INDIVIDUAL DIFFERENCES IN CONSTRUCTIONIST LEARNING ENVIRONMENTS: QUALITATIVE INQUIRY INTO COMPUTER MEDIATED LEARNING ARTIFACTS

by

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(Under the direction of Rob Maribe Branch)

ABSTRACT

The purpose of this study was to explore how individual differences are used in the construction of learning artifacts while working within a constructionist learning environment. The research questions focused on the products the learners produced, the process the learners engaged in and the constructionist learning environment's support of the learners.

Qualitative methods were employed to select participants, collect and analyze data, as well as illustrate the emergent themes from the data with attention with rigor and trustworthiness. A case study design was used with five participants purposively selected from an eighth grade geography class at a small, private day school in the southeastern United States. Data were collected through interviews, observations and artifacts. Data analysis employed the constant comparative method in a recursive nature in order to generate meaningful, data-driven themes.

From across the data collected to answer the research questions, five themes emerged: (1) internal influences, (2) external influences, (3) beliefs about projects, (4) tools

for technology-rich environments, and (5) learning outcomes and products. Internal influences included the participants' abilities, motivations, self-management and their perceptions about effort. External influences included teacher expectations and directions, grades, time and practical considerations. The intangible characteristics of projects, such as enjoyment, freedom and autonomy, and the concrete qualities, such as images, color and interactions, contributed to the participants beliefs about projects. Tools for technology-rich environments used in the unit on human rights were comprised of resources, scaffolds and collaborations. Computers as a resource in the learning environment were used primarily as a productivity tool. Finally, learning outcomes and products encompassed the intentional cognitive goals of the unit in addition to affective goals.

The emergent themes as related to the research questions indicated that learning products represent a blend of decisions about individual differences. Situating the results of this study within existing literature, a model was proposed to understand the influences on decisions by learners. The ecology of learning products model included six layers: (1) a biology substrate, (2) abilities, (3) a cultural filter, (4) opportunities to develop expertise, (5) a contextual filter and (6) learning products and artifacts.

INDEX WORDS: Constructionism, Individual differences, Computer mediated learning, Project-based learning, Student centered learning, Learning environments, Abilities, Learning artifacts, Multiple Intelligences

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DEDICATION

To my wife, Katie —

You began *this* journey with me as we began our lives together.

I look forward to all our journeys to come.

A.T.W.T.T.M.A.B.

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RESEARCHER'S NOTE: As I have been writing up the results of this study, most days in our local newspaper, The Athens Banner-Herald, *reports of the conflicts between India and Pakistan over the small Himalayan region of Kashmir. The possibilities of nuclear war seem palpable. I am sure that without this research I would have scanned the headlines of these articles and moved on to something more local with greater impact. Without Allison, Bob, Brittney S., Brittney T., Brock and their Geography teacher, I would never have known about the tragedies in a small corner of Asia, or in Argentina, Sri Lanka and Sudan. I thank all of you for letting me learn along side of you and opening my eyes to countries and situations that seemed too far away except for all we discovered on the Internet.*

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CHAPTER 1

INTRODUCTION

Individual differences acknowledge aptitudes, skills and preferences inherent to all learners whether in formal or informal learning settings. The complexity of learning is reflected in these differences. An individual must be willing or motivated to learn; he or she must be able to learn; the environment must foster learning; and the instruction must be effective for the learner (Jonassen & Grabowski, 1993).

In an attempt to understand how and under what conditions individuals learn best, researchers (for example, Caudill, 1998; Dunn & Dunn, 1979; Gordon, 1998; Hassler, Birbaumer, & Feil, 1985; Kirby, Moore, & Schofield, 1988) have attempted to isolate these variables independent from one another. These included cognitive styles (Renninger & Snyder, 1983), learning styles (Dunn & Dunn, 1979; Gregorc & Ward, 1977), learning modalities (Samples, 1992), and various individual abilities (Doxey & Wright, 1990; Eliot & Hauptman, 1981; Gardner, 1983; Karma, 1982). Much of this research has relied on two assumptions summarized by Jonassen and Grabowski (1993): "Individuals differ in their abilities to process information, construct meaning from it, or apply it to new situations [and] different learning outcomes require different skills or abilities" (p. 19). These assumptions indicate much of the learning has been predetermined for the learner. Learning environments that encourage freedoms for the individual may offer broader access to distinctive skills and abilities.

Over the past decade, others have addressed the individual's needs with constructionist learning environments. Rooted in constructivism, constructionist learning environments provide the individual autonomy over, and responsibility for, what is learned (Means, 1994; Means & Olson, 1994; Wilson & Cole, 1991). With resources, scaffolds and coaching, many of the responsibilities for learning are relocated from the teacher and to the learner. These environments encourage individuals to explore and examine a variety of problems and resources, to construct personal strategies for handling these problems, as well as to negotiate and share solutions with others (Barrows & Tamblyn, 1980; Blumenfeld et al., 1991; Collins, Brown, & Newman, 1990; Levstik & Barton, 2001; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Moursund, 1998; Perkins, 1991).

The flexibility inherent to constructionist learning environments promotes individual differences by accommodating different styles or modes of learning, various representations of learning and different abilities and ability levels (Kafai & Resnick, 1996a). This flexibility calls into question the assumption that the skills or abilities associated with any given learning outcome are known or can be predetermined in order to manipulate the learning environment to accommodate or foster specific individual differences. Providing learners freedom and latitude to explore content and solutions may make predetermining the different skills or abilities associated with specific learning outcomes impossible. Both research (for example, Renninger & Snyder, 1983; Vos, 1997) and pedagogy (for example, Pinkerton, 1994; Ross & Schulz, 1999; Simeone, 1995) have been based on the assumption articulated by Jonassen and Grabowski (1993) that teachers, instructional designers and course developers can accommodate individual differences by determining the skills and abilities learning outcomes require. These conclusions may need to be adapted or challenged

as accountability for learning resides with the individual in constructionist learning environments.

As a learning theory and instructional model, constructionism has extended the notion of learner-centeredness (Harel & Papert, 1991; Kafai & Resnick, 1996b). Constructionism posits that individuals learn best when they are constructing a personally-meaningful object, or artifact, that can be shared with others and reflected upon. These artifacts can include plays, poems, pie charts or toothpick bridges. Learning environments should promote the creation of artifacts that represent the learning in addition to encouraging autonomy and responsibility for learning by the individual.

Looking to the individual and his or her learning differences offers a unique perspective to constructionism. Concentrating on the inherent qualities of the learner, such as abilities, helps bring into focus how an individual relates to his or her environment, how knowledge is constructed and how learning is interpreted in artifacts. These interpretations of learning are filtered through an individual's learning differences and are subsequently reflected in the learning artifact. Therefore, the learning artifact not only represents the learning but also reflects the individual differences of the learner. Fundamentally, constructionism affords flexibility for the learner and for what is learned.

There are numerous examples and strategies for implementing constructionist learning environments, including project-based science (Blumenfeld, Krajcik, Marx, & Soloway, 1994; Blumenfeld et al., 1991; Marx et al., 1997), project-based learning (Land & Greene, 2000; Lundeberg, Coballes-Vega, Standiford, Langer, & Dibble, 1997; Moursund, 1998; Wolk, 1994), disciplined inquiry (Levstik & Barton, 2001), constructionism (Harel & Papert, 1991; Kafai & Resnick, 1996b), and open-ended learning environments (Hannafin, Hall, Land, & Hill, 1994, October; Hannafin, Land, & Oliver, 1999). Many of these methods include

design activities; however, some researchers (Tobin, Tippins, & Gallard, 1994) caution against pedagogies that are distinguished by practical or applied projects. Jonassen and Reeves (1996) assert that many of these projects do not encourage deep or meaningful processing. So, while they may be hands-on, they are not "minds-on," and may not provide opportunities for reflection or synthesis and evaluation of content.

Statement of the Problem

Adapting instruction to accommodate learner differences has been successful in teacher-centered instructional environments (see for example, Dunn & Dunn, 1979; Renninger & Snyder, 1983; Samples, 1992). However, individual differences have yet to be fully explored in constructionist learning environments. Dewey (1938) promoted "learning by doing," where individuals experienced learning through activities reflected in real life. Vygotsky (1962; 1978) also encouraged experiential learning. More recently, Brown, Collins and Duguid (1989) and Lave (1990) have proposed learning is contextualized for individuals. Through interactions with the environment, including people and technologies, individuals create meaning. The most effective learning environments, suggested by Vygotsky, afford learners personal interest and the opportunity to negotiate meaning from others (Brush & Saye, 2000). So, pedagogy that fosters personal interests and interactions with peers, experts and technologies seem to offer an alternative to teacher-centered instruction.

Constructionist learning environments present one method for learner-centered instruction. Models for implementing constructionist learning environments and examples of constructionist projects are presented throughout the literature: Brush and Saye (2000), Drake and McBride (1997), Harel and Papert (1991), Jonassen, Carr and Yueh (1998),

Jonassen and Reeves (1996), Kafai and Resnick (1996b), Land and Hannafin (2000), Levstik and Barton (2001), Marx, Blumenfeld, Krajcik and Soloway (1997), Moursund (1998) and Scott (1994). Despite constructionist learning environments purporting to accommodate diversity among learners (Kafai & Resnick, 1996b; Marx et al., 1997), there is very little research that examines how individual differences are represented in these learning environments and in what ways individual differences are reflected in the learning artifacts that are constructed within these environments.

Purpose of the Study

The purpose of this study is to explore how learners incorporate their individual differences into the construction of computer mediated learning artifacts within a constructionist learning environment. More specifically, this research seeks to describe the interaction among learners, the constructionist learning environment and the creation of computer mediated learning artifacts.

Significance. The interactions among the learners and the learning environment should be meaningful to a number of constituents. First, to inservice and preservice teachers, the design of curricula and learning environments that engage their learners is essential. Individualizing instruction for each learner is a goal the current educational system struggles with daily (Gardner, 1983). Understanding how learners feel the learning environment affects them is a voice sometimes unheard. Exploring how learners personalize learning for themselves may be valuable for teachers when making instructional decisions, such as instructional delivery, available resources and assessment.

Second, for instructional designers and curriculum designers, understanding how learners' differences are interpreted in the learning environments designers have constructed

is an important segment in the cycle of evaluation. Integrating the results of learner analysis with the results of formative and summative evaluations sustains the avenue for recurrent improvements to the design. How learners use robust resources, such as computers and the Internet, when creating artifacts of learning also provides valuable data to designers as they plan effective implementations in everyday settings, such as K-12 classroooms.

Finally, researchers contribute to the research-to-practice circuit. Understanding how learners learn and represent their learning in complex learning environments provides data about individualizing instruction by the learner and the design of instruction centered on the learner. Blending research results into preservice teacher education and inservice professional development completes the cycle to refine pedagogy. Improving classroom instruction and effecting educational change are also worthy research agendas for action researchers teamed with cooperating teachers.

Assumptions. Each of the constructionist learning environments identified in this study has unique characteristics; however, some assumptions are common across all of the constructionist learning environments in the conceptual foundation for this study. Constructionist learning environments require learners to be responsible for aspects of learning that may have been previously directed by the teacher (c.f. Perkins, 1991). One assumption is that learners are able and will be actively engaged in these activities in order to enable their success within the environment. Learners will need to analyze problems in order to generate goals and synthesize possible solutions (Hannafin et al., 1994).

A second assumption is that learners will be able to employ metacognitive skills in order to be successful in the learning environment. Self-regulation, self-management, and self-assessment will be necessary for success. Learners must be able to monitor their own progress and determine actions to be taken (Grabinger, 1996). Those who do not have these

skills may find themselves overwhelmed by the scope of the activity, because they are not only managing new content but also attempting to employ executive controls that are new as well. Research suggests that these skills can be improved through practice (see Grabinger, 1996 for a comprehensive review).

Lastly, many constructionist learning environments emphasize collaboration among learners. Whether to accommodate for too few resources or to capitalize on peer interactions, it is often assumed that learners have the skills necessary to work in groups successfully. Johnson and Johnson (1989) as well as Duffy and Cunningham (1996) suggest that individuals must have instruction on how to work together effectively, negotiating differences and sharing decision making with regard to cooperative and collaborative learning environments.

Limitations. This study is limited by three factors. First, many constructionist learning environments rely on technological tools to support learning (see for example, Kafai & Resnick, 1996b; Marx et al., 1997). Differences in the learners' computer skills and expertise may affect how they represent their learning and limit the ways in which their individual differences may be manifested. Second, the learners' metacognitions and their ability to verbalize how their individual differences are represented in their artifacts may be difficult. This is also dependant to a degree on the researcher's ability to elicit and interpret the learner's meaning with relation to how his or her differences are incorporated into the artifact. Finally, as mentioned previously, constructionist learning environments often use cooperative or collaborative forms of learning (Jonassen, 1995; Marx et al., 1997; Moursund, 1998). Individuals who are unskilled at working with others may have their personal viewpoints obscured by more gregarious or persuasive individuals. Therefore, their

individual differences may be overshadowed by others and not completely represented in the final artifact.

Delimitations. This study focuses on the learner and how he or she behaves in the learning environment. While studies, such as Brush and Saye (2000), have suggested more research is needed with respect to teachers in non-traditional learning environments, this study does not attempt to investigate the teacher's role nor present the teacher's point of view. However, the teacher is an integral part of the instructional environment and cannot be removed from the study, which attempts to understand the subtleties and complexities native to the learning context. Therefore, the teacher is a fundamental part of the learning environment and interactions among learners and the teacher must be included as other resources, scaffolding methods and collaborators.

Research Questions

Learning is a complex process. Attempts at investigating isolated characteristics of individual differences (for example, Renninger & Snyder, 1983; Vos, 1997) dismiss the other elements of the learning environment. By seeking to understand and interpret the interactions among the learners, the constructionist learning environment and the learning artifacts, more data will be garnered about how individuals represent their learning, as well as how individuals function in environments with less teacher direction and more learner autonomy. Results of other research (for example, Brush & Saye, 2000) suggest many factors contribute to the success of learning environments and isolating these variables provides little evidence for effective designs or implementations. As suggested by Jonassen and Reeves (1996) it is important and relevant to explore learners' behaviors within constructionist learning environments, where individuals are active in constructing artifacts that are meaningful to them.

This study will explore four research questions:

1. Within a constructionist learning environment, in what ways do computer mediated learning artifacts reflect individual differences?
2. In what ways do learning artifacts reflect a learner's knowledge?
3. How does the construction of learning artifacts allow learners to tap individual differences?
4. How do constructionist learning environments support individual differences?

CHAPTER 2

REVIEW OF LITERATURE

Education in the Industrial Age focused on transmitting a common skills set (Strover & Bryant, 1983) with little regard for an individual's abilities or desires. This educational structure with emphasis on mathematical and verbal skills is still in place today (Gardner, 1983). The Information Age, however, some authors (for example, Dietrich, 1999; Messmer, 1996; Ross & Bailey, 1994) suggest, requires knowledge and skills in addition to those stressed in the Industrial Age, and some researchers (for example, Harel & Papert, 1991; Kafai & Resnick, 1996b) suggest individuals learn better when elements of instruction are personally meaningful. So, as teachers make grass-roots changes to transition away from an Industrial Age system, two elements are becoming more commonplace in the classroom: learner-centered instruction and computers.

Learner-centered teaching methods permit individuals more flexibility in what they learn and how they demonstrate their knowledge. With the focus on the learner, there seems to be some evidence that making accommodations for learners' differences in instruction helps improve learning (Dunn & Dunn, 1979; Renninger & Snyder, 1983; Samples, 1992). There has been a long history of attempting to match instruction to learner traits, or differences (see Jonassen & Grabowski, 1993); however, much of this research is founded on the assumption that "different learning outcomes require different skills or abilities" (p. 19). This assumption may need to be adapted or challenged as increased autonomy of and responsibility for learning is returned to the individual.

One example of a learner-centered pedagogy is constructionist learning environments (Harel & Papert, 1991). Constructionism offers an instructional model for emphasizing the construction of knowledge and knowledge artifacts, while supporting individual differences among learners (Kafai & Resnick, 1996a). Although little of the research examines differences among learners directly, the literature base provides insights about implementation with teachers (Blumenfeld et al., 1994; Scott, 1994) and students (Stratford & Finkel, 1996).

