if their classrooms would participate. Students and their parents were provided the opportunity to have the student decline to participate. Most classes that completed the study did so during homeroom ($n = 18$). In two cases, the teachers taught multiple sections of a particular content area class (e.g., science or language arts). This accounted for the remaining eight classrooms. Table 1 includes the demographic information for 461 of the 476 students who completed the SKLI and were included in the analysis.

In all three data collection phases, the students completed a number of instruments, including the SKLI. Teachers administered the SKLI as it best fit into their schedules. Typically, the SKLI was administered first in the sequence of the instruments, following completion of a brief demographic survey. In the field study, students took, on average, 26 minutes to complete the 15 items. A challenge in developing the SKLI was creating a coding system that would take into consideration the premise of SKLs—that students do make links based on what they know and that those links may not always be obvious to others. We elaborate our coding development process through the two pilot studies and the final field study.

Development of Coding System

Stage 1 coding. The goal in the development of the coding system was to establish levels for the link-reason pair responses students chose. Thus, the link-reason pair was the unit of analysis. Conceptually, it is only in the reason given that the potential usefulness of the link could be accounted for. For example, the fact that a student might be reminded of fruit after reading about an orchard does not point to the level of the linking sophistication. The elaboration of the link, or the reason the student chose the link, provided the evidence for the potential value of the link. For example, a student who was reminded of fruit because of a trip to a vineyard had a useful link in terms of generative learning opportunity—the

student had an example on which he or she could draw to further understand. This link was quite different from that of a student whose reason for the link might have been because she was hungry. A single question with 8 links and 8 reasons garners 64 potential responses of varying potential usefulness.

While unusual in instrument development, we largely used a qualitative framework for developing the link levels. This development involved three broad stages: developing baseline levels (Pilot 1) using multiple raters; and then two stages of refinement (Pilot 2 and field study), with two raters engaging in a negotiation process. In Stage 1, five graduate students (four in educational psychology, one in school psychology) coded the link-reason pairs based on the classification levels that stemmed from earlier studies (Schuh et al., 2005): 0 = syntactically incorrect (grammatically did not make sense), 1 = syntactically correct, but no semantics (grammatically made sense but seemed to have no meaning), 2 = simple semantics (i.e., surface and not likely useful in understanding the text), 3 = semantic potential-implicit (potentially useful in understanding the text, scaffolding needed), 4 = semantic potential-explicit (an elaboration that showed deeper processing). The intra-class correlation average measures across the five raters coding the 20 items in the two SKLI forms used in Pilot 1 was .842. Single measure intra-class correlation for the five raters individually was .516. These five reviewers' scores provided a starting point to further refine the coding system. Given response variations among the reviewers, the initial level for each link-reason pair was the modal response of the five coders. The mode was chosen because it avoided the influence of outliers among the five coders. For example, a coder might choose an extreme on the scale (0 or 5) because of his or her own background knowledge.

Stage 2 coding. In Stage 2 coding, the first author and a graduate student in educational psychology who had extensive experience working with young adolescent students as a music teacher continued to refine the coding system. The primary goal in this phase of the coding system development was to better understand those links students had made that could be, in a measurement sense, errors (i.e., students incorrectly marked a choice because what they marked seemed to make no sense; these were coded as 0 or 1). Given the theoretical foundations of the study, it seemed hypocritical, on the one hand, to say that links students make are unique and contingent upon their own prior experiences and, on the other hand, say their responses are unworthy of value because we could not figure out the link. Therefore, link-reason pairs chosen by more than five students that had been initially coded as 0 or 1 were reexamined to consider how the students may have interpreted the choices. In this way, the coding analysis aligned well with qualitative methods of coding, seeking the meaning that emerged from the data of the informants (Merriam, 2009). In Pilot 2 we updated codes for 28 of the link-reason pairs. It is worth noting that this coding review, as well as the one in the field study described next, was blind to individual student responses, dealing only with frequencies of responses for given coded link-reason pairs. The coders had no means of understanding how the refinements in coding would change individual scores and continuity among them.

Stage 3 coding. Stage 3 coding followed from the implementation of the field study and was conducted by the same two individuals as in Stage 2. As the school demographics indicate, the students in the field study of the SKLI were a more diverse group than those in the pilot studies in terms of community size and SES, as indicated by percentage of students receiving free/reduced-price lunch, and largely included individual fifth and sixth grade classrooms rather than mixed-grade classrooms.

Again, the link-reason pairs students had selected that had been coded as 0 or 1 were reviewed. Consider the example in Table 2, which includes the frequency of responses for question 3 found in Appendix A. The rows indicate the link choices, and the columns indicate the reason choices for the 456 students who completed the item. In this item, we noted that the coding for link-reason pair 5–1 (reminded the student of pollution because it had a lake) and 5–3 (reminded student of pollution because they are both created by water in air) may have missed potential student meaning, given that students did choose these pairs ($n = 9$ and $n = 8$, respectively). For each item, we reviewed the link-reason pairs that had initially been coded as level 0 or 1, trying to interpret the pair as a student might (i.e., trying to find meaning). In this case, the coding level was changed to level 3. The students likely had examples or knowledge of pollution that may be relevant to their understanding of the content and could be further developed with appropriate scaffolding. The initial coding had relied too much on the syntactic structure of the pair, while the students ignored grammatical elements of the pairs, allowing the options to become their choices.

Table 2
Cross Tabulation for Frequency Counts for Link-reason Pairs for SKLI Question 3 (see Appendix B) Prior to Final Coding Analysis

	Reason								
Link	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**Total**
L1	0^{0}	1^{1}	4^{4}	1^{2}	4^{1}	1^{1}	2^{3}	1^{2}	14
L2	1^{0}	46^{3}	2^{1}	0^{1}	1^{3}	12^{3}	5^{4}	0^{2}	67
L3	2^{2}	3^{3}	0^{0}	1^{0}	2^{3}	2^{0}	0^{0}	0^{3}	10
L4	0^{0}	1^{4}	2^{3}	2^{4}	0^{3}	0^{4}	3^{4}	1^{3}	9
L5	9^{0}*	6^{4}	8^{1}*	23^{3}	27^{3}	145^{3}	32^{4}	9^{3}	259
L6	1^{0}	3^{2}	0^{0}	0^{0}	0^{0}	0^{2}	0^{0}	1^{2}	5
L7	6^{2}	2^{2}	1^{0}	0^{0}	0^{3}	1^{4}	1^{0}	0^{3}	11
L8	4^{2}	4^{3}	6^{2}	0^{3}	55^{2}	10^{2}	1^{2}	1^{3}	81
Total	23	66	23	27	89	171	44	13	456

0–4: Coding levels prior to final coding analysis.

* Coding level changed to 3 following final analysis, given student responses.

Review within rows and columns also identified particular links or reasons that might be problematic in general. For example, in an item in which students read a brief passage about milling grain, one link was the word *flower* (a sounds-like or same-word cue). While we had initially coded most of the link-reason pairs with *flower* as 0 or 1 (the choice did not make sense either syntactically or semantically, given the text), further examination of that link showed that students had interpreted the word as *flour*. In this case, it seemed odd to penalize the student for ignoring the spelling of the word, since we wanted to understand their meaning, and we did not intend to study correct homophone usage. Therefore, when the link-reason pair warranted, we recoded the pair (e.g., reminds me of *flower*, they are both cooked, milled, or baked) as a 3—they had an example. In this final coding review, we changed the coding of 33 link-item pairs from 0 or 1 (186 individual student responses out of 6,849 (2.7%), with nearly one-third of these in response to the milling question) to a level indicating that the student had made a personally meaningful link. Given this analysis of the coding, the instrument is more ecologically valid, being sensitive to links that young adolescent students made. At this point, the remaining 0 and 1 scored link-reason pairs were considered errors and omitted from further analysis. Descriptions of the final coding categories are included in Appendix B.

Results

The SKLI was grounded in a constructivist perspective, noting that learners will make sense of information they encounter, given their prior knowledge. Prior knowledge between individuals and within a single individual, given prior experiences related to different content, will necessarily vary. Therefore, sophistication of links for an individual could potentially vary as well. This was the case, in that inter-item reliability for the SKLI was $\alpha = .35$. This low indicator of internal consistency seems similar to those found on some situational judgment tests (SJT), in which participants read or view a scenario and respond to it. In a synthesis of SJT studies, Lievens, Peeters, and Schollaert (2008) noted a range in internal consistency of 0.43 to 0.94; noting that when participants are asked to make a single choice when given a scenario, reliabilities may be as low as .24. Whereas prior learning among individuals may not vary (for example, it seems likely that most middle grades students will have studied Martin Luther King and human rights in school, given its inclusion in fourth grade social study books in the United States), what is salient as each student reads the text may vary. Given these sources of variation, our goal was to provide each learner a linking profile, noting his or her *typical* linking behavior, given a variety of content.