In addition to increased uses of more learner-centered instruction, such as constructionist learning environments, computers are becoming more ubiquitous in classrooms. Although the research to support improved learning with computers and other media is inconclusive (Clark, 1994), authors purport access to technology enables learners to investigate and research with more authenticity. In addition, it has been suggested that computers offer a means to present information in multiple ways, such as through multimedia, as well as to help students construct knowledge in multiple ways (Jonassen & Reeves, 1996; Marx et al., 1997). With computers, individuals are constructing representations of learning as computer mediated learning artifacts. This seems to be consistent with researchers who support higher-order thinking activities (Blumenfeld et al., 1991; Harel & Papert, 1991; Kafai & Resnick, 1996a; Tobin et al., 1994).

Despite the extensive literature on individual learning differences, little has been directed toward learner-centered environments, such as constructionist learning environments. More specifically, only limited literature addresses how learner differences are accommodated in constructionist learning environments as individuals construct computer mediated artifacts. This review uses the main research question "Within a constructionist

learning environment, in what ways do computer mediated learning artifacts reflect individual differences?" as a guide to focus the examination of literature.

The three main variables within this question were used to guide the literature search: (1) constructionist learning environments, (2) computer mediated learning artifacts and (3) individual differences. The resources for this review were collected through a variety of methods. Recommendations from colleagues and faculty provided a number of valuable references and leads to other research. Keyword searches in *ERIC*, *PsycINFO, GALILEO Interconnected Libraries* (GIL) and other library databases were helpful in providing initial references. The bibliographies in these references and other seminal works permitted locating edited chapters, books and conference presentations not often available in database searches. Mining-the-bibliographies method was especially helpful in locating references that are now available on the Internet, such as conference presentations.

This review of related literature is organized into three sections. First, a survey of how individual differences has been primarily researched and interpreted is presented. Second, a definition of computer mediated learning artifacts is considered. Finally, the conceptual foundations to support constructionist learning environments are examined, along with implications for practice.

Individual Differences

The basic tenet of constructivism is individuals construct meaning (Vygotsky, 1978). By focusing on the first portion of this premise — the individual — the importance of differences among individuals and how they learn becomes evident. Individual differences recognize the aptitudes, skills and preferences inherent to all learners whether in formal or informal educational settings (Jonassen & Grabowski, 1993). The literature is replete with cognitive styles (Renninger & Snyder, 1983), learning styles (Dunn & Dunn, 1979; Gregorc

& Ward, 1977), learning modalities (Samples, 1992) and various abilities (for example, Gardner, 1983, 1999; Karma, 1982; Osborn, 1983). All of these classifications and taxonomies attempt to address the individual learner's needs.

When learners prefer one method of instruction to another, research has demonstrated that making allowances for the preference can improve academic achievement and learning (Dunn & Dunn, 1979; Renninger & Snyder, 1983; Samples, 1992). Creating a learning environment that acknowledges and tolerates individual learning differences may enable students to perform better. For example, Renninger and Snyder (1983) reported that learners with field independent cognitive styles outperformed cohort learners that were field dependent on mathematical and verbal assessments. The current educational structure emphasizes mathematical-logical and verbal-linguistic skills (Gardner, 1983) for all learners with a certain amount of inflexibility in instructional strategies, affording field independent learners an advantage. Can field dependent learners succeed in a field independent environment? While additional research is needed to address this concern, learners are highly adaptable and still learn in spite of many instructional interventions (Jonassen, Campbell, & Davidson, 1994).

Samples' (1992) work concurred with Renniger and Snyder: Learner performance improved when learner differences were acknowledged and incorporated into the classroom environment. "Learning modalities offer reluctant learners a chance to demonstrate that they possess sophisticated knowledge that goes beyond their skills in reading and writing" (p. 64). So learners who are strong in other learning modalities may benefit from representing their knowledge in an alternative manner. However, there are criticisms about our ability to accommodate individual differences.

Not a clear picture. Not all researchers and practitioners support the facilitation of individual differences. O'Neil (1990) reports the improvements demonstrated when learning differences were accounted for might be artificial. Students may simply perceive someone cares about their success and their needs. In essence, the learners are demonstrating a Hawthorne Effect (Cook, 1967), synthetically reacting to a contrived treatment.

While these student perceptions may be true, the complexity of learner differences may not be attributable to any one single factor, such as learning styles or learning modalities. Instead, the educational system — that structures learning methods around mathematical and linguistic knowledge — may be reinforcing a sense of failure to students who cannot learn in Industrial Age classrooms (Grobecker, 1998). This recurring negative attitude of being unsuccessful in Industrial Age classrooms may build a resistance to learning altogether. Reckinger (1979) added, "if they are oral learners, kinesthetic learners, independent learners, or any of the many other combinations of diverse elements that make up personality and learning styles, their chances of getting through the traditional system with their self-esteem in tact are close to zero" (p. 255). She also cites a study conducted by the director of California Youth Homes, where at the time, 70–80% of the juveniles in detention centers were auditory learners.

Some of the strongest support for integrating learner differences into the classroom has the least research to endorse its use. The intuitiveness of learner differences is a moving factor. While we recognize individuals in a multicultural view — gender, ethnicity, and learning disabilities for example — personalizing education to an individual seems as logical as any other accommodation that may be made. Researchers (Dunn & Dunn, 1979; Gardner, 1993; Gardner & Hatch, 1990; Gregorc & Ward, 1977; Renninger & Snyder, 1983) seem to agree that making accommodations for learner differences allows students to learn

in methods best for each student. Students may then be able to capitalize on their strengths and play an active role in their learning and knowledge construction — fundamental skills needed in the Information Age — but there are challenges to successfully accommodating differences.

Challenges to implementation. Acknowledging and implementing learner differences in the classroom does not come without challenges. O'Neil (1990) referencing Anthony Gregorc, creator of the Gregorc Style Delineator™, cautions that attempting to teach to all learning styles can quickly cause teacher "burn out." Burn out is described by Abel and Sewell (1999) as emotional exhaustion, depersonalization and a devaluation of personal accomplishments. As time demands increase and classroom climates deteriorate, Abel and Sewell suggest that exhaustion sets in and few education goals are accomplished for students. These are concerns as teachers attempt to modify instruction for learners. Gregorc (1999) through his own research has chosen not to pursue developing an instrument for children due to inconsistent validity.

Whether teachers should address all learner differences is an important question as well. Renniger and Snyder (1983) and Barbe and Malone (1981) report students often learn the most when their learning preference matches the teacher's learning preference. So, exposing learners to a larger number of preferences may also improve student learning without overextending an instructor's resources or capabilities. However, Dunn and Dunn (1979) contend that it is not practical to match a teacher and a student's styles, and to some extent, this may be another form of ability grouping.

Research regarding individual differences has attempted in many cases to isolate one characteristic of the learner within the learning environment (for example, Cronbach, 1971; Cronbach & Snow, 1977; Dunn & Dunn, 1978; Dunn & Dunn, 1979; Gordon, 1998;

Gregorc & Ward, 1977; Hassler et al., 1985; Sadler Smith, 1997). Isolating characteristics of learners has led to attempts at adaptive or individualized instruction by instructors, software designers and curriculum coordinators. As mentioned above, individuals are adaptive and learn in spite of treatments to the learning context (Jonassen et al., 1994).

Individual Differences and Technology

Technology as an integral part of the learning environment supports the learning and the learner, often offering accommodations for individual differences. Settings that encompass this direction to technology includes open-ended learning environments (Hannafin, Hill, & Land, 1997), learning with technology (Jonassen et al., 1994), software and microcomputers (Means & Olson, 1994; Smith, 1996), constructionism (Harel & Papert, 1991; Kafai & Resnick, 1996b) and cognitive tools (Jonassen & Reeves, 1996; Schacter & Fagnano, 1999).

The use of technology to improve learning has yielded inconclusive results (Clark, 1994; Russell, 1999). However, throughout the literature about technology-supported learning, three themes emerge as powerful advantages to supporting learning and learners: (1) personalized or individualized instruction is possible; (2) authentic learning and knowledge construction can be achieved; and (3) learners can access higher-order thinking skills. This section will examine all three themes in relation to the literature on technology-supported learning.

Individualized instruction. The current educational system disregards much of the individual needs of learners during instruction (Gardner, 1983). However, a learner-centered paradigm shifts the focus from a teacher-directed environment to a context where the learner is active in the learning environment (Dewey, 1916; Vygotsky, 1978). This constructivist perspective affords the learner more individualized instruction (Jenkins, 1996).

More recently, situated cognition (Brown et al., 1989) and cognitive apprenticeships (Collins et al., 1990) have been presented as avenues to contextualize learning and encourage learners to personalize content.

Gilliver, Randall and Pok (1998), Jonassen and Reeves (1996), Schacter and Fagnano (1999) and Smith (1996) have reported improved learning through engaging the learner and offering the learner autonomy within the learning context. Because learning for many individuals may be a slow process, providing adjunct resources such as a class website with instructional tracks for different ability levels may provide learners with an online tutor, as well as allow the learner to actively control their learning (Gilliver et al., 1998). Ross and Schulz (1999) have outlined how to use the Internet to support various differences, such as visual, auditory and tactile learners, as well as social learners and learning styles. Technology may have the potential to support learning through individualized instruction. Using websites to augment instruction may supplement classroom discussions, furnishing an easy bridge between a more formal classroom environment and an informal learning environment.

However, Schacter and Fagnano (1999) caution that ease and efficiency are not requirements for meaningful learning. Instead, all technology-supported learning must be founded on sound learning theory and psychological theory to assure the most effective — not necessarily efficient — means of learning. In addition, they propose that computer based instruction, which should individualize instruction to accommodate learner differences, such as prior knowledge and learning styles, has only moderately improved learner differences.

Still, Jonassen (1994) and Papert (1983) purport that technologies that allow learners to construct their own meaning individualized the knowledge. This personalization may

improve retention and prevent inert knowledge (Smith, 1996), so that transfer within domains and across domains may be facilitated.

Authentic learning and knowledge construction. Computer technologies often offer the opportunity for learners to experience content and inquiries which otherwise might be inaccessible to them. Software can emulate and illustrate real world situations, such as decision support software that teaches business students the processes and decisions necessary to develop a package of wages and benefits (Smith, 1996). These types of software engage the learner and allow the individual to construct their own knowledge and make meaning of foreign concepts (Jonassen et al., 1994). Activities that incorporate this type of software lends authenticity to school tasks that under different conditions may seem compartmentalized or irrelevant.

Technology also offers the opportunity to extend thinking and produce artifacts that might not have been possible. Means and Olson (1994) report that learners can "obtain, manipulate, organize and display information" (p. 16). Software applications such as web browsers, spreadsheets, databases and multimedia applications are just a few examples. Jonassen and Reeves (1996) suggest these types of applications extend the learners capabilities by affording fewer cognitive resources to rote tasks. Learners are active in the construction of the knowledge and are offered flexibility in the ways it is presented.

Jonassen, Campbell, and Davidson (1994) contend the most effective use of multimedia environments allow learners to create their own artifacts as demonstrations of their knowledge. Still, complex, real world situations, such as gravity, inertia and acceleration in physics, may be challenging for learners, so technology may offer opportunities to apply abstract concepts, receive immediate feedback, reflect on inaccuracies, and do so without serious penalty or repercussion. Manipulating variables, experimenting and identifying

relationships lend credence to content and offers relevance for learners, cementing knowledge constructions.

Accessing higher order thinking skills. Because technology affords the opportunity for learners to work with complex, authentic tasks representative of real world situations, learners are forced to evaluate, critique, synthesize and generate new knowledge. All of these processes are inherent to higher order thinking skills. Open-ended learning environments present learners with tools in which to address problems situated in authentic contexts (Hannafin, 1992). Learners maintain a significant amount of autonomy in open learning environments, construct their own knowledge, as was discussed before, and manipulate and interpret data in order to understand new knowledge. Autonomy and responsibility within the learning environment give individuals the opportunity to manage their learning at their own pace and interest. Similarly, microworlds may offer learners of any ability level the freedom to manipulate abstract concepts, such as gravity and inertia, in a concrete environment (McLellan, 1994).

However, not all technology may support higher order thinking skills, authentic learning or individualized instruction, and further research is needed in this area to determine which software applications are capable of supporting these goals. Currently, it is contingent upon instructional designers, school administrations and classroom teachers to make appropriate software selections. Only with the selection and integration of appropriate software founded on learning theory and strong content can learners capitalize on technologies that stimulate thinking and problem solving (Means & Olson, 1994). When technologies incorporate all these elements, they become robust to support learner differences and learning.

Defining Computer Mediated Learning Artifacts

Understanding artifacts. Merriam-Webster's collegiate dictionary (2001) online defines *artifact* as "something created by humans usually for a practical purpose." This denotation seems consistent with other authors and researchers intentions. Greenfield (1999) suggests "the term *artifact* is being used to encompass all humanly manufactured articles" (p. 93). More anthropologically, Ezell and O'keeffe (1994) present that artifacts are "the imprint or inscription of the human on the object, page or body" (p.3).

Stahl (2000) offers an interpretation that is intimated in the original dictionary definition: purpose. "Artifacts, (e.g., gestures, works of art, computer simulations) have human intentions or meaning embodied in their designs. These meanings are incorporated and preserved in the artifacts" (para. 7). Ezell & O'Keeffe (1994) echo this focus on meaning and purpose, emphasizing intent and aim by individuals during the creation of artifacts.

Focusing on the meaning in artifacts is especially important for learning. As individuals use technology tools to convey their ideas and interact with content, it is important to maintain a focus on the learning and meaning inherent to artifacts. The Association of American Geographers (1999) proposes examples included in business portfolios as evidence of learning. These learning artifacts are "any object/item that can represent [an individual's] accomplishments and qualities in a tangible form" (para. 8).

Media and mediation. Learning artifacts, whether created in the classroom, boardroom, manufacturing floor, or village hut, can be used by individuals other than the creator. Artifacts, more specifically learning artifacts, become mediators with the environment. Cole (1996) interprets mediation as the use of artifacts to regulate human behaviors with the world, but especially with other people. So, it seems that individuals use others' learning

artifacts in order to create their own learning artifacts. The interaction with media — audile, visual and tactile elements — aid individuals in interpreting their environment, as well as representing their interpretations.

Atwood (1974) offers a taxonomy for media as individuals communicate ideas (summarized in Table 1). Demonstrative is the first level of media. These media forms are the most literal and are direct portrayals of the idea, such as step-by-step instructions, experiments and inventions. Representational media are used to *represent* reality when it is not easily displayed. Examples of representational media may include sculptures, photographs, simulations, plays and drawings. Symbolic media fill the final category. These media are a translation of reality by the individual; they are neither "the real thing, a model or a facsimile" (p. 20). Symbolic media include speeches, advertisements, dances, and graphs.

Table 1. Media for communications

Forms of Media	**Uses**	**Examples**
1. Demonstrative	Literal illustrations of reality	experiments, inventions
2. Representational	Represents reality	Sculptures, photographs, simulations
3. Symbolic	Translation or interpretation of reality	Persuasive speeches, advertisements, dances

These media offer some insight into how individuals interact with their environment, as well as communicate their knowledge and learning. The exchange with these media cultivate "human development through the mediation of cultural tools" (Smagorinsky & O'Donnell-Allen, 1998, p. 214). An individual's learning, therefore, is supported and mediated through cultural tools, including technology, and the learning artifacts not only reflect the individual, but the media and the culture as well.

Mediated learning. Computer mediated communication has dominated much of the literature on mediated learning (see for example, Herring, 1996). However, Fitzpatrick and Hardman (2000) in a review of other authors concur that

> one of the important features of the applications of computers in the classroom is that they can be seen as supporting new mediational means, resulting in a restructuring of the way cognitive tasks or activities are undertaken. The concept of mediation not only emphasizes the roles of the computer itself in classroom learning, as a highly salient new component of the classroom setting providing opportunity for the coordination and joint construction of knowledge, but also the inherently social and situated nature of cognition (p. 3).

In addition to emphasizing the usefulness of the computer to orient tasks and skills, Gayeski (1997) also includes interactivity as an important piece to computer mediated learning: "computer mediated learning is the use of interactive, microprocessor-based digital media (CD-ROMs, computer-based tutorials, electronic performance support systems, the Internet and Intranets, virtual reality simulations, and online collaboration and information management systems) as tools that aid individuals in learning and applying new concepts and skills" (p. 1).

The role of the computer as a "partner" in the learning context is explicated by other authors as well. Taylor's (1980b) seminal piece proposes a classification scheme for the role of the computer in the learning context. The role of the computer as either a tutor, tool or tutee helps illustrate the interactions among the individual and the computer during learning.

The role of the *computer as tutor* is usually synonymous with computer-assisted or computer-aided instruction. Experts program the software to teach or review content with learners. Exemplars of the computer as tutor present content, and based on interactive responses, subsequent content is modified or adapted to the individual, including mode of presentation and level of complexity or difficulty. In these unique cases, records are kept, so

progress can be tracked. However, many software applications in this category are simply "drill and practice," sometimes called "drill and skill," modifying only level of difficulty.