Using only those link-response pairs coded as 2 through 4, the overall mean for this group of students completing the SKLI was 2.88 (*SD* = .205), with scores ranging from 2.21 to 3.43. There were no apparent gaps in this distribution that would prompt useful identification of groupings within this small range of scores. As we scanned this data distribution, we were struck by how individuals with the same means could vary in terms of the distribution of their linking level. For example, a student having frequencies of 2–11–2 (level 2, level 3, and level 4 responses, respectively) would have the same mean score as a student who had five responses (5–5–5) at each level. However, we viewed these two patterns of responses as being quite different—one student made a variety of links of varying potential value, while the other primarily used links of similar potential value.

To address our concern about the limited usefulness of the mean as an outcome of the SKLI, cluster analysis was used to begin development of student linking profiles. The analysis included targets of 5 to 20 clusters (squared Euclidian distance), using each students' frequency distribution. Conceptually, we were able to describe the clusters that emerged. For example, students who had frequencies averaging 7, 7, and 1 for link-response levels 2, 3, and 4, respectively (*n* = 33), seemed to draw on irrelevant surface links and potentially meaningful links equally, but had minimal responses that indicated deeper links with elaboration. In contrast, students who had frequencies of 2, 9, and 2 (frequency for levels 2, 3, and 4; *n* = 27) used primarily level 3 links that were potentially useful for understanding the content and few simple or elaborated links. While the overall means of these two groups differed (2.6 versus 3.1), consider a third cluster that included frequencies 4, 5, and 5 (*n* = 32) for the three types of links. This group indicated a variety of linking levels. While it differed from both other groups, the mean for the group was

Table 3
Number of Students' Frequency of Response Levels

	Number of Students		
Frequency of Response	**Level 2 Response**	**Level 3 Response**	**Level 4 Response**
0	7[l]	0[l]	36[l]
1	23[l]	1[l]	82[l]
2	57[l]	0[l]	132[m]
3	88[m]	8[l]	106[m]
4	111[m]	19[l]	53[h]
5	74[m]	44[l]	31[h]
6	35[h]	62[l]	18[h]
7	39[h]	88[m]	3[h]
8	15[h]	84[m]	0
9	8[h]	72[h]	0
10	3[h]	52[h]	0
11	1[h]	23[h]	0
12	0	6[h]	0
13	0	2[h]	0
14	0	0	0
15	0	0	0
Total	461	461	461

l = Low frequency. Level 2: *n*=87, Level 3: *n*=134, Level 4: *n*=118;

m = medium frequency. Level 2: *n*=273, Level 3: *n*=172, Level 4: *n*=238;

h = high frequency. Level 2: *n*=101, Level 3: *n*=155, Level 4: *n*=105

Table 4
SKLI Profiles Including General Frequencies of Level of Responses, Number of Students, and Definitions

Profile	Included groups (n)	N	Definition
A	**HL**L (22) **HL**M (49) **HL**H (4)	75	Strong in level 2 links, without much use of level 3 links. These are the lowest level of processors, relying largely on surface links coupled with few links that could benefit from elaboration.
B	**HM**L (19) **HM**M (7)	26	Strong in level 2 links and some use of level-3 links.
C	**ML**M (16) **ML**L (2)	18	Little use of level 3 links. This small group may include errors or other anomalies.
D	**MM**L(20) **MM**M (69)	89	This group of students used all three levels of linking. They have the flattest profile, using all three levels of linking.
E	**MH**L (45) **MH**M (54)	99	Strong in level-3 links but still using level 2 links.
F	**LH**L (10) **LH**M (38)	48	Strongest and clearest level 3 links.
G	**MLH** (36) **MMH** (31)	67	High frequency of level 4 links while retaining a moderate use of level 2 links.
H	**L**MM (5) **L**H**H** (8) **L**M**H** (21) **LLH** (5)	39	High frequency of level 4 responses coupled with low use of level 2 links.

Note. Profile letters are hypothesized to be developmentally ordered from early to late. Level 2 links draw on surface characteristics and may not be useful for understanding the content. Level 3 links are those that could potentially be used for gaining understanding of the content. Level 4 links are those that, by their very nature, indicate a deeper understanding of the content.

quite similar to that of the second group (3.02). A student's frequency distribution was conceptually more meaningful than the student's mean. We noted 19 different clusters that captured seemingly different conceptual groupings.

Problematic in the interpretation of the cluster analysis results was the uneven distribution of the frequencies across link levels. Far more level 2 and level 3 responses exist for this group of students than level 4 responses. An examination of the distribution of frequencies for each response level revealed varying distribution peaks. These peaks indicated typical frequencies of each link level for these middle grades students. For this group of students, level 2 responses peaked at 3–5 questions ($M = 4.18$, $SD = 1.97$), capturing that type of linking; level 3 peaked at 7–8 questions ($M = 7.60$, $SD = 2.00$), and level 4 responses peaked with 2–3 questions ($M = 2.51$, $SD = 1.52$). The total frequency distribution for each level was divided into three groups indicating use of that level: low, medium, and high, indicating how frequently a student included a particular level of response. For level 2 responses, frequencies of 0–2 ($n = 87$) indicated low usage of that particular link level, frequencies of 3–5 ($n = 273$) indicated medium usage, and frequencies of 6-11 ($n = 101$) indicated high usage (Table 3). For level 3 responses, frequencies of 0-6 ($n = 134$) indicated low usage for this group of students, frequencies of 7–8 ($n = 172$) indicated medium usage, and frequencies of 9–13 ($n = 155$) indicated high usage. For level 4 responses, frequencies of 0–1 ($n = 118$) indicated low usage, frequencies of 2–3 ($n = 238$) indicated medium usage, and frequencies of 4–7 ($n = 105$) indicated high usage for this group of students.

Each student's personal frequency distribution was assigned a code at each level, indicating the relative amount of level 2, 3, and 4 responses. For example, a student who had frequencies of 4–10–1 (levels 2, 3, & 4) was assigned MHL (medium use of level 2 links, high use of level 3 links, and low use of level 4 links). These final eight frequency groups were compared

Table 5
Cross Tabulation for SKLI Profiles and Grade Level

		SKLI profile							
Grade		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
5th	Count	59	19	15	74	78	39	47	29
	% of Profile	16.4	5.3	4.2	20.6	21.7	10.8	13.1	8.1
6th	Count	16	7	3	14	21	9	20	10
	% of Profile	16.0	7.0	3.0	14.0	21.0	9.0	20.0	10.0
Total	Count	75	26	18	88	99	48	67	39
	% of Profile	16.3	5.7	3.9	19.1	21.5	10.4	14.6	8.5

Note. $N = 460$, given existing missing data.

with one another and qualitatively grouped into linking profiles. Frequency groups that shared at least two general frequencies were clustered (Table 4). For example, consider row 1 of Table 4. **HL**L, **HL**M, and **HL**H were grouped together, given the high number of level 2 responses paired with a low number of level 3 responses. These students largely used level 2 links (surface links), and the level 3 responses seemed yet to develop. The links the students in this group initially made, given a brief passage to read, largely drew on surface features of the content that were not useful in understanding the content.

We hypothesized that these frequency sequences could be organized developmentally (e.g., students with more 2s were at a different developmental level than a student with more 4s). Inspired by Seigler's (2005) notion of strategy development as a guide, we hypothesized that a learner may use a number of strategies at one time, but as one linking strategy gains prominence a lesser strategy may recede. Table 4 includes the proposed developmental ordering of these profiles. For example, Profile A (HL*) is proposed to be developmentally earlier than Profile C (MH*) because, as the incidence of simple links have declined, links that are potentially useful for promoting understanding and depth of processing