The second role a computer can take in the learning context is as a tool. The *computer as a tool* is in the most basic sense a function to accomplish a task. With software, the computer can become a word processor, calculator, presentation editor, or web page builder, for example. As a tool, the computer is often flexible in its applications, being used interdisciplinarily as needed, such as a spreadsheet for stocks in social studies and for charts in math. Many computer tools are also designed to increase productivity, such as editing texts in word processors or editing photographs in image manipulation software.

The final category — *computer as tutee* — presents the most challenge to the individual. The learner must tutor the computer by learning to program. Taylor suggests three benefits to tutoring the computer. First, a learner must understand the content in order to instruct the computer. Second, the learner through structuring the programming and content for the computer will learn how the computer works, as well as how his own thinking is structured. "Third, because no predesigned tutor software is necessary, no time is lost searching for such software and no money spent acquiring it" (p. 4). This last benefit may or may not be applicable for everyone.

Time *is* required to research the appropriate programming language for specific learners and for specific disciplines or tasks. For example, the popular Logo programming language was developed to promote problem solving, logical thinking and manipulation of mathematical concepts. Today, the Logo products have expanded to include other disciplines as well, including music and robotics. So time would be necessary to choose from among the products, (see, for example, http://el.www.media.mit.edu/groups/logo-foundation/products/software.html) and while public domain versions of some of the

products are available, others such as the robust MicroworldsPro costs approximately $139.00 (see http://www.microworlds.com/solutions/mwpro.html). While time and expense are also related to using the computer as a tutor and tool, the gains for using the computer as a tutee are still considerable: "deep" thinking occurs (Dwyer, 1976) as suggested by Taylor above, and there is flexibility in what is learned ad how it is learned (Papert, 1980).

While this framework is not exhaustive, it does recommend a beginning typology from which to describe computer mediation and to recognize the role of the computer in the learning context. New applications such as Javascript for web pages and Stagecast™ Creator for building simulations are beginning to blur the lines among these categories.

Computer mediated learning artifacts. The discussions above have attempted to partition *computer mediated learning artifacts* into its essential parts in order to grasp the complexity of the term. It was important to identify its complex elements in order to begin to understand what these individual pieces mean and how they, in turn, fit together. Computer mediated learning artifacts are the products created as a result of interacting with a computer in one or more significant ways during the course of learning. Creations such as word processed research papers, pie charts, booklets, web pages or electronic presentations are computer mediated learning artifacts when they are produced as a result of learning and with the aid of a computer — even though the final product may not be in a digital format.

Jonassen and Land (2000) provide a framework for situating computer mediated learning artifacts into the learning context (see Figure 1). The individual as a learning agent interacts with mediators (tools, signs, models, methods and theories) in order to make meaning of content. Through this mediated interaction, the individual produces artifacts — representations of his learning and reflective of the culture and context. In the production

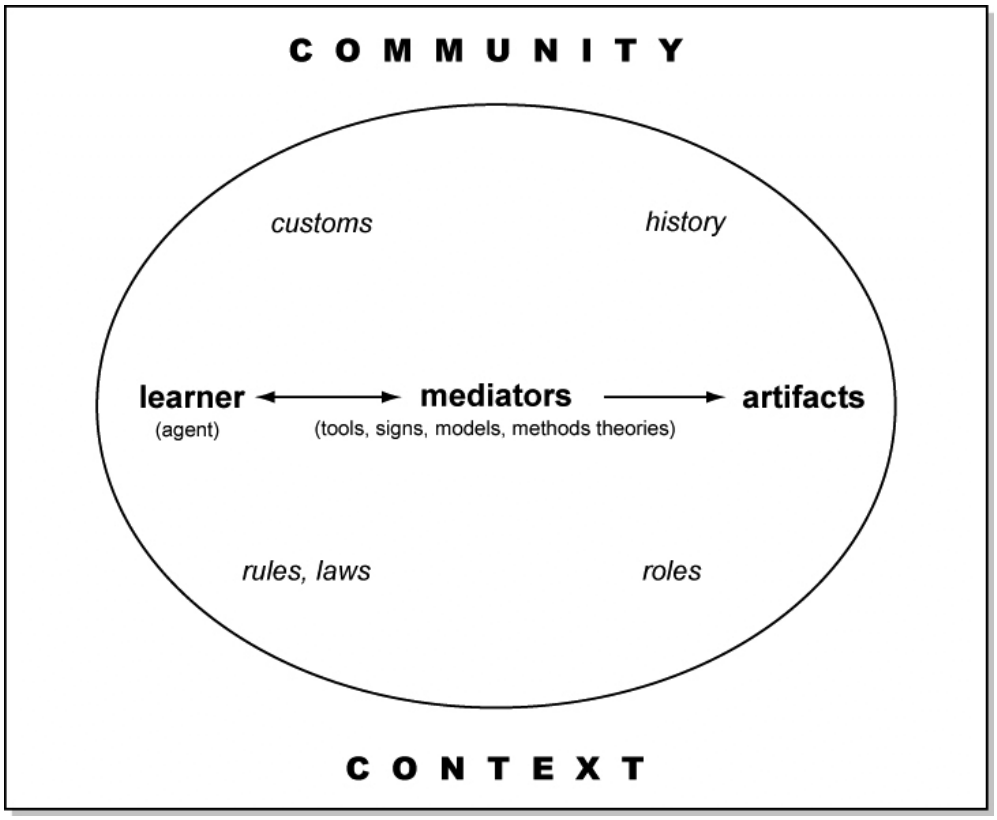

Figure 1. Learning in context. From Theoretical Foundations of Learning Environments (p. vii), by D.H. Jonassen and S.M. Land, 2000, Mahwah, NJ: Lawrence Erlbaum Associates. Copyright 2000 by Lawrence Erlbaum Associates, Inc. Reprinted with permission.

of computer mediated learning artifacts, the computer has played an important role in the development of learning artifact and often of the learning itself.

It is important to understand computer mediated learning artifacts because learning and the products of learning are individualized to the learner. By understanding the products of learning as well as the developmental process of these products, there may be a more complete understanding of what has been learned by the individual.

An important assumption to note about the framework provided by Jonassen and Land (2000) is that the context must support the generation of artifacts. An additional assumption is that each individual as the learning agent interprets the content, context and culture differently, so artifacts constructed by each individual will be unique from others in

the context. One such context that supports these assumptions is constructionist learning environments.

Constructionist Learning Environments

Constructionism (Harel & Papert, 1991; Kafai & Resnick, 1996b) posits that individuals learn best when they are constructing an artifact that can be shared with others and reflected upon, such as song lyrics, sculpture and websites. Another important element to constructionism is that the artifacts must be personally meaningful, where individuals are most likely to become engaged in learning. By focusing on the individual learner, constructionist learning environments strive for "considerable individualization of curriculum, instruction and assessment—in other words, the project is learner-centered" (Moursund, 1998, p.4). So, learning is individualized by the learner: The learner has considerable autonomy over what specific content is learned and in what way or ways it is learned (Means, 1994; Means & Olson, 1994). During the creation of these learning artifacts, individuals negotiate meaning with resources, including technological tools for learning (Jonassen et al., 1998; Jonassen & Reeves, 1996), communication (Cifuentes & Hughey, 1998) and collaboration (Koschmann, 1994). So, capitalizing on current technologies to support learning and learner differences is often embedded in constructionist learning environments.

Constructionism is a learning theory as well as an instructional strategy (Kafai & Resnick, 1996a). The principles of constructionism are observed in other instructional methods and pedagogies, such as project-based science (Blumenfeld et al., 1991; Marx et al., 1997), project-based learning (Land & Greene, 2000; Lundeberg et al., 1997; Moursund, 1998), disciplined inquiry (Levstik & Barton, 2001), open-ended learning environments

(Hannafin et al., 1994; Hannafin et al., 1999) and student-centered learning environments (Land & Hannafin, 2000).

Constructionist learning environments consolidate tactile constructions with cognitively-rich activities while in the active creation of personally-meaningful learning artifacts (Jonassen et al., 1994). Constructionist learning environments typically include the following elements (see Table 2):

Table 2. Common elements of a constructionist learning environment

Elements	**Explanation**
Introduction	A way to "set the stage" or serve as an anchor for the activity
Task, guiding question or driving question	The primary mission of the investigation. It should doable following the investigation process.
Investigation	A process that results in the creation of one or more shareable artifacts
Resources	Subject matter experts, textbooks, hypertext links, laptop computers, spreadsheet software, etc.
Scaffolding	Teacher conferences to help learners assess their progress, computer-based questioning, project templates, etc.
Collaborations	Opportunities for teams, peer reviews, external content specialists, etc.
Reflection and transfer	Classroom debriefing sessions, journal entries, extension activities, etc.

One example of integrating hands-on with minds-on activities was included in the Secretary of Education's conference on educational technology. Penuel and Means (1999) describe the results of a course rooted in multimedia projects consistent with constructionist learning environments. The learners were observed to be "engaged in the kinds of higher-level cognitive activities characteristic of multimedia design … deciding on the structure of presentations; creating multiple representations, models and analogies; arguing about or evaluating information; thinking about one's audience; and revising or editing work" (para. 38). Compared to more traditional, teacher-centered classrooms, the teachers were observed as more likely to give responsibility to students for their own learning and more likely to be

facilitators of learning. The students were observed to be in what Penuel and Means describe as dialogic discourse, where learners are engaged in discussions with teachers but the discussions are not always teacher directed.

Technology in constructionist learning environments. The original definition of constructionism (Harel & Papert, 1991) states that learning artifacts may include non-technology generated creations, such as poems and sand castles. However, many of the examples reported throughout the literature employ technology tools to augment and extend the learning environment (see for example, Kafai & Resnick, 1996b). Some of the learning environments and instructional frameworks discussed above are consistent with the principles of constructionist learning environments and also exploit technology. For example, "many open learning environments, such as simulations and microworlds, rely heavily on technology to support student experimentation" (Land & Hannafin, 2000, p.2).

The uses of technology vary across different contexts and disciplines. Described earlier, human-computer interactions can be thought of in terms of three uses: (1) the computer as tutor; (2) the computer as tool; and (3) the computer as tutee (Taylor, 1980a). It also seems, though, that while the computer may be used in these usually discrete ways, computer uses in constructionist learning environments may blur these lines or may be used in more subtle ways. With inquiries, technology lends authenticity to investigations, such as reflecting the methods scientists use to investigate and study phenomena (Marx et al., 1997). Technology also supports multiple representations of knowledge, both in presentation and in knowledge construction. Through visual, audile and tactile media, learners interact with content through multiple modalities (Kafai & Resnick, 1996a). Likewise, technology can support the construction of knowledge in multiple ways, such as translating tabular data to charts and two-dimensional representations to virtual reality.

Gaining confidence in constructionist learning environments. A challenge to shifting from a teacher-centered environment to a learner-centered one, such as a constructionist learning environment, is the increase in autonomy for the learner may be uncomfortable. The suggestions for gifted students working in these environments may be applicable to all learners. Stephens (1996) suggests three strategies for building learner's confidence as responsibility for learning increases. First, she suggests helping learners stay organized and on task by working toward project due dates. For example, in the flexible instructional strategy of WebQuests, scaffolds are built into the project to support learners in organizing prior knowledge and new knowledge (Dodge, 1998). In addition, the step-by-step nature of WebQuests provide learners with concrete evidence of progress.

Second, Stephens suggests that learners "choose a support person with whom they can share their progress and receive feedback in periodic conferences" (para. 7). This capitalizes on the collaborative nature of constructionist learning environments. Through peer reviews and expert consultations, learners evaluate current mental models and accommodate new learning. Finally, learners can assist in generating the criteria on which they will be evaluated. "If students are familiar with the agreed criteria prior to beginning work on the projects, they will be more apt to produce successful projects" (para. 7). Rubrics, including agreed upon criteria, allow assessment to be more objective and reliable across learners (Pickett & Dodge, 2001).

Chapter Summary

Over the past decade, interest in constructionist learning environments has helped renew interest in learner-centered pedagogies. Recognizing the individual, his abilities and the artifacts he creates as a result of learning in these environments is critical to more fully understanding how these environments work. In this chapter, research examining individual

differences was reviewed. When learners prefer one method of instruction to another, research has demonstrated that making allowances for the preferences can improve academic achievement. Criticisms, however, suggests learners are synthetically reacting to the contrived conditions. Technologies to support individual differences have included individualizing instruction, using authentic learning and knowledge construction and accessing higher order thinking skills. The products created as a result of interacting with a computer in one or more significant ways during the course of learning was presented as the definition of computer mediated learning artifacts with literature to support the historical and cultural derivation. Finally, an overview of constructionism and constructionist learning environments was presented including a list of elements common across constructionist learning environments. Challenges to working in constructionist learning environments include the changes in roles for the learners. To become more comfortable in these environments project due dates, scaffolds, peer conferences and participating in the generation of the grading rubric were suggested.

CHAPTER 3

METHODOLOGY

The purpose of this study was to explore how individual differences are used in the construction of learning artifacts. Four research questions guide this study:

1. Within a constructionist learning environment, in what ways do computer mediated learning artifacts reflect individual differences?
2. In what ways do learning artifacts reflect a learner's knowledge?
3. How does the construction of learning artifacts allow learners to tap individual differences?
4. How do constructionist learning environments support individual differences?

Research Design

This study focused on the in-depth perceptions of learners as they develop computer mediated artifacts in a constructionist learning environment. With the principal goal of this research to present the individual views of these learners, a qualitative study was most appropriate for this type of study. The ontology inherent to qualitative research assumes that reality is subjective and is seen "through the eyes of the participants, where each perception is a valid interpretation of reality" (Cresswell, 1994, p. 5). The qualitative approach allowed the opportunity to represent a reality through the eyes of each individual.

Qualitative research methods. Merriam (1988) identified five characteristics of qualitative research to distinguish this type of research from more quantitative, positivistic research endeavors. First, qualitative researchers are interested in understanding the meaning people

have constructed for themselves, preserving the possible multiple realities that may exist among individuals. Second, while the quantitative researcher may employ pretests, surveys, and statistical software, the qualitative researcher is the primary instrument for data collection and analysis. Third, qualitative research usually involves fieldwork, where the researcher engages in the context with the participants to observe and record behaviors in a natural setting. Fourth, qualitative research primarily employs inductive reasoning, where patterns and themes emerge throughout study, while deductive reasoning is often used in quantitative research to find support for a prescribed notion. Finally, qualitative research produces rich descriptions, where the findings are comprehensive and meaningful.

Two other characteristics also distinguish qualitative research from other types of studies. Qualitative research permits an emergent, flexible design, where categories are identified during the research process. While quantitative research attempts to use a relatively large random sample to extrapolate to even larger populations, a qualitative sample is usually nonrandom, purposeful, and small.

This study relied on these combined seven characteristics as presented in Table 2 in order to represent the complex context of a constructionist learning environment. This study was interested in how learners felt their individual differences and acquired knowledge were represented in their computer mediated artifacts. The researcher explored these ideas through fieldwork in the classroom to become familiar with the participants and the context and to make the research as naturalistic as possible. Analysis of the data derived codes, patterns and themes to understand the case, and the report was filled with rich descriptions to fully represent the case.

Case study method. Because the construction of computer mediated artifacts by learners in a constructionist learning environment represents a bounded system (Merriam, 1988), the

case study design was an effective means to examine this phenomenon. Centered on describing how individual differences are reflected in computer mediated learning artifacts, this research attempted to provide information about an innovative alternative to individualizing instruction. The case study method was also appropriate to this study as the process of constructing artifacts was explored. Case study is an effective method for examining phenomena that develop or proceed over time (Merriam, 1998).

Characteristics that distinguish case studies from other types of qualitative research include the following: particularistic, descriptive and heuristic. The particularistic nature of case study forces the research and analysis to be extremely specific. Similar to other qualitative research is the description incorporated into case studies. The description is often thick and rich, representing the views of the participants with many details. Heuristic means that case studies rely on the participant's meaning to "illuminate the reader's understanding of the phenomenon" (Merriam, 1998, p. 30). In this study, the participant's perspective will provide data to understand how each individual's abilities are reflected in his or her learning artifact. This perspective governs the research and analysis in order to yield the most beneficial and relevant data and descriptions of the phenomenon.