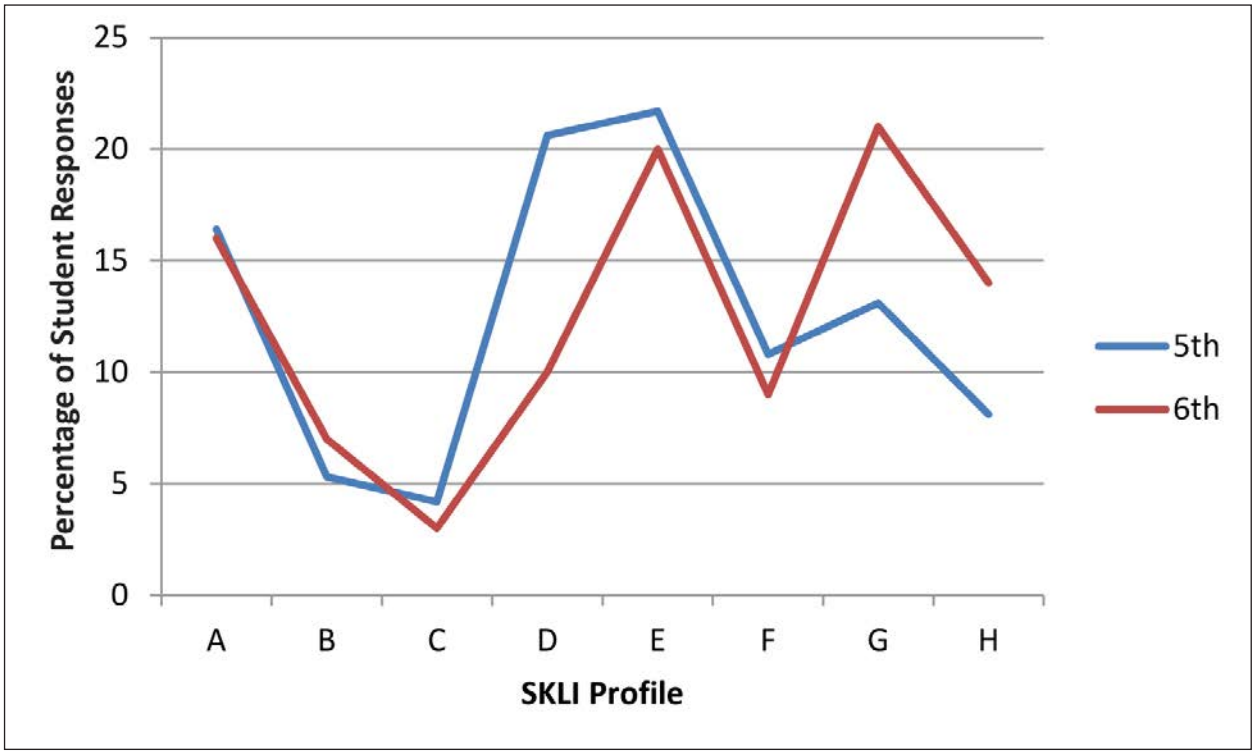

Figure 1. SKLI profile type by grade level

Table 6
Cross Tabulation for SKLI Link-Level Profiles and SKLIP Student Perceptions of Linking Attributes They Consider

			SKLIP Student Linking Attributes				
			Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**
SKLI profile	A	Count	16	26	6	18	8
		% of group	21.6	35.1	8.1	24.3	10.8
	B	Count	6	13	0	7	0
		% of group	23.1	50.0	.0	26.9	.0
	C	Count	5	6	2	2	2
		% of group	29.4	35.3	11.8	11.8	11.8
	D	Count	22	33	9	17	8
		% of group	24.7	37.1	10.1	19.1	9.0
	E	Count	25	32	7	24	10
		% of group	25.5	32.7	7.1	24.5	10.2
	F	Count	5	22	4	13	4
		% of group	10.4	45.8	8.3	27.1	8.3
	G	Count	11	20	10	15	7
		% of group	17.5	31.7	15.9	23.8	11.1
	H	Count	8	9	6	10	6
		% of group	20.5	23.1	15.4	25.6	15.4

Note. N = 454, given existing missing data.

have increased. Likewise, Profile H (L*H) is proposed to be developmentally later in linking information, given the low number of level 2 links and the high number of level 4 links.

We explored our hypothesis about the developmental aspect of these linking profiles through cross-tabulations of the linking profiles with student grade (Table 5 and Figure 1). While the trends were nearly identical for fifth and sixth grade students, what is clear in Figure 1 is the general prominence of a greater use of high-level links, those that indicate elaboration, for some sixth grade students. Problematic in this interpretation is the narrow age range of this group of participants. To further consider the developmental progression of linking, a broader age sample would need to be surveyed. Our expectation is that younger students would have fewer deep links, despite having content knowledge.

SKLI Linking and Student Perceptions of Linking

In the field study, students also completed the Student Knowledge Linking Instrument—Perception (Kuo et al., 2010). In one component of the SKLIP, students responded to two multiple-choice questions asking them to select the attributes on which they believed they typically linked. Choices included attributes of looks, behaviors, or processes. The resulting categorical groups included Group 1—*learners who state they use only one strategy* (consider how things look or how they behave); Group 2—*learners who state they use various combinations of how things look and how they behave*; Group 3—*learners who perceived they included process attributes along with one other attribute, either looks or behaviors*; Group 4—*learners who included all three attributes*; and Group 5—*learners who claimed they did not do any of the processes.* We did not include Group 5 in further analysis. Conceptually, Groups 1 through 4 are ordered in terms of complexity and quantity of attributes the students considered, and our expectation was that these categorical levels would align with the linking profiles from the SKLI.

A cross tabulation of the SKLI profile types and the SKLIP perceptions of attribute types does not indicate a clear relationship between students' perception of the types of attributes they link on and the links they actually made in the SKLI (Table 6). However, when the SKLIP data were collapsed,

Figure 2. SKLI profiles by SKLIP student perceptions of the types of strategies they use when linking new information

comparing SKLIP Groups 1 and 2 (who indicate comparing on how something looks or behaves) with SKLIP Groups 3 and 4 (who also compare on processes), an expected trend becomes apparent (Figure 2). Although the Pearson Chi-square statistic was non-significant, students who had low SKLI linking profiles were less likely to compare on processes ($\chi^2(7, N = 409) = 6.110, p = .527$). In other words, those who primarily create simple links also seemed to lack strategies that would prompt deeper links. Making comparisons or links based on processes may provide the often analogical connections evident in level 4 links (e.g., comparing Middle Ages serfs with current individuals who are poor). Further study is necessary to better understand what elements allow students to create these deeper connections.

Discussion

The SKLI prompts students to demonstrate their typical knowledge-linking level. Student linking, it is hypothesized, is important in the development of learners' new understandings, particularly when considering learning from a constructivist perspective and the stance in middle level education that students need to be able to create a variety of connections using prior knowledge and in- and out-of-school experiences. We believe the value of the SKLI lies in three areas: methodological, developmental, and instructional.

The conceptualization and development of this instrument was based on a constructivist perspective of how learners build their own understandings of content they learn in school. The response types were derived from data that captured the types of links that middle grades students do make. Specific response items and the values that were given, in terms of scoring, drew directly from students links in a number of ways. First, the link-reason pairs stemmed from categorical data about the types of links that students make, given content in their classrooms. Second, given the students' response to the items in the study, the response pairs that were initially coded as being inconceivable as links were, upon closer inspection, adjusted as students selected those link-response pairs, thereby better capturing the links that young adolescents make. In many ways, the development of the instrument was responsive to how students think. Given these efforts, the methodological value of the SKLI is its strong ecological validity as well as its strong face validity.

As students grow from childhood to adolescence, a number of developmental changes take place. Along with cognitive changes, such as the transition from primarily concrete to more abstract thinking

(S. D. Powell, 2011), these middle grades learners continue to gain prior knowledge both in and outside school. As these learners gain prior knowledge, the substantive links they make between what they are learning and what they know should increase as they become more adept at identifying similar relationships that exist between their current learning and what they already know. As they transition from more concrete forms of thinking to more abstract thinking and develop greater prior knowledge, they also become better able to increase their ability to inhibit particular responses and extraneous information (Kuhn & Franklin, 2008) in their learning environments. While SKLs may be offered overtly in class, and addressed or discarded as the teacher chooses, they may also be internal thoughts rather than being expressed aloud. As such, it is the learners' responsibility to regulate those links with their prior learning, inhibiting those that are not useful and exploring those that may be. However, a fine line divides inhibiting personal understandings that may be spontaneously cued in a learning environment and exploring potentially relevant ones that could add depth and relevance to understanding academic content. Kim's (2011) analysis of more than 40 years of norming data for the Torrance Test of Creative Thinking notes a decrease in a number of types of creative thinking around grade 6. In contrast to the continued development of inhibition in early adolescence related to focusing attention on relevant information and tuning out irrelevant responses, links such as those captured by the SKLI may well be fodder for creativity and analogical thinking, a goal for effective middle grades classrooms (Center for Collaborative Education, n.d.). Seemingly irrelevant links may be useful, at the very least providing a glimpse of the student's situation definition.

While students will vary in prior knowledge, they may also vary in terms of surface or deeper processing of information. Developmentally, the data in this study indicated a non-significant trend for some sixth grade students to use more higher-level links when linking text from a short passage with what comes to their minds, given that information. Although we noted the use of simple links for all students, the links of the younger students typically lacked this type of elaborative element. This trend could be prompted by older students' potential familiarity with the content. In future studies with the SKLI administered to older and younger students, the students should be prompted to indicate their familiarity with the content of a particular passage to further explore this potential developmental trend. Ideally, a longitudinal study noting how students change their linking strategies is needed, particularly given the developmental shift from concrete to abstract thinking abilities for this age group. The documentation of the developmental sequence that may follow from further study might be best characterized as a type of "school" development, in that it considers the integration of personal knowledge with the expanding curriculum of school.