Context

The setting for this study was an eighth grade Geography class at a small, private day school in the southeastern United States. As compared to public schools, this institution offered many freedoms or advantages for students, including breaks during the day, study halls to begin homework and seek help, and a comfortable atmosphere for learning. There were approximately 15 students in each class period with the teacher covering 4 periods per day. The Geography curriculum was centered on themes, such as population, conflict and famine, to discuss the human and physical geographies of the world.

The day school represented a technology-rich environment. For this study, *technology-rich environment* was defined as the use of ubiquitous computing and access to the Internet and school intranet at any time. The school had implemented an initiative to integrate laptop computers into their academic curriculum and had a long history of technology innovations. The technology infrastructure of the school included a wireless network across the campus, so students had Internet and Intranet access at any time and anywhere on campus. Eighth grade teachers had been using laptops for approximately three years, while the eighth graders were in their second year of using laptop computers. A previous study (Hill, Reeves, Heidemier, Grant, & Wang, 2000) described the primary teaching style used in seventh and eighth grades as directive and didactic. The teachers and administration expressed a desire to move toward more learner-centered approaches and self-directed learning.

For this study, the cooperating Geography teacher and the researcher collaborated to design a WebQuest that incorporated the elements of constructionist learning environments (see Figure 2). Through collaborations during a pilot study, the cooperating teacher seemed eager to employ more student centered approaches, such as a WebQuest, that would take advantage of the available technology-rich environment afforded her students, such as internet research, electronic note cards and computer mediated artifacts. This study followed one content unit, geography and human rights, during the year-long course for ten weeks (see Table 3). The complete set of web pages developed for this unit are included in Appendix A.

Figure 2. Sample web pages from Geography and Human Rights WebQuest. (A complete set of the web pages developed for this unit are included in Appendix A.)

To situate the content, the participants were asked to design an exhibit for a Human Rights Fair that offered an in-depth look at current human rights violation within one of five countries, Argentina, Kashmir, Sierra Leone, Sri Lanka, and Sudan. The artifacts produced as part of the WebQuest were not isolated away from the curriculum, but instead, integral to the curriculum.

Table 3. Elements of constructionist learning environments for stages of geography and human rights unit

	STAGES OF GEOGRAPHY AND HUMAN RIGHTS UNIT			
Elements	**Stage 1: Physical & Human Geography Characteristics Grid (2 Weeks)**	**Stage 2: Defining Human & Civil Rights (2 Weeks)**	**Stage 3: Research Paper (4 Weeks)**	**Stage 4: Human Rights Exhibit (2 Weeks)**
Introduction	Since many of the violations of human rights are extended across the globe, it is difficult for students at Athens Academy and at other schools in our community to understand what is occurring in these countries and to grasp why these events are happening. You will create an exhibit to be displayed in a Human Rights Fair to be held just before Spring Break for your friends and younger students to experience. In order to create an authentic exhibit, you will construct a series of artifacts that represent elements of the violations on human rights. With these elements as background material, you will build an exhibit like you would experience in a museum about your specific human rights violation.			
Task	• Research & identify the physical and human geography characteristics for one of five countries	• Define, compare & contrast human and civil rights	• Describe the human rights violations in a chosen country in a research paper	• Design a museum exhibit about the human rights violations in the chosen country
Process or Investigation	• Research the five physical geography themes for this country: Location, Place, Human environment interaction, Regions, Movement Also, research the human geography themes for this country: Government, Political issues, Religion, Ethnic groups, Current conflicts, Economic Issues	• Review UN Universal Declaration of Human Rights • Create a list of human rights to share in class • Contrast civil rights with human rights	• Research the human rights violations facing the chosen country today.	• Brainstorm the qualities of interesting, poor, emotionally evocative exhibits • Describe the goal & features of the exhibit • Construct exhibit

Resources	• WebQuest web pages • WWW links, e.g. CIA World Factbook & US State Department Background Notes • Link to class-compiled grid for all countries to aid discussion	• WebQuest web pages • WWW links, e.g. UN Universal Declaration of Human Rights & first Civil Rights bill	• WebQuest web pages • Electronic notecards • WWW links to countries' information • Peers & teacher • Media Center • Creating Works Cited page at Noodletools.com	• WebQuest web pages • WWW link to existing museum exhibits • Research paper • First-hand fictional accounts • Editorial/opinion documents
Scaffolding	• Microsoft *Word*® template to fill in researched information • WebQuest web pages • Guiding question	• Guiding questions • WebQuest web pages & links	• Electronic notecards template • Writing process guidelines • Citing sources presentation WWW link • Sample title page for download	• Brainstorming guide & in-class session • Design form • Checklist
Collaborations	• Participants worked with Table partner • Compared and edited information with another pair in class		• Peer conferences & edits • Teacher conferences	• Peer review of design goals & preliminary exhibit
Reflection & Transfer	• Class discussion	• Class presentation & discussion	• First-hand fictional account • Editorial/opinion document	• Human rights unit evaluation

Participants

The nature of qualitative research demands the researcher seek "to discover, understand, and gain insight" (Merriam, 1988, p. 48) by sampling from those individuals who will provide the most rich information. This is the heart of purposeful sampling. Miles and Huberman (1994) identified sixteen strategies for purposeful sampling. From the sixteen options, this study implemented a criterion strategy to determine the target sample and within this sample used the maximum variation strategy.

The maximum variation strategy "documents diverse variations and identifies important common patterns" (Miles & Huberman, 1994, p. 28). This strategy accommodated for differences in gender, ethnicity and abilities. To maintain a balanced perspective, an approximately even number of males and females were selected. To represent multicultural viewpoints, diversity in ethnicity was sought.

To meet the criterion sample, students were selected based on responses from a Multiple Intelligences self-report inventory (see Appendix B). Participants were selected from those with a score of 35 or above (out of a possible 40 points) in at least two categories from among the approximately 60 eighth grade students. A score of 35 was chosen to represent exceptionally high expertise in an ability category in order to reduce the number potential participants. Also, the students at this day school have high abilities in many areas, specifically those consistent with academic success, such as mathematics and verbal/linguistics. To help distinguish among the already unusual population, a level at approximately the upper 15 percent was chosen to obtain the most robust data.

For the case study approach, breadth and depth of data are imperative for in-depth analysis. To strengthen the richness of data, five students were selected for a detailed exploration of the research questions. The five participants were chosen from among

students with diverse abilities as defined on the Multiple Intelligences self-report instrument to obtain a maximum variation sample, as well as from teacher recommendations and from those who have consented to participate in the study.

The participants in this study selected pseudonyms at the beginning of the data collection, and these were used throughout all the data collection and the research report. The five eighth-grade participants for this study were as follows:

- *Allison* was a white female. She was 13 years old — "soon to be 14" as she put it. She had been at the day school for four years. She attended a public school prior to fifth grade. Allison investigated Kashmir, a region in India.
- *Bob* was a white male. He was 14 years old, and he had been attending the day school for three years. Before that time, he attended a religious private school. Bob researched Sri Lanka.
- *Brittney S.* was a white female. She was 14 years old and had been at the day school since she was three years old. Brittney S. examined Sudan.
- *Brittney T.* was a white female. She was 14 years old, and this was her first year at the day school. Before this year, she had attended a religious private school. Brittney T. analyzed the human rights violations in Argentina.
- *Brock* was an Asian male. He was 14 years old. He had been at the day school for two years. Prior to attending the day school, Brock had attended a public school in South Korea. Brock also investigated Argentina.

Data Collection

Many sources of data were used to inform the results of this study. Table 5 provides an overview of the methods used and a timeline for overall data collection.

Self-report. A Multiple Intelligences self-report inventory (see Appendix B) was distributed to all the potential eighth grade participants. This instrument was used to help select the participants for the study. Created by the National Dropout Prevention Center at Clemson University, *Assessing My Multiple Intelligences* is designed to aid individuals in determining their levels of expertise in the eight categories of abilities determined by Howard Gardner (1983). This instrument has yet to be validated. While the results may be limited in this respect, this instrument was used to describe the participants — not in hypothesis testing — and was supplemented with the interview protocol to mitigate this deficiency. The results from this instrument were also used in data analysis by providing preliminary codes.

Interviews. Because this study sought to understand how computer mediated artifacts produced by the learners represent their knowledge, this data could only be obtained through the participant's knowledge; therefore, interviews were the most appropriate method. Moreover, because this study attempted to elicit the perspective of the participants concerning this process, it was imperative to use their own words.

Four rounds of interviews were conducted with each of the five participants, although the case study design remained flexible in the event more interviews were needed. Interview One was conducted at the beginning the human rights unit. The second and third interviews were conducted during the WebQuest. Interview Four was conducted at the conclusion to the unit. Each of the interviews lasted approximately 30 to 45 minutes in length to accommodate the school period schedule. A semi-structured interview protocol was used with all five participants. A semi-structured interview allowed variation in the order and phrasing of the questions and additions to the protocol, such as additional questions and

probes to specific individuals (Patton, 1990). While the interview protocol was a guide, the questions were flexible to represent the emergent nature of the phenomenon under study.

The Interview Protocol (see Appendix C) was open-ended to indicate the semi-structured nature of the interviews. This protocol included the interview questions for four interviews, but the protocol was flexible to reflect the emergent nature of qualitative research. The protocol referred to responses for each participant from previous interviews and the Multiple Intelligences self-report inventory.

Observations. Historically, observations have been synonymous with fieldwork or field research and observations allow the researcher to become immersed in the participant's context (Guba & Lincoln, 1981). The construction of computer mediated artifacts lent itself to observational data. The purpose of the observations was descriptive information to supplement and complement the interview data. Observations occurred during the class periods with constructionist learning. During this time, the researcher was a partcipant observer in the setting, contributing to the instruction at the request of the cooperating teacher. The observational data was collected in linear-time data as a stream of behaviors, and the researcher's attention was emergent and not focused on any specific behavior. This observational data was used to help formulate second-, third- and fourth-round interview questions.

The Observation Protocol provided structure and aid in management of the observational data (see Appendix D). This protocol enabled the researcher to maintain systematic and consistent notes while collecting data. The Observation Protocol was used during all observations. The data collected with this instrument were useful in corroborating data collected during the interviews; however, these data were not especially useful as independent data points in this study.

Artifacts. Because this study looks at a process of construction of mediated artifacts, participant-generated artifacts or documents were obtained to provide data to support how computer mediated artifacts reflect learner differences and how the mediated artifacts reflect the individual's learning. Process documents such as preliminary outlines, brainstorms, or emails were considered to help explain the phenomenon and supplement subsequent interviews. End-of-the-unit evaluations and reflections were collected to supplement interviews and data analysis. The artifacts produced by the participants also supplemented the fourth-round interviews as reflective aides and referents. Photographs or screen captures of the final projects were taken and examined during data analysis.

Table 4 summarizes the data collection procedures and indicates how they relate to the research questions.

Table 4. Research questions and data sources

Research Questions	**Data Sources**
1. Within a constructionist learning environment, in what ways do computer mediated learning artifacts reflect individual differences?	• Interviews • Observations • Artifacts
2. In what ways do learning artifacts reflect a learner's knowledge?	• Interviews • Observations • Artifacts
3. How does the construction of learning artifacts allow learners to access individual differences?	• Interviews • Artifacts
4. How do constructionist learning environments support individual differences?	• Interviews • Artifacts

Pilot Study

A pilot study was conducted during Fall 2001 in order to test procedures, methods and instruments with a small number of learners before beginning a larger, in-depth study. The focus of this study was guided by the research question: In what ways do computer

mediated learning artifacts reflect individual differences in a constructionist learning environment?

This study explored two eighth graders' views as they constructed timelines of global conflicts in a Geography course, specifically the Protestant-Catholic conflict in Northern Ireland and the Arab-Israeli conflict in the Middle East. This project was part of the Geography curriculum and was not an isolated project for research purposes only. The participants were selected based on their responses to a Multiple Intelligences self-report inventory (see Appendix B). Following a case study design, the participants were observed during two classes using the Observation Protocol (see Appendix D) and three interviews were conducted with each participant. Photographs of the timeline artifacts the participants made were taken for analysis (Appendix E). Data analysis included using the constant comparative method (Glaser & Strauss, 1967) to recursively derive themes from the interview, observational and artifactual data.

Changes made. Overall, the procedures and data collection methods worked well in the pilot study. A few adjustments were made based on the pilot study. These are described in the following paragraphs.

As a result of the pilot study interviews, changes were made to the Interview Protocol (Appendix C) in order to clarify the meaning of questions and make them more specific for each participant. Another alteration to the Interview Protocol dealt specifically with the Round Four interview. It was useful to have the learning artifact with the participant in the interview. The researcher and the participant both were able to refer to specific elements in the artifact.

Another change based on the pilot study relates to time. The pilot study data were collected in approximately two weeks. While appropriate to the curriculum, the brevity of

the pilot data collection period permitted limited observational data; however, the data were sufficient to corroborate the importance of examining process, as well as product. The interview data collected during the pilot also indicated that some abilities identified either by the participant or by the self-report instrument are evident during the construction of the learning artifact as opposed to in the artifact itself. This study added additional weeks based on the results of the pilot study.

Finally, changes were made to enhance data collection related to individual abilities. The Multiple Intelligences self-report inventory identifies levels of expertise in eight categories. Participants may identify other abilities not presented in the instrument; this was indicated in the interviews of the pilot study. While a series of instruments administered to the participants may be more comprehensive, another way to encompass these other abilities is through the interviews. The views of the participants critical to the case study design; therefore, it seems important to allow the participants to speak of their abilities based on their understanding. Changes were made to the Interview Protocol to permit the participants to discuss their abilities with and without reference to the eight categories in the Multiple Intelligences inventory.

Procedures

The procedures for this study were categorized into three phases. Table 5 summarizes the data collection procedures for this study.

In Phase I, consent and assent forms were distributed to the all the parents of the eighth graders and the eighth graders themselves. In addition, the eighth graders completed a Multiple Intelligences self-report inventory, and the participants were selected based on these instruments. This part of Phase I was conducted during the Fall semester before the Geography and Human Rights unit began after the school's winter break. As the human

rights unit began in the Spring semester, Round One interviews were conducted with each of the participants. Finally, the interviews began to be transcribed and preliminary codes applied. Round Two interviews were personalized for each participant.

Table 5. Data collection procedures

12 WEEKS			
	Phase I (1 Week)	**Phase II (10 Weeks)**	**Phase III (1 Week)**
Participant's Role	• Complete consent & assent forms • Complete Multiple Intelligences self-report inventory • Round One interview	• Begin constructing learning artifact • Round Two interview • Round Three interview	• Complete artifact • Round Four interview
Researcher's Role	• Distribute consent & assent forms • Conduct Multiple Intelligences self-report inventory • Select participants • Conduct Round One interview	• Observe classres • Conduct Round Two interview • Conduct Round Three interview	• Conduct Round Four interview • Collect artifacts • Photograph artifacts

Phase II began as the participants continued to follow the steps in the WebQuest on geography and human rights. The WebQuest resulted in the construction of an exhibit, similar to one at a museum, in a Human Rights Fair at the day school. The design of the exhibit was chosen by the participants and included examples such as dioramas, electronic presentations, websites or poster displays. Classroom visits were made to observe the learning and construction process, using the Observation Protocol. Round Two interviews were conducted. Transcriptions and coding of these interviews were begun. Based on observations, Round One and Round Two interviews, adjustments were made to the Round Three interview protocol. As participants continued to work on their artifacts, observations continued. Round Three interviews with the participants were conducted, transcriptions and

coding begun. Reflecting on the previous observations and interview data, modifications were made for the Round Four interviews. Questions in Round Two and Round Three interviews attempted to elicit from the participants how individual differences were used in the process of constructing the artifact.

In Phase III and at the completion of the learning artifacts, the final interviews (Round Four) were conducted. Each participant's human rights exhibit was available during the interview for reflection and reference. The questions in the Round Four interview protocol referred to the artifact and asked the participant to interpret the artifact with respect to the research questions. The artifacts produced as part of the study were collected for analysis and photographed electronically.

Data Analysis

Data analysis offers the opportunity to structure and organize the data gathered into a reasonable and comprehensible form for the reader. Data analysis for this study was governed by the constant comparative method developed by Glaser and Strauss (1967) for grounded theory research. While this study does not attempt to generate theory, the constant comparative process can be extrapolated to reflect the inductive process inherent in all qualitative research. By constantly scanning the data, initial themes or classifications, called codes, were determined. These classifications were consistently reviewed, refined and discarded as new data is analyzed. Patterns in these distilled themes helped answer the research questions. This process was used with each data type in order to corroborate findings and supplement themes. QSR *N5* (formerly *Nud*Ist*) was used to help organize and manage the data analysis process.