Given this type of school development, what are potential implications for teachers? First and foremost, SKLI profiles provide a foundation for understanding a student's situation definition, from which a teacher can proceed with instruction. Knowing a student's typical link levels may allow the teacher to more quickly conceptualize how the learners are viewing the information. The learner's profile points to typical components of what a student's initial situation definition may be; in other words, what of the content or item being learned might attract his or her attention or seem most relevant. It is only in the adult understanding of the learner's view that growth in the zone of proximal development is facilitated through scaffolding, prompting a redefinition of the learner's view. To redefine how a learner is considering the content, it seems important to understand how the learner initially defines it.

For example, consider a learner who initially creates a link regarding Martin Luther King, noting a relationship between human rights issues today and those of serfs during the Middle Ages. This learner may be ready to attempt a deeper analysis than the learner whose initial link is that King was African American, or a learner who thinks of a "king." Each of these responses provides an indicator of where the student is along a personal trajectory at a particular time. This unique attempt at meaning-making will likely point to a logical direction a teacher may use to proceed with individual students within the same content area. Those learners who exhibit primarily level 2 links may benefit from scaffolding that focuses on structuring the task or the content (Reiser, 2004), particularly helping the learners to focus their efforts on particular elements that expand beyond those simple characteristics. Students who exhibit links that show potential for learning, such as level 3 and level 4 links, may benefit from scaffolding that is more problematizing in nature (Reiser). This form of scaffolding prompts students to elicit their decisions in more detail, further elaborating and justifying their link. From this scaffolding, a situation

redefinition for the learner may occur, fostering deeper understanding.

While the SKLI was developed with information from a variety of sources, the SKLI also may be viewed as a template from which teachers may develop a brief pre-assessment about a particular content area. Given a brief passage from a teacher-chosen content area and reflection on the kinds of errors and links that student have made in the past, a teacher may develop response options for what the topic and text reminds the student of and the potential reasons for their link. A teacher also may use an open-response question to gather information. These strategies would allow the teacher to discover the students' prior knowledge, misconceptions, and linking prospects in an efficient way.

The use and regulation development of links may be fostered in particular kinds of classrooms (e.g., Schuh, 2003). Allowing the kinds of links on which the SKLI is based provides students an opportunity to share their voice (National Middle School Association, 2005). Placing value on the diversity of links students make acknowledges that "the development of all young adolescents occurs in the context of classrooms, families, peer groups, communities, and society" (Standard 1), aspects that become keenly visible through the SKLI choices students make. While this also may be accomplished through questioning or K-W-L activities, an instrument such as the SKLI allows equitable participation of students and, in particular, provides permission to link beyond the classroom walls.

Certainly, limitations appeared in the development of the SKLI. The first limitation concerns the view of the learner in relation to an item. What if a learner does not find a choice that aligns well with what came to mind? Although we felt that the breadth of choices provided would make it possible for students to find something related to their idea, given how the question development was approached, we have no assurances that they did. Perhaps students who chose pairs that were coded as 0 or 1 were unable to find their idea and randomly responded. We removed the *other* option because of the coding difficulties that it presented for a large study and also for further use. However, for teachers using the instrument or a single item, it may serve their purposes to include an *other* category to capture other links that students may have with the content. Choices that included words that served as homophones (such as flour and flower) will be updated in the next version of the SKLI.

In addition, although we had chosen the content from fourth grade sources, we gathered no information about the students' familiarity with the content. A students' linking level could be contingent on prior knowledge rather than any type of linking process. Further exploration will help tease out the role of these variables.

Finally, the knowledge linking process is complex. Given the premise of constructivism, prior knowledge is always in play. What students know will certainly affect their understandings. Further, what they know varies by any number of factors, including opportunities such as if or where an individual may take a vacation, learner engagement with parents and friends, as well as other opportunities within school and beyond. As with any measure, the outcome, in this case the SKLI student profile, provides only one small aspect of a larger, complex phenomenon.