Data analysis began after the transcription of the first round of interviews. Initial codes were developed during the analysis of the first interview. Adjustments were then

made to the second round interview protocol. Notes from observations of the artifact development process were compiled and coded to supplement subsequent interviews as well. After the second round of interviews were transcribed, open codes were assigned and any preliminary interpretations noted. This process continued through the last round of interviews.

At the end of the study, the computer mediated learning artifacts were captured electronically for analysis with the developing codes and themes. While it is impossible to predetermine what the artifacts may have looked like or which abilities they may have included, the artifacts were analyzed with respect to the data collected in the interviews as the participants explained their construction process. The artifacts were to be analyzed with regard to the results of the self-report instrument. Codes were applied to the artifactual data and combined with the interview, observation data and researcher's notes.

Codes from the interviews, observations, artifacts and researcher's notes continued to be distilled in a recursive manner. The data analysis process was necessary to "make sense of massive amounts of data, reduce the volume of information, identify significant patterns and construct a framework for communicating the essence of what the data reveal[ed]" (Patton, 1990, p. 372). During the coding process, codes were combined and clarified. Themes, or categories, were developed with the assistance of Dr. Janette R. Hill, a member of the advisory committee, that encompassed the codes and represented patterns in the data. These categories were reviewed and revised. Finally, member checks were completed by the participants to review the transcripts, categories developed and descriptions written. These changes as a result of the member checks were negotiated with the participants. In addition, peer reviews were frequently conducted with members of the researcher's advisory committee to verify the data driven process.

Validity and Reliability

The quality and rigor of research is often described in terms of internal and external validity and reliability. However, in qualitative research, it is more appropriate to think of credibility, transferability and dependability (Merriam, 1988).

Triangulation, member checks and peer reviews were used to insure the internal validity, or credibility, within this study. Triangulation results from the use of multiple researchers, multiple data sources or multiple methods to corroborate findings. This study used multiple participants who offered multiple data sources, including interviews, observations and artifacts. The recursive process inherent to the rounds of interviews allowed for a cursory member check with the participants. Member checks in this study comprised of reviews of interview transcripts and themes derived from the analysis. In addition, transcripts and themes elicited from each of the participants were reviewed with the cooperating geography teacher to confirm and support the experiences the participant has described in the data. Peers and colleagues also reviewed the themes for authenticity from the data.

External validity typically deals with the transferability of results. This is a paramount concern in qualitative research, where a small, purposive sample is chosen to understand a phenomenon. Sufficient detail must be provided so that readers can determine under what circumstances the results and study design would apply in other circumstances (Merriam, 1998). This study used thick, rich descriptions, including quotations from the participants, in order to provide sufficient details for the reader.

Reliability often reflects how well a study can be replicated. In qualitative research, this can be thought of in terms of the dependability of the results given the data presented (Lincoln & Guba, 1985). To support the dependability of the findings, along with the

triangulation of data, an audit trail was used to document "how data were collected, how categories were derived and how decisions were made" throughout the study (Merriam, 1998, p. 207). In addition, a statement of the researcher's bias was included.

Limitations

There were three possible methodological limitations to this study. First, limitations of this study were consistent with limitations associated with all qualitative research. While much empirical research attempts to generalize findings to a larger population from a relatively small sample, case study findings are typically less generalizable and more dependent on the reader to note common elements within their own experiences (Merriam, 1998).

Second, the Multiple Intelligences self-report inventory has yet to be validated. Reliance on this means to select the participants of the study may be suspect. To overcome this potential limitation, questions in the interview protocol allowed the participants to discuss their abilities outside this framework, as well as with reference to this framework. This method lent credence to the use of purposive sampling in order to obtain the most rich and beneficial data to understand the meaning individuals have constructed for themselves with regard to each individual's abilities. This was characteristic of the heuristic nature of case studies.

Finally, the pilot study data collection lasted approximately two weeks. I did not feel like this was a sufficient length of time to examine the process associated with artifact creation. To address this perceived limitation, this study spanned ten weeks. While it is not possible to predetermine whether this extended time frame would be adequate to capture the process necessary to sufficiently understand how computer mediated learning artifacts reflect individual differences, other studies (Jennings, 2001; Penuel & Means, 1999) have used

longer time frames with success. Therefore, I hoped the extension would address this limitation.

Statement of Researcher's Bias

Because the researcher is the primary instrument for data collection and data analysis, it is important to clarify the lens through which the researcher viewed the study. This clarification aids the reader in ensuring the validity and reliability of the results. My bias is influenced by my professional and personal backgrounds.

My professional background includes teaching in a project-based, "learning by doing" four-year undergraduate curriculum. This pedagogy was and continues to be very successful for the students as they enter industry-related professions. The curriculum supported the notions of constructionism through allowing the individuals to construct products of their design, while learning skills of their profession. The result of this thriving curriculum may influence my perspective while observing a K-12 setting within a single classroom.

My personal background includes enjoying writing, reading, creating designs, playing the trumpet and performing on stage. Some of these abilities were cultivated during my K-12 education while others were not. I feel these abilities have been invaluable to developing my expertise in certain areas and complement expertise in others. As I explore how abilities are incorporated into classrooms, it will be important to be cognizant of this bias as other individuals and institutions may or may not value these in the same ways.

Chapter Summary

A qualitative inquiry methodology was used to explore individual differences in constructionist learning environments as they were manifested in computer mediated learning artifacts. An embedded case study design met the study's purpose and provided

data to inform the research questions. Five participants were purposively selected from an eighth grade geography class at a small, private day school in the southeastern United States. Data was collected through interviews, observations and artifacts. Data management and organization was facilitated through qualitative data analysis software, QSR *N5*. Data analysis employed the constant comparative method in a recursive nature in order to generate meaningful, data-driven themes.

CHAPTER 4

INDIVIDUAL CASE ANALYSES

The purpose of this study was to explore how learners incorporated their individual differences into the construction of computer mediated learning artifacts within a constructionist learning environment. The descriptions below profile each of the five participants in this study. Details of each participant are provided in context of their lives as eighth graders in a Geography class at a technology-rich, private day school.

Each participant profile is expressed in terms of an introductory vignette followed by five categories: (1) identifying individual differences, (2) using computers, (3) building computer mediated learning artifacts, (4) working in constructionist learning environments, and (5) making connections. Four of the five profile categories correspond with the research questions for this study, as well as the related literature for this study. One additional category, *making connections*, was added in order to bring together themes from across the profile categories. Table 6 highlights the attributes for each of the five categories.

Quotations used within each profile indicate literal remarks by the participants. Few grammatical and mechanical changes were made in order to maintain the authenticity of the participants. Italics used within quotations represents emphasis the participant placed on specific words. Erickson (1986) suggests that the interpretive commentary identifies to the reader those elements that are "salient for the author" (p.152). I made judgements about the data as I analyzed, organized and reported them in a relevant and meaningful manner.

Pseudonyms were selected by the participants and used throughout this entire research report.

Table 6. Participant profile categories and their attributes

PARTICIPANT PROFILE	
Category	**Attributes**
Identifying individual differences	• Multiple Intelligences • School subjects • Other activities • Strengths • Weaknesses
Using computers	• Views about computers • Use of computers for learning
Building computer mediated learning artifacts	• Descriptions of the participant's artifact
Working in constructionist learning environments	• Opinions of projects and project-based learning
Making connections	• Interpreting the relationships among individual differences, using computers, building computer mediated learning artifacts and working in constructionist learning environments

Allison

Allison was conscientious, articulate and reflective. If she was running late for one of our interviews, she always apologized. During our conversations together, she often thought out loud and explained what she meant. For example, during one of our interviews, she felt awkward when I ask her how some of her abilities, like bodily-kinesthetic and mathematical/logical, were used in her research paper. She was sure bodily-kinesthetic was not used, but she was skeptical how mathematics and logic may be in her research paper. She first decided math and logic were not, but then interrupted me as she began to formulate how it might be:

Researcher: You said you were really good at athletics and math, too. Do you think either of those two things are somehow in your paper?

Allison: Um, [laugh] no athletics, I don't think. [laugh] But, math…[pause]

Researcher: It's okay to say, "No."

Allison: I don't think so. [laugh] Not really.

Researcher: Why do you —

Allison: Maybe, well actually maybe like not numbers as much maybe concepts for math. Like the order of the paragraphs, like patterns and that kind of thing you use in math, and the order that you organize your essay so that it flows well when it follows. That's about it though.

Allison made the interviews easy. She articulated her ideas with little prompting. She often gave examples in her own life to support what she was saying. For example, she described herself as a "perfectionist." When producing projects, she said she had to feel good about the way her project looked, comparing herself to her Mom.

> In papers and this goes for posters, too, my mom is the same way, I'm a really big perfectionist. And if something is not right and I don't feel good about it, I work at it and revise it until it's perfect or meets my standards.

Identifying individual differences. Allison rated herself at 35 or above (out of a possible 40 points) in three of the eight Multiple Intelligences: verbal/linguistic, visual/spatial and interpersonal (see Figure 3.). She also rated herself above 30 in three other intelligences: logical/mathematical, bodily/kinesthetic and musical. All six of these intelligences were addressed by Allison throughout our interviews, including school subjects, athletics, music and drama. They are discussed below in context.

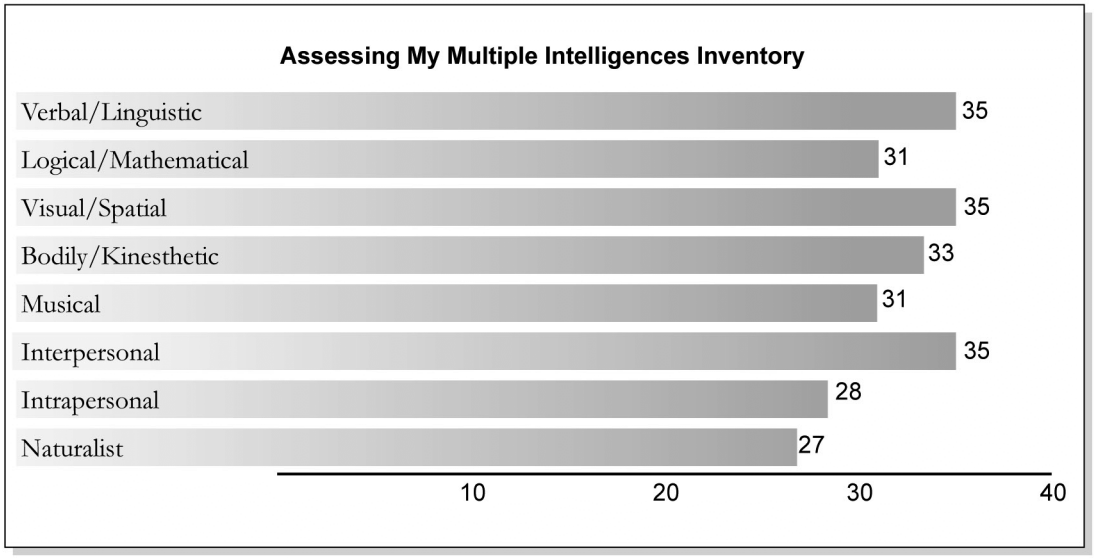

Figure 3. Allison's results on Assessing My Multiple Intelligences inventory.

Allison thought she was good at English and Math in school. "English is more fun," she said, "because I like to write and I like to read." Math on the other hand was just "okay." Math she felt was more rote and lacked creativity. As she explained it, "Math is more like you do this; and you have to know the facts; and you do this; and you don't get to create things on your own. It's just kind of like you do the problems."

Outside of school, Allison was involved in a number of other activities. She participated in "*a lot*" of athletics. She played soccer, basketball, volleyball, and she used to "do swim team in the summer." She thought she was the best at volleyball. She did not have to practice as hard at it; it was her "best" sport. Basketball, however, required more effort, and Allison indicated she enjoyed it less:

> Basketball is probably what I have to work the hardest at, because I haven't played it as long. I've only played it — well, I've played it for a while — but I don't enjoy it as much, though. It doesn't come as naturally to me, and it's more probably — this may sound kind of weird — but like I said about Math, it's my best subject, but I probably have to work the hardest at it. And that's one of the reasons that I'm better at it, because of what effort I put in to it.

Allison recognized the effort required for basketball, like the effort required for math class. She also recognized that because basketball did not "come as naturally," it required more effort, unlike volleyball.

Allison participated in fine arts, too. She liked art, especially drawing and painting. Allison described her fine arts abilities in terms of things she had been doing since she was younger:

> Since I was little, my Dad — I've always like to have something that I was doing at the time, like because I like to make things and do things with my hands and that one of the reasons I like art.

Music, particularly singing, however, was just "okay." Singing had changed for Allison. The opportunities to practice singing and enjoy singing had diminished. She explained why:

> Well, I mean singing, [sigh] I used to be better at it, but as I've gotten older I've liked it less and less, because I have a church choir that I'm a member of, and it's really boring, and I don't enjoy going anymore.

The poor experiences she had led her to disengage. She continued singing informally, though. She still enjoyed "singing to the radio and . . . singing with [her] friends."

Allison felt her strongest abilities were "athletics and just school in general." She judged herself in school by the "good grades" she earned. Sports were second nature; they had been "played all [her] life" so she was "pretty good at them." One sport, soccer, however, was different. She thought she was really good at playing soccer, but she didn't

enjoy it. She compared soccer to math class: She made "pretty good grades" but she didn't "look forward" to it.

Allison thought she was weakest in drama class. She attributed this to her lack of self-confidence. She particularly felt vulnerable during impromptu improvisations. She observed:

> I'm not very self-confident to start with and I don't like getting and I don't like making speeches whatever and getting in front of people. Especially like when we do improv and that kind of thing, and I have to come up with it. Just all of a sudden and go up there. It makes me really nervous, and I'm not really good at it.

Using computers. Allison liked using computers. She liked using them for schoolwork and for fun.

> I like computers. Um, I think they're fun to use like to type on instead of having to write out stories in English and that kind of thing. And they make things that were once boring really fun, and I like computer games. And at my house, we just installed a wireless internet all through my house, which makes it fun to use my computer, because I can go up into my room to go on the Internet.

She characterized herself as "pretty good at computers" but not a "computer genius." She saw the advantages for herself for using a computer to complete her schoolwork: "I'm a much faster typer than I am a writer." Allison felt that using computers made her work "easier" and "faster."

Allison could not "think of anything [a computer] makes harder." She even preferred Internet research to using books. I ask her why using books for research was unpleasant. She replied, "It's just harder. I mean, on the computer, when you enter in something to research it, you have all these websites and articles." She added, "You can go on the Internet and do your bibliography on Noodletools." Though using computers did not make

research harder, reading from the monitor was something Allison did not like: "I guess something I don't like about researching as much on the computer compared to books is that you can flip the pages to read it, and I don't like reading on the computer screen." She preferred to print out the pages from the Internet.

Allison thought the computer could limit her creativity. Though she enjoyed using the computer and creating presentations in Microsoft *PowerPoint®*, she felt she could be more creative without the computer. She explained: "I guess you can be a little more creative when you're doing a project, like if you're making a poster or something instead of making a PowerPoint. Because, there's only so many creative things you can do in PowerPoint."

Building computer mediated learning artifacts. Allison's exhibit for the Human Rights Fair examined the violations in Kashmir, a territory in the northeast section of India (see Figure 4). She had originally wanted to build a structure that was a room for visitors to walk into. But after a conversation with her dad, she decided against that idea, because of practical reasons. Allison chose to adapt her original concept by combining two tri-fold boards, such as the ones many students use in science fair displays, in order to make a "six sided thing that surrounds you."

The right side of Allison's artifact explicated the specific violations in Kashmir. She synthesized parts of her research paper on Kashmir into smaller, readable chunks, printed out from her computer with large headings. She included images she searched, downloaded and printed from the Internet. Text and images brought to life the "terrorism," "torture" and "killings" in Kashmir.

Allison's exhibit included an expanded in-class writing activity. She wrote additional first-hand accounts of individuals who may live in Kashmir. "It was kind of interesting to

Figure 4. Allison's human rights exhibit with articles of clothing (at left) for visitors to become Kashmiri characters.

create. . . . possible people that were there, because there could be somebody that lives there that, lives exactly like that." Allison planned for visitors to choose a number and "become one of the first-hand accounts," and then read the account to others. She thought this connected with her interpersonal skills:

> Um, interpersonal might also have to do with the first-hand accounts because I wanted to do something that was more social that would actually make the person get in touch with what was happening instead of just learning some facts that they might never remember. To actually feel something about what was going on, like be sad or angry about it.

During one of Allison's peer conferences, a classmate suggested she add clothing so visitors could dress up like the characters. Allison excitedly incorporated this into her exhibit. Allison didn't think this conflicted with her weaknesses in drama, because "I guess

this shows that I like hands on things [pointing to character costumes], like not really acting things out myself, but having something to do instead of just looking at the project."

Allison considered her other strong abilities from the Multiple Intelligences inventory and how they may have been used in her exhibit:

> Uhm, not really musical. Um…bodily-kinethetic, because I wanted to do a poster where you touch things and things on creating it. And, I don't know...math…except for maybe putting some of the things I organized and where I put them. And that's about all.

Allison was disappointed after the fair by the number of visitors that stopped and looked at her exhibit:

> I was kind of disappointed that I had spent so much time doing it, and nobody, really I mean, people would look at it, but nobody really actually looked at it for a long time or read what was on there or did the [become a character activity] . . . . So it was kind of like I'd spent a really long time on it, and I was the only person that got anything out of it . . . . I wished somebody had paid more attention to my first-hand accounts, because it took me a really long time to write them and figure out what I was going to say and try to make it meaningful. And that was, I mean, I know it was kind of long and people aren't going to want to get up there and read, but I wished somebody had read some of them. Because, I think that was one of the most important parts of my project even though they were made up.

I questioned Allison about being "the only person that got anything out of" her exhibit. She recognized, that building the exhibit was not just for visitors to the fair:

> Well, it was kind of disappointing, but it is okay because I think one of the main goals for the project was for us to get something out of it. So, even though it did take me that much work, I did it and it ended up being a good way to put everything together for me.

Allison's exhibit consolidated the efforts she had put into learning about Kashmir, and though she was deflated, she felt the endeavor still held value for her.

Working in constructionist learning environments. Allison liked working on projects. She linked the enjoyment of working on projects from a number of sources: working with her Dad, doing art and doing hands on activities. She explained:

> Since I was little with my Dad — I've always liked to have something that I was doing at the time. Like because, I like to make things and do things with my hands and that's one of the reasons I like art.

Projects were also different from "regular class work." Class work seemed to Allison to be activities the teacher created, and she didn't have much say in. Projects, on the other hand, allowed her to be creative. She remarked:

> I like projects, I guess, because it's more fun . . . to be able to put something together on your own, and that's some of the reasons I sometimes like not having a computer do projects or PowerPoints or something, because I think it's fun to create the poster boards and everything and decorate it, because it used art when you decorate it.

As mentioned before, Allison thought computers limited her creativity. She seemed to prefer to conceive all the aspects of her projects, as opposed to using some of the prefabricated templates in Microsoft *PowerPoint*®.

Allison thought the human rights project they worked on was different from other activities, projects and class work. In the past, other projects had been tedious with "little requirements." Despite this, she could see the continuity of the human rights unit.

> Parts of the project are homework and we turn them in. I like it because it's not — sometimes in class we start something and then we'll skip to something else and then start something else. And I like this, because it's like every night you do something for homework, and it just builds on it.

Making connections. Allison had been concerned about using her computer and maintaining her creativity. She used her computer as a tool to produce the elements of her

exhibit. She generated graphics and sections. She downloaded images and printed these to accompany her first-hand accounts. Her stories and fact summaries were typed in Microsoft *Word*®, printed out and affixed to her display. The constructionist learning environment gave her the flexibility to choose not to produce her exhibit solely on the computer. Allison was still able to be "neat," "creative" and "hands on."

Allison's exhibit consolidated many of her strengths. Allison rated herself and described herself strong in verbal/linguistic skills, such as English and writing. These were integrated into the first-hand accounts. She also rated herself capable in visual/spatial skills, such as art and layout. These skills were augmented by her logical abilities for the layout and organization of her exhibit.

Allison was also strong in interpersonal skills. Her understanding of others combined with writing skills are evident in her emotional and creative fictional accounts. Her reluctance with drama, however, seemed in conflict with her interpersonal skills. These skills may be influenced by the developmental stage of Allison and/or her peers. Honess (1992) suggests that adolescents' strengths may be affected by personal conditions, such as fear of isolation, and social conditions, such as friends and subcultures. Fear of presenting in front of her friends could explain this incongruence.

Musical, intrapersonal, naturalist and bodily-kinesthetic skills were not part of Allison's exhibit. Although Allison considered interacting with her exhibit through the character costumes and creating her exhibit "hands on" to exemplify bodily-kinesthetic intelligence, this ability is generally considered to be an individual's high sensitivity to movements of the body, such as with dancers and figure skaters (Gardner, 1983). The construction of Allison's exhibit may have revealed her preference for tactile or haptic learning (Caudill, 1998). A propensity for hands-on activities is consistent with a tactile learning modality.

Bob

Bob was articulate and sometimes comical and sometimes cynical. During our final interview, we discussed if he felt he learned the necessary content. He was tired of the project, and he felt it had went on too long.

> Researcher: Do you think you learned what you were supposed to?
>
> Bob: *Uh, yeah*. I think I got the picture like a few weeks before we did our project, but yeah.
>
> Researcher: How did you know?
>
> Bob: Because everything became repetitive after that: the projects, the human rights, a lot of countries that I just don't care about too much honestly.

Bob researched Sri Lanka but was more concerned with the current war on terrorism in Afghanistan, because of the influences from September 11, 2001. Bob remarked, "I still like want to think about [pause] what is going on in Afghanistan. I kind of disregard my thoughts about human rights, because, you know," and then quietly, "*I kind of hate 'em*." Bob was at odds with what he had learned about human rights violations in Sudan and the conflict that was occurring in the Middle East. He preferred to set aside his knowledge in order to feel the dislike for terrorists.

Identifying individual differences. Bob rated himself at 35 or above in three intelligences — logical/mathematical, bodily/kinesthetic and interpersonal — on *the Assessing My Multiple Intelligences* inventory (see Figure 5). He also rated himself above 30 in three other intelligences: verbal/linguistic, visual/spatial and intrapersonal.

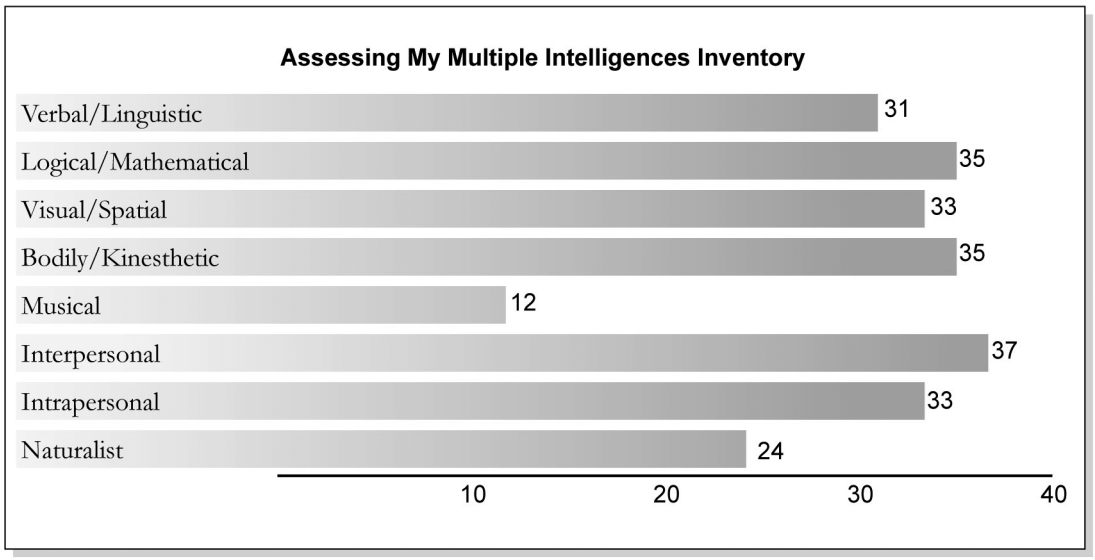

Figure 5. Bob's results on Assessing My Multiple Intelligences inventory.

In school, Bob thought he performed well in Science, Geography, English and Math. He judged his successes based on grades: "I do pretty well in English. I'm getting an *A* every semester. I think I've gotten an *A* in everything except Math for every semester." Bob enjoyed Science the most. "And Science, I just like Science. I think it's cool." However, physics was a component of Science he didn't enjoy: "There's a whole lot of math involved." Our discussion led to why he didn't enjoy Math — his worst subject. He was flustered as he told me:

> I do pretty well on the homework. But when it comes to tests, I just — I can usually — well, I think I did pretty well on this last test. I'm pretty sure I missed two, but I think I did well on the other ones. It's just when it comes down to the tests, I don't think [the Math teacher] gives me enough time, and I just start to panic and try to get through quicker. So, I make small mistakes. I think that's one of the reasons my test taking skills in Math are not great.

Bob thought he was good at a number of other activities. He liked to build things. It was an activity he shared with his father: "I think I'm good at like — I can build things

pretty well. Like I know how to weld and stuff. My Dad likes to do a lot of woodworking and stuff, so I can do well with that."

He was also involved in school athletics. He thought he was "okay" at football and "okay" at baseball. In football, he played "weak guard, weak tackle and defensive tackle." In baseball, he was "trying out for pitcher this year and second base." He seemed to understand the commitments necessary to do well at sports. Sports are what he worked hardest at: "I work hard basically at all my sports, but that kind of thing goes with every sport you play. You've got to work hard at it." Bob was anxious about moving up to high school from eighth grade: "When I go up to high school and I lose all that confidence." Later he remarked, "I know when I get up to that level it's going to be just like horrible. I know there are guys who can bench me."

Of all the activities he was involved in — woodworking, welding and sports — he felt he didn't need to choose one over another. Instead, he liked them because they offered him different outlets:

> I like them all equally. They are all kind of different. Like football, it's a kind of a contact sport and get a little aggression out. Baseball. It's more — you know, you've got to work at it a lot more. It's not as much hitting as building up certain muscles. And woodworking is just kind of like fun, because you get to saw wood and you get to make your own thing. And welding is just because all the sparks and everything.

Bob was taken aback when I asked him about his strongest abilities: "I'm not quite sure. I've never really thought about my strongest abilities . . . . Like when I think about what I'm really good at, when I think about that, I think I'm being conceited in a way." After some thinking, he decided: "Like I talk to some people pretty well. I don't get all shy. Well, I don't anymore. I used to."

I asked him to think about it differently:

> Researcher: What do you think comes easiest to you? What do you have to work the least hardest at?
>
> Bob: Wood working, welding and possibly science. My English is pretty good.

With English, he felt that he hadn't "learned a lot of new stuff lately," so it didn't require significant work. Science was still "cool," but "a good teacher" made him enjoy it more. Woodworking was "easy just because it doesn't take a lot of strength or anything." He knew "how to build lots of things," but often his woodworking projects didn't "come out right." Sometimes, though, he didn't "have enough time."

Though he struggled with defining his strengths, Bob without hesitation noted he was weak at "doing math" and "spelling." As mentioned above, Bob struggled with Math in school. For example, he felt he needed more time on tests and made too many small mistakes. Bob described spelling as a challenge:

> I think I do pretty well with English, but when it comes down to a few words. There are just some words that I can't spell right. I continuously spell this wrong. Like a while ago, it used to be *maybe*. I used to spell it like "m-a-b-e-y." But, I've gotten kind of used to spelling it the right way. But there are just some words like that that I can't spell right.

Using computers. Bob characterized himself as "I do pretty well with computers." Bob was comfortable with the hardware, software and vocabulary surrounding computers. During our first interview, he related a humorous story about his computer expertise:

> I'm like the only person in my household who can work a computer very well. So, I was like really sick one day and my mom decided that we needed to install a modem then. So, she got me on the phone with the Dell guy and I had to install this thing. And meanwhile I'm about to throw up, and she's like just hurry up and install it and you can go to the bathroom. And I'm like, whatever.

Bob enjoyed the niceties of using his laptop on campus. For example, he said "It makes it real easy to do PowerPoint" and to "do research on the Internet without having to come down [to the media center]." With the Human Rights research paper, he felt the computer made his reference citations go more smoothly: "It makes it a lot easier 'cause you can just copy the page format" from the Internet.

Bob's laptop often frustrated him. He felt that repeatedly their laptop computers were "really slow," and his battery didn't work anymore. "It's basically just plug it in all the time," he said. He was anticipating receiving a new laptop in another year. He particularly did not like when the computers would unexpectedly shutdown or "freeze up":

> And when they freeze up, because I'll get frustrated with the computer, and especially *these* laptops. 'Cause my laptop, the screen broke and I had to go through and clean out the disk space [so it could be repaired], and I can't figure out how to do it. It kind of gets annoying.

Bob went on to emphasize that "*these* laptops," naming the manufacturer, may not be "exactly the best company to buy laptops from."

Building computer mediated learning artifacts. Bob investigated the human rights violation is Sri Lanka. The artifact he produced for the fair hyperlinked a series of separate Microsoft *PowerPoint*® presentations (see Figure 6). Orginally, he had begun working on a tri-fold board to accompany his presentations, but stopped. He felt he had to "make a board" but discontinued the effort "because glue got everywhere . . . and it didn't work too well."

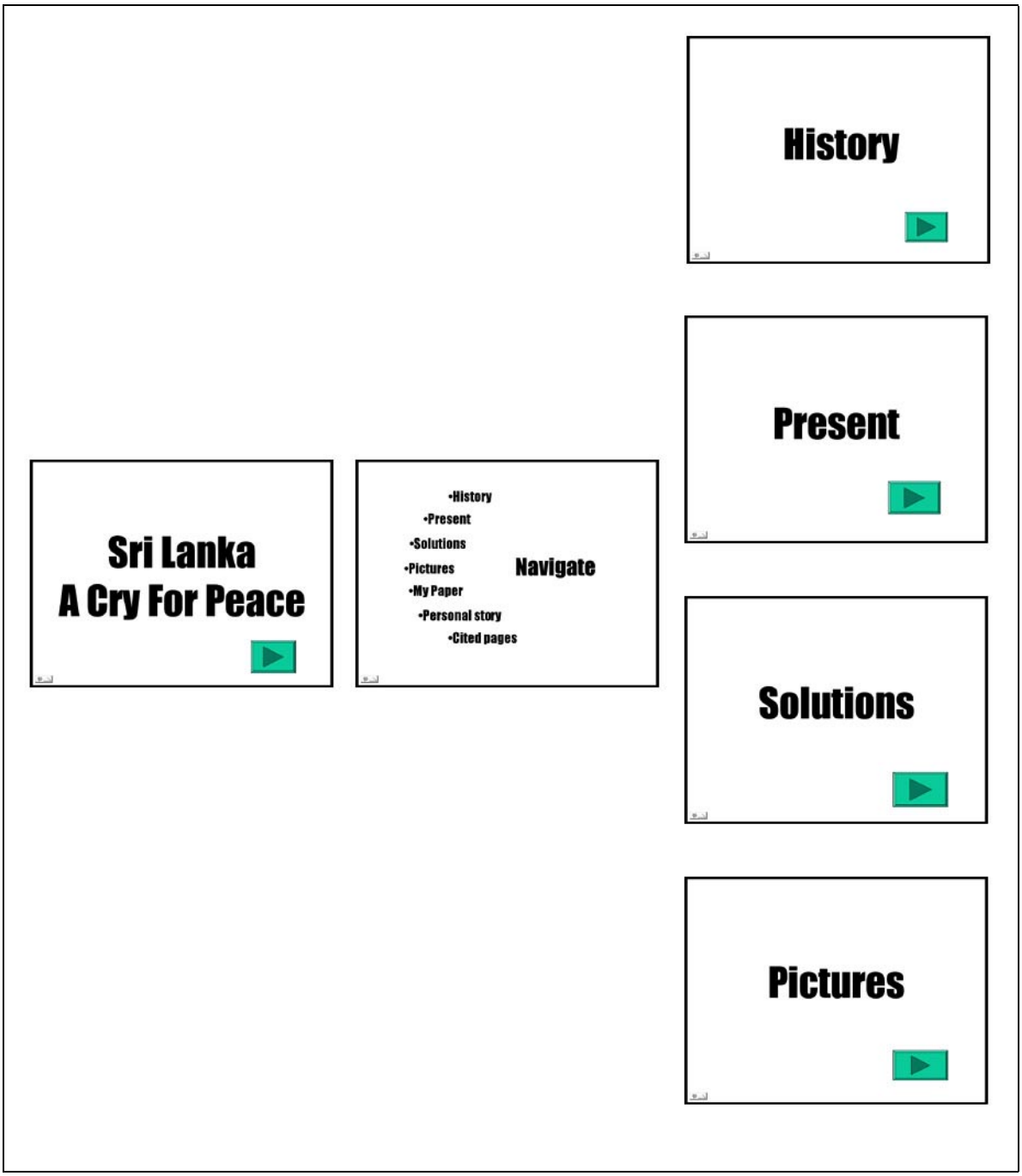

Figure 6. Bob's human rights exhibit with four Microsoft *PowerPoint*® presentations (at right) hyperlinked to the intro presentation (at left).

Bob's presentation divided the content into different strands, such as the history of Sri Lanka, what was currently happening, solutions to the violations and a gallery of photos. The text on the slides were in a large point size to facilitate reading, and the amount of text per slide had been summarized and abbreviated. Instead of distributing the images throughout the presentations, he consolidated them all into a gallery. The shared background of his presentations was a simple red design with a gradation of black into the center. He was trying to make the display "serious."

Bob's exhibit used a common navigational structure throughout all the presentations. Large "next" and "previous" arrows directed visitors to proceed through the presentations. Bob said he was comfortable with Microsoft *PowerPoint*® before he began his exhibit, "because we have done so much in the last year." However, prior to beginning his project, Bob had not used the hyperlinking function in Microsoft *PowerPoint*®. During one of my observations, Bob asked the teacher if it was possible to "jump" from one presentation to another while remaining in the Slide Show mode. The teacher replied that she didn't know, but that they should ask me. I explained to Bob briefly how to use hyperlinks and action buttons in Microsoft *PowerPoint*®. Bob mastered the hyperlinking and interface design to make the exhibit interactive for his visitors.

Working in constructionist learning environments. Bob enjoyed making projects he liked. For example, he said, "When it's something I like, like making a PowerPoint comes pretty easy, so that doesn't bother me as much as writing a five-page essay about why you like it." He appreciated that projects in the past had offered him more flexibility and more options. He remarked, "I mean, something that has to do visually. You can do a little more effects with it or something like that. It's nicer than just writing a paper on it." Research papers and essays, he felt, we more restrictive.

In general, Bob divided project-based work into two categories: projects for fun and projects for a grade. Each had different requirements with a different state of mind:

> A project for a grade is something you'd write a paper or a report. A fun project is something you do on PowerPoint and you can have pictures and stuff. And you can do animation and be more creative. With the project for a grade, it's you know, you have a set thing you have to do. It's like you have to do a paper and a poster and present it to the class or something.

Bob felt that projects made with Microsoft *PowerPoint®* were projects for fun and you could "do them . . . however you want," and they were, subsequently, graded with that in mind.

During our first interview, Bob suggested that he liked when projects were extended and extensive.

> I actually like when projects take a long time, because you have more time to do them. You might have to get more information, but it's better than doing a bunch of little ones. But, that's just my personal opinion.

He seemed to prefer the continuity of projects over segmented activities. During our third interview, Bob felt differently about the human rights project.

> Researcher: So, you've been working on this human rights stuff since you guys got back from school. I mean, since you got back from Christmas.
>
> Bob: Yeah.
>
> Researcher: It's been a long time.
>
> Bob: Yes.
>
> Researcher: Are you ready to let it go?

Bob: Yes. I'm ready. This, this has lasted longer than I think when we studied the civil war in 7th grade. So, uh, it's, uh, I'm ready to move on to a different thing.

Researcher: When did you get to a point that you were ready to move on?

Bob: After the paper.

Researcher: After the paper? And why do you think it was after the paper?

Bob: Because, you know, I thought I'd be done with the project and everything, and then along comes this next part. You have to make a board and power point and whatever.

Our last interview was not much different. The tone of our interview was clouded by how jaded Bob was with the project.

Bob: Um…like shortening the amount time that it took because it took like Christmas until a month ago. That's a long time for a project.

Researcher: It was ten weeks. You actually did four projects in that ten weeks. That's a long time. Were you tired of it?

Bob: I was very tired of it at the end . . . . but other things, it seemed like it was repeating itself and the same thing over and over like human rights/civil rights. I think, we got the point awhile back, but it was just like *drawn* out.

Bob felt the content had been redundant, and the length of investigation had been too long.

Making connections. Bob rated himself strong in verbal/linguistic skills, logical/mathematical skills, visual/spatial skills, bodily/kinesthetic skills, interpersonal skills and intrapersonal skills. His verbal/linguistic skills, logical skills, and interpersonal skills were used in both his research paper and his human rights exhibit. His research paper was

rated at Grade 9.6 by the Flesch-Kincaid Readability Scale in Microsoft *Word*®, a grade level above his own. Also his logical skills were combined with his verbal skills to produce a research paper and exhibit that was organized and easy to follow. Bob described his structure as "One. Two. Three." It was so he and his audience could follow his thinking. It was a robust model. In his research paper, he used a timeline organization, discussing past to present. He carried this structure over to his exhibit and divided the Microsoft *PowerPoint*® presentations into similar categories.

Though his exhibit was a self-guided tour, Bob also combined his logical thinking with his interpersonal skills. He indicated that he took into account the audience during the production of the exhibit:

> I think you have got to think what people are going to want to see, if they are going want to have lots of pictures or lots of words…you'll probably not want to have lots of words because you don't want to be reading about Sri Lanka, a country that they've never heard of and if that happens, they don't know where it is.

A sensitivity to others' desires and motivations are characteristic of interpersonal skills (Gardner, 1983). Bob's visual/spatial skills were used in the creation of his presentations for his exhibit. The slides are easy to read and well layed out.

Bob's intrapersonal skills may not be evident in his research paper nor his exhibit. Intrapersonal skills are generally considered to be introspective and self-reflective (Gardner, 1983). It may be difficult to locate evidence of these skills in his products. However, during the research and writing of his research, he may have used this ability in an effort to come to understand what was happening in Sri Lanka, as well as his feelings. For example, at the beginning of this section, I described how Bob wanted to set aside his new knowledge about human rights violations in order to "hate" the terrorists in Afghanistan.

Bob did not use his two lowest rated intelligences, musical and naturalist, nor his stronger bodily/kinesthetic intelligence in his paper or his exhibit for the fair.

Brittney S.

What was most striking about Brittney S. was how empathetic she was toward the plight of Sudan. Repeatedly she told me how she had become immersed in her project, imagining what it must be like to live in Sudan and how useful it seemed. During a conversation about projects in general, she commented, "Because you actually get involved with it and you are doing something with the information, not just repeating it down on paper." Another time she told me, "Because, with my [exhibit] I wanted it to not be just information, and I wanted it to be involved and I already accomplished that through my stories and the hands-on kind of stuff."

Yet again, she explained a unique opportunity to relate to others what the Sudanese were experiencing:

> Yeah, I think you actually learn more about, with this kind of [project]. In the past, you memorize information so you can spit it back out on paper and then never…like deal with it again. But, this is a very interesting. Like over spring break or something, a man from Sudan, which is my country, came to visit, the stables where my horse is at, because they were touring farms, areas, like 10 or so, 15. [The men] had been rescued to get education and stuff and when they came out to see like horses and stuff. That was really like neat because when the people at the stable didn't really understand why they were there, and didn't understand what they had been through and I could kind of like explain to everyone and it made me kind of feel like I knew about what they had gone through and what their life had been like.

Identifying individual differences. Brittney S. rated herself above 35 in two of the intelligences: visual/spatial and naturalist (see Figure 7). Her exceptionally high score in the Naturalist intelligence was one of the reasons she was considered for this study. During one of our follow-up interviews, Brittney S. indicated she was interested in biology, and she

wanted to be a veterinarian. Brittney S. also rated herself above 30 in two other intelligences: verbal/linguistic and interpersonal.

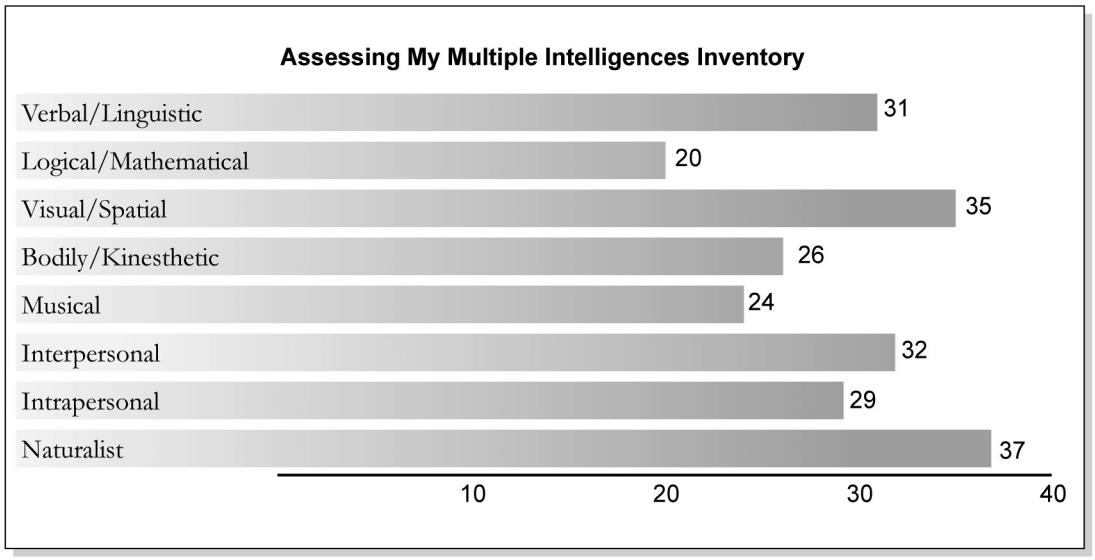

Figure 7. Brittany S.'s results on Assessing My Multiple Intelligences inventory.

Brittney S. thought she was good at English, Geography, Biology and Spanish. She thought she was good at English, because she liked "to write a lot." She described her relationship with English: "I like English. Anything I can relate to, I'll enjoy. Like numbers, I don't relate to them, so I don't like them." Geography gave her to opportunity to "learn about the world where" she lived and because "you don't really know about how other people live in this world." Throughout all our interviews, Brittney S. didn't mention any science-related topics other than biology. She said she liked biology, because she wanted to be a veterinarian. Spanish was different from the other subjects. Brittney S. thought she was good at Spanish, but she did not enjoy it. She described it: "I just think it's a waste of time, maybe."

Outside of school, Brittney S. felt she was good at art, basketball and riding horses. With art, she thought she had "a good imagination." In basketball, she "really like[d] it" and she thought she was "tall" so that helped. She enjoyed riding and thought she was good at it also. But, it wasn't always pleasant. She explained: "Sometimes I don't like doing tedious work. I would just rather have fun riding them. I don't like training them all the time."

Brittney S. thought her strongest ability was "to have fun." She went on to say, "I can, I just like doing the stuff I like." As she thought more, she decided that she had "a good ability to draw and imagine stuff, and I just have an opinion about everything."

Her weakest ability affected all parts of her life: "Staying organized. I'm sloppy. Getting up in the morning. I'm kind of lazy, too." Organization was what she had to work the hardest at also. She depicted her struggle as: "I have to — really staying organized. I'll lose stuff. I have to really make a point to remember what I need to do and stuff. I'll always forget to do stuff."

Using computers. Brittney S. viewed computers with pros and cons. For her own amusement, she thought computers were "fun to get online at night and do email and play games and stuff." Computers were also useful for learning. She expressed the access computers gave her to knowledge and understanding that were beyond her geographical boundaries:

> That you can like . . . get more information and learn a lot more stuff that you wouldn't be able to without them. 'Cause their like a link to the world you don't know about. You can like go and find out about Africa, and you like go to the Internet or something and watch a video. That would be hard to do, you know.

Computers often just made tasks "easier." She thought computers were "good because they make a lot of shortcuts. You don't have to go check out books or find [books]. You can just type something in and it does it for you."

Computers had shortcomings, too, for Brittney S. "Sometimes they can be annoying like slow," she said. "And it takes a long time, 'cause you expect them to be fast, and I get impatient." Sometimes computers would disappoint her, like when "you need them to do a project they always break." Among all the pluses and minuses with computers, Brittney thought they were "pretty good" and she "pretty much enjoy[ed] everything about them."

Building computer mediated learning artifacts. Brittney S. researched Sudan. Her exhibit combined a tri-fold board and a Microsoft *PowerPoint*® presentation to concentrate on the slavery in Sudan (see Figure 8). The center of her display featured two fictional diary entries from individuals in Sudan. These were typed in Microsoft *Word*® and printed out. On each side were images she downloaded from the Internet. Her stories seemed to be the central elements to her exhibit. She described their purpose:

> I spent a lot of time writing a personal story that would be really detailed and give people an understanding of what it would be like to be a slave. 'Cause I think you can relate more to, um, what, you can understand something better if you can relate to it. And kind of get involved and have, like, stronger feelings about it.

Alternating with the images were small flaps. On the outside were trivia questions about Sudan she had hand-written, and visitors could lift the flaps to check their guesses with answers she had hand written. Brittany S. used her own words to provide answers to questions like *What are human rights?* and *What is the difference between human and civil rights?*

Brittney S. also included a Microsoft *PowerPoint*® presentation. The presentation presented background information, specifically looking at slavery in Sudan. Visitors could

click through the five slides. Brittney S. thought if she had put more effort into her presentation she could have made it "less plain." Though she had accomplished what she wanted to with the exhibit, she was a little disappointed, because she thought she "could have spent a little more time on it."

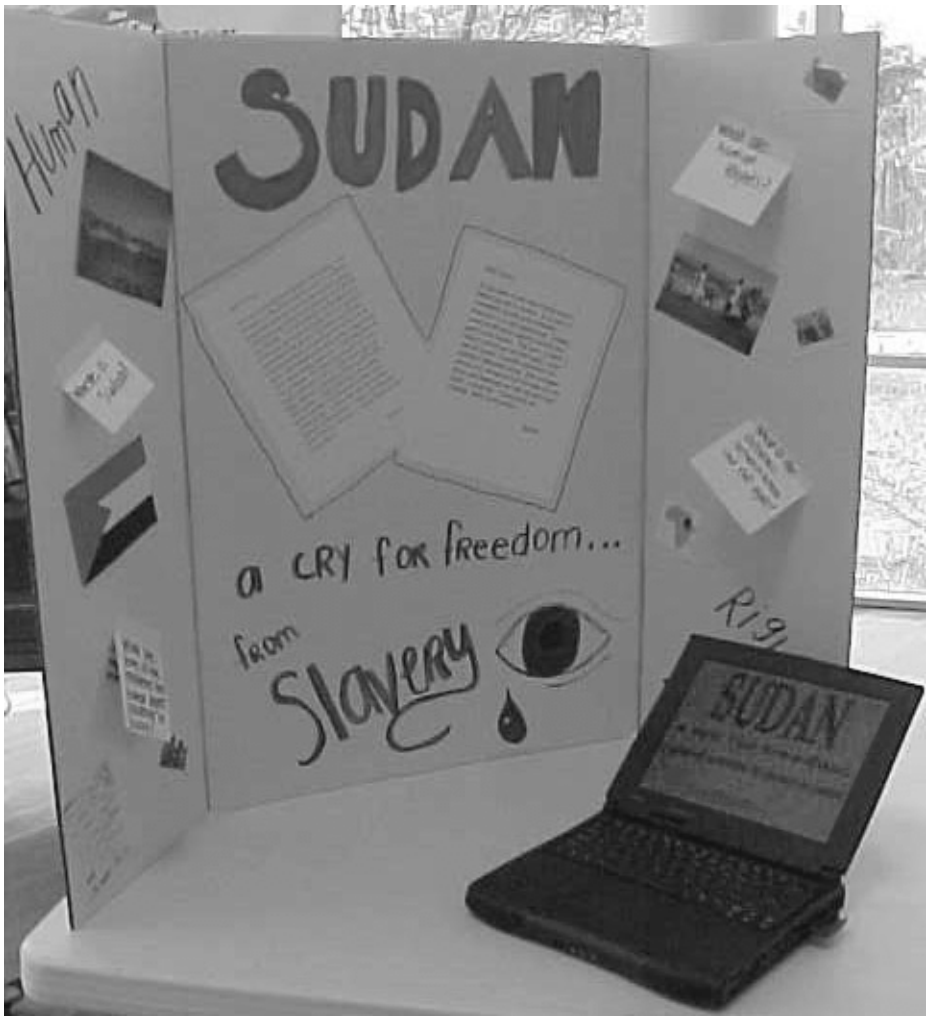

Figure 8. Brittney S.'s human right exhibit with diary entries and a Microsoft *PowerPoint*® presentation on her laptop.

Working in constructionist learning environments. Brittney S. viewed project-based work as an opportunity to study a topic in depth and to make use of the information she was accumulating. As mentioned in the introduction section to Brittney S., she repeatedly described her opportunities to become "involved" with the content and the people of Sudan. For this same reason of engagement, Brittney S. thought projects were different from tests. She described projects as "better than tests, different than tests. So you can like get involved with it, and it's like a good change. It's a lot more interesting than tests. You can learn a lot about something." In a later interview, she also indicated the usefulness of project work over tests: "Because . . . you are doing something with the information, not just repeating it down on paper."

The human rights project had been "pretty good" for Brittney S. She seemed to feel an appreciation for the knowledge she was gaining.

> I think it's good, because sometimes in America we don't face a lot of our human rights and stuff being violated. So, you don't really know about how other people live in this world. You know how like lucky you are, and then you know a whole different thing you ever understood. You get to learn about what rights you have, 'cause [pause] I guess that's all.

However, Brittney S. thought the project had taken "a really long time." She also thought that some of the content they had covered had been duplicated. She thought "in the project we don't — we do the same stuff over, repetitive, like talk about it."

Making connections. Brittney S. was the strongest in verbal/linguistic, visual/spatial, interpersonal and naturalist abilities. Her verbal/linguistic and interpersonal skills represented the combined depth of her research paper and, subsequently, her exhibit. Her obvious emphasis on becoming "involved" in the plight of the Sudanese and communicating

that to herself and others represents the mixture of these abilities. The diary entries on her display board achieved her intent. As she put it:

> Brittney S.: I gave, like, a lot of description, like they have a little hut, and I really described everything about it to give the readers a real good feeling about the surroundings and where they live.
>
> Researcher: And where did you get that information?
>
> Brittney S.: I took what I had already researched and learned and put like my own imagination in it.
>
> Researcher: Uh hum.
>
> Brittney S.: And wrote what I thought it would be like in my diary entry.

Even her imagination — that she felt she was strong in — came into play in order to convey her feelings and the feelings of others, characteristic of interpersonal skills (Gardner, 1983).

Brittney S. rated herself high in visual/spatial skills. For this project, these were not evident. Her display was a little sloppy. This may have been confounded between her unorganized nature and her lack of time to commit to the exhibit. During our last interview, she said she was disappointed in her exhibit, because "just maybe that I could have spent a little more time on it."

Her strong naturalist intelligence along with her weaker intelligences, such as logical/mathematical, bodily/kinesthetic, musical and intrapersonal, appear not to have been used in the construction of her artifact.

Brittney T.

Brittney T. was shy. She even told me so. She said, "Once I get to know someone I'm not." But more than just Brittney T. being shy, she seemed uneasy with social situations.

For example, during one of my observations, Brittney T.'s class was conducting peer reviews of fictional first-hand accounts they had written in small groups. While other groups were reading their writings out loud to the members of their clusters, Brittney T.'s group remained silent. Instead, they each circulated their laptops to one another and read from the screens speechlessly. Afterward, all the members were reluctant to be critical of one another's work.

During another observation, the class was reviewing their in-process exhibits. Each student met with two students to discuss their exhibit. During one of Brittney T.'s conferences, she and another female student seemed very comfortable with one another. They laughed as they spoke. What was poignant during this exchange was that Brittney T. said, "I hope the ninth grade doesn't come [to the Human Rights Fair]." Elkind (1967) suggests that adolescents are preoccupied with the reactions of others. This may explain Brittney T.'s discomfort with others and reluctance for others to view her work.

Identifying individual differences. Brittney T. rated herself above 35 in two of the intelligences: bodily/kinesthetic and interpersonal (see Figure 9). She also rated herself at 30 or above in three other intelligences: verbal/linguistic, visual/spatial and musical.

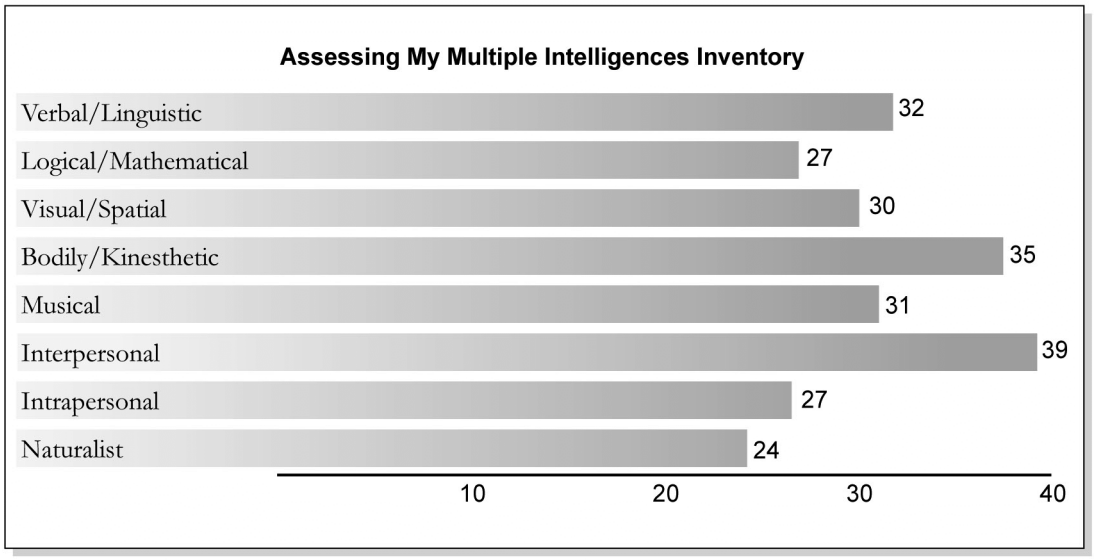

Figure 9. Brittney T.'s results on Assessing My Multiple Intelligences inventory.

In school, Brittney T. thought she was good at English and Geography. With English, she said, "I've always kind of understood it." She went on to couch English against math class: "You don't have to do math problems and stuff." She enjoyed English because "you get to read books and you get to write about stuff." Geography was like English; she enjoyed it, thought she was good at it, and thought it was "fun."

Outside of school, Brittney T. played sports and liked art and drama. She played volleyball, basketball, tennis and rode horses. She said she enjoyed volleyball, but was not "that good at basketball and tennis." She added that she had to work the hardest at basketball. She liked to ride horses, and with art she just liked "to draw."

Brittney T. thought her strengths lay with her ability to write and her ability to talk. She said she could "just fill up a page really fast." During one of my observations, her Geography class was writing first-person accounts of individuals who lived in the countries they were studying. I noticed at a half hour into writing, Brittney T. had already begun her second page. All the other students except one were still on the first page. Brittney T. also thought she was strong in talking. She laughed as she said, "I can just talk for a while."

Brittney T. felt her weakest abilities were math and meeting new people. She said she struggled with "math and doing math problems." As mentioned earlier, Brittney T. described herself as shy with new people, but became more comfortable with them over time. Math and her bashfulness were not just sudden weaknesses, they had been traits throughout her life.

Researcher: Do you feel like you've always been that way?

Brittney: Pretty much.

Researcher: With math, too?

Brittney: Uh-hum.

Using computers. Brittney T.'s feelings about computers were best summed up as she stated: "I'm fine with it." She felt she knew how to use them to get her schoolwork done. But if the computer "breaks or dies," she admitted, she didn't know how to fix it. She didn't appreciate when they would "freeze and you can lose your work."

Brittney T. felt using a computer made her schoolwork easier. Typing notes and papers was easier than writing with pencil and paper; it was not "so hard on [her] hands." Using the online help, thesaurus and dictionary was effortless. She interpreted the advantages as: "And like you have a lot of sources on [computers]. You can just go to the dictionary and look things up." Plus, the Internet provided Brittney T. with an endless resource for information: "And you can — you have so much information right there. Instead of having to go down to the library and stuff."

Brittney T. also felt pressured by the laptops they used in her school. She felt that the teachers had expectations about how she and her classmates should use their laptops. She noted:

> They expect you'll — to get a project done faster. And if you have a class and you need to work on a project, they'll know if you don't get done. They'll say you weren't giving your full attention to the project or something in class.

The computers were helpful to make her schoolwork easier, but they were also a burden. The advantages came at a price for Brittney T.

Building computer mediated learning artifacts. Brittney T.'s human rights exhibit was composed of a tri-fold board and web pages on her laptop (see Figure 10). Along the two side panels of the board, she synopsized the major sections of her research paper, noting the weak economy, the government, the Dirty War and the imprisonment of innocent citizens. She used large text with bullets and graphic headlines printed from her computer to divide the sections. In the center of her board, Brittney T. presented images she downloaded from the Internet, including the Argentine flag.

Figure 10. Brittney T.'s human rights exhibit excluding her first-hand accounts web pages on her laptop.

On her laptop, Brittney T. offered visitors the opportunity to click on images embedded in a web page she built in Microsoft *FrontPage*®. Each of the images hyperlinked to a first-person account she had written. Brittany T. had not used Microsoft *FrontPage*® before this exhibit. Her Geography teacher had suggested she use it and had shown her how to create the web pages, insert the images and create the links.

Working in constructionist learning environments. Brittney T. appeared to dislike projects. She did not seem to like the effort they required. In her words, "You have to put all your work and make it perfect and then present it. And I think it's easier to just like do little bits of things at a time."

She did, however, seem to value what she was learning about with respect to human rights and countries where human rights are violated. She noted, "[This unit] is helping us learn about South Africa and human rights all over the world." She also felt that as she investigated Argentina she could realize the circumstances the citizens were facing: "I can just imagine what happened. In Argentina, there was a Dirty War and just a lot of different things and lot of torturing and killing and stuff and I can kind of imagine that."

Making connections. Brittney T. rated herself the strongest in interpersonal intelligence. This seemed to conflict with her shy personality and reluctance to present to others. During one of our interviews, Brittney T. described the human rights project as "better than a regular project." Often at the end of projects in her classes, she and her classmates would stand in front of the class and present their final products. This is what Brittney T. considered to be a "regular project." Part of the concern Brittney T. had for projects may have been attached to how projects had ended with presentations. She appeared to dislike presenting to the class. She compared a "regular project" to the human rights project: "Just

like, you're just like presenting it in front of the class and stuff. I don't like presenting things that much, so it'll be easier just to like have people come in and look at it."

Though Brittney T. was bashful with others, her interpersonal abilities coupled with her good verbal/linguistic skills played a strong part in her exhibit. The moving first-hand accounts she wrote communicated the plight of three Argentinians. Her sensitivity to their feelings are indicative of interpersonal skills (Gardner, 1983). Her discomfort with others may be a factor of her development. As mentioned at the beginning of this section, adolescents like Brittney T. are preoccupied with how they look to others and believe others are as critical to themselves as they are (Elkind, 1967).

One of Brittney T.'s other abilities, visual/spatial, was also used to produce her exhibit. Her display was well organized. The structured layout of her tri-fold board also gave visitors an easy method to interact with her content. The graphical headings, large bulleted text and images provided an eye-pleasing design to accent her important details.

Brittney T.'s other stronger abilities, such as bodily/kinesthetic and musical intelligences, along with her weaker abilities, logical/mathematical, intrapersonal and naturalist intelligences, appear not to have been used to produce her human rights exhibit.

Brock

Brock was from South Korea. He had only been at the day school for a year and a half at the beginning of this study. Prior to coming to the United States, he attended a public school in South Korea. His mom didn't work, and his dad didn't live with him. His dad worked for the market exchange in South Korea. He was a dealer. Brock said each summer they "go back to Korea" but they would not go back there to live.

Because he already spoke another language, he didn't need to take French or Spanish or Latin, like the other eighth graders were required. So he had an extra open class period.

When visiting the school, I would often see Brock in the hallway during one of his open periods using his computer: sometimes working on homework, sometimes listening to music with headphones, sometimes checking email or surfing the web, sometimes doing them all at once.

I came to understand Brock's affinity for computers. I wasn't alone either. During one of the last meetings with all the participants, I was asking the participants to read through my descriptions as a member check. Brock was concerned when I described him as being "enamored with computers." He said he was not into computers *that* much. I was quickly concerned that maybe I had overstated his use of computers or maybe had misinterpreted what he had told me. His fellow classmates and participants looked up from their own descriptions, and in unison said, "Yes, you are!"

Identifying individual differences. Brock rated himself at 35 or above in three intelligences: logical/mathematical, visual/spatial and naturalist (see Figure 11). He also rated himself at 30 or above in three other intelligences: musical, interpersonal and intrapersonal.

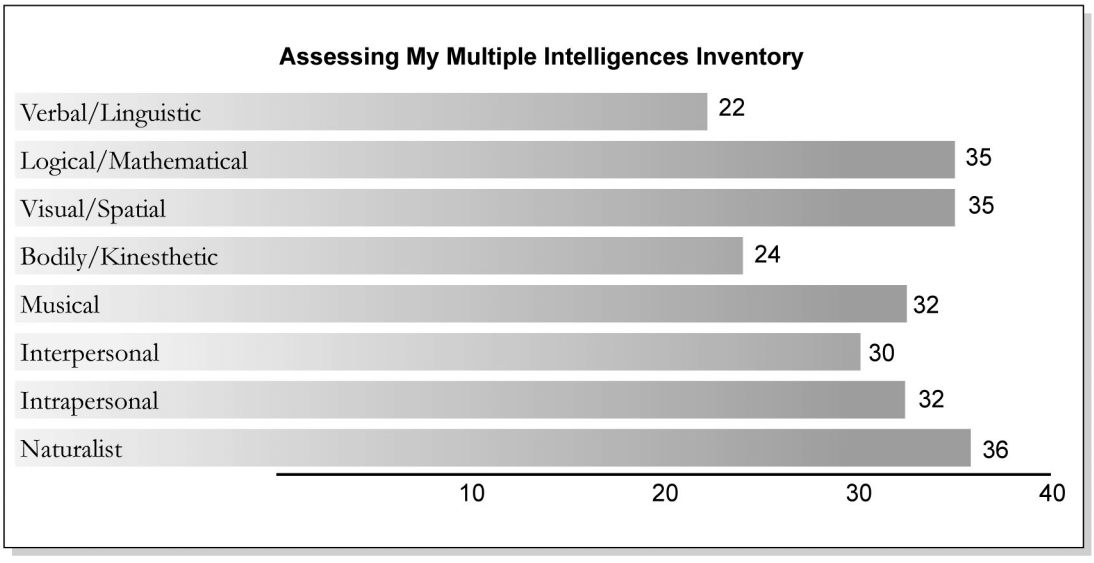

Figure 11. Brock's results on Assessing My Multiple Intelligences inventory.

In school, Brock thought he was only good at Math. He felt it came easy to him. He did not think he had to work very hard at all in Math. He got the best grades in Math, and he liked Math the most, too.

In other activities, Brock thought he was good a playing the clarinet, playing soccer and art. He had only been clarinet for about two months when the study began. He admitted, "I'm just beginning." But he felt he was pretty good at it. Soccer and art were similar. He just liked them. He could not explain why, though. He said, "I just like it."

When I asked Brock about his strongest abilities, he said, "Thinking." He went on to say "solving, calculating and math." He seemed to think that "solving" problems and "calculating" was what Math was about. He used to have to study and work harder for Science class, but when Math was involved, he liked it more. He described his struggle as: "I used to work hard in Science. I had the lowest grade. But now I like it. We're into physics now, and it's math." Solving physics problems made the connection that Brock needed to make Science easier and more gratifying — more like Math.

Brock thought his weakest ability was "concentrate." He described that many times at home he would "just like daydream and lose [his] thoughts." I followed up with him about how he tries to work at concentrating. As he laughed he said, "I don't work. Try to concentrate."

Using computers. Brock couldn't come up with anything he didn't like about computers, except when "the Internet server was down." He was enamored with computers. As he described it: "I totally like it."

At home he could "get on the Internet and download games." Using a computer also made completing his schoolwork faster. "When in Word to type, it's easier to type." He could type faster than writing by hand. He also thought it was easier to get pictures from the

Internet. For projects, if he had a choice to use a computer or not, Brock indicated he would choose to use a computer. He liked to use his hands to create products, but he preferred to use his computer to do it.

Building computer mediated learning artifacts. Brock's exhibit for the Human Right Fair combined a couple of different technologies (see Figure 12). His introductory page was a simple web page, generated in Microsoft *FrontPage®*. It included five bullet points of the major elements from his Argentina research paper and two hyperlinks, one for an electronic presentation of background information on Argentina and one for an electronic presentation of political cartoons.

One of the hyperlinks launched a Microsoft *PowerPoint®* presentation that expanded on the five bullet points from his web page. The slides included images he had searched