Summary and Conclusion

The SKLI provides a look at the types of links a learner may make with new content. This article documents the development of that instrument, noting how it was grounded in the types of links middle grades students made. Students' scores on the SKLI are classified into one of eight different linking profiles, capturing the typicality of each students' links as being surface level links, links that are potentially useful for learning but in need of scaffolding, and those links that show an elaboration of deeper understanding. Although not of statistical significance, the results of the field study with 461 students indicated a trend of sixth grade students using deeper links than those used by fifth graders. To justify this trend, a study using a wider age range of students is needed. We also considered the level of links students make with their perceptions of what they may do when they create links, noting, again, a trend (although non-significant) toward those who compare on processes having more level 4 links. Our work continues as we begin to consider the relationship between the students' linking profiles and their achievement on a standardized achievement measure. Our expectations, given previous research (Owings et al., 1980; Peterson et al., 1982), is that more successful students will be more adept at making and using personal links. Additional studies of how teachers may foster (Schuh, 2003) and how students evaluate and regulate the use of personal links seem useful, given the current constructivist view of how learners develop their understandings.

Learners do bring a variety of experiences with them into the classroom, and those experiences are lenses through which they approach their learning tasks. While diversity will exist across student experiences, similarities may exist in how learners may use those experiences as they explore new content. Perhaps most important, no single teacher knows all the similarities students find with the content, but effective teachers allow students to have opportunities to lay those cards, so to speak, on their learning table. If we truly seek education that has relevance, then student experiences have value; yet it is only in giving learners opportunities and permission to share those links, in providing an environment that values them, and in prompting students to think about them that these links can be used as foundations for learning and promote personal relevance in the content. Linking profiles are one means to provide teachers a glimpse into how a learner might view content at a particular time, given his or her experiences.

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Appendix A
SAMPLE ITEM FOR FINAL SKLI

When coal and oil are burned, gases enter the air. These gases mix with rain to form acid rain. Acid rain has harmful chemicals that wash into lakes.*

THINK! What came to mind while you read this?

(Slide the cover-up sheet to the next stop sign when you have your idea.)

Choose the topic or idea that best matches what you thought of when you read the passage. If none of the choices match exactly, choose the one that is closest to your idea. Mark only one circle.

What I read reminds me of …

- ○ A rainbow.
- ○ A fire.
- ○ A book, movie, or TV show.
- ○ The ozone layer.
- ○ Pollution.
- ○ Someone I know.
- ○ Some place I've been.
- ○ Acid rain.

THINK! Why do you think that topic/idea came to mind?

(Slide the cover-up sheet to the next stop sign when you have your idea.)

Which of the following choices best matches why you think the topic came to your mind? If none of the choices match exactly, choose the one that is closest to your idea. Mark only one circle.

It reminded me of that because …

- ○ It had a lake.
- ○ Both involve burning something.
- ○ They are both created by water in the air.
- ○ That's what it's like today.
- ○ It was about acid rain.
- ○ They both are harmful.
- ○ Other things get in the air.
- ○ We did a project on it.

Go to the next page when you are ready to go on.

* Note: Citation not included on student copy (Mallinson et al., 1993, p. 340, reprinted here with permission by Pearson Education).

Appendix B
FINAL RESPONSE CODING LEVELS FOR SKLI

1: The relationship between the link and reason is unidentifiable. These pairs may be syntactically incorrect, make no semantic sense, or indicate that the learner was not relating the link with the reason but rather looking at the choices individually (i.e., the link relates to the reading, the reason seems to link to the text, but the link is unrelated to the reason).

2: The relationship between the link-reason pair and the text is one that reflects a surface element of the text that is not expected to help the learner understand the text. The link often stems from a surface cue that is not a critical characteristic in the text (e.g., a link about color, when color is irrelevant to understanding the concept in the text) and is unlikely to help the learner make progress toward the learning goal.

3: The student has noted a link-reason pair that has potential to aid in addressing the text and, thereby push the student toward the learning goal. This level link is often realized in an example—the learner has had some type of experience that seems relevant in understanding the text, moving the student toward the learning goal. However, given the link-reason pair that the learner has created, there is need for asking them additional questions to help them apply what they know to the text.

4: Students who make these kinds of links indicate an understanding of the relationship between their link and the text in a way that indicates they have a deeper conceptual understanding. Oftentimes, this link is realized as an analogy. Rather than having to ask the learner to explain his or her link so that the teacher and others can understand it, the link is apparent and conceptually deep, fostering a conversation about multiple shared attributes between his or her links and the text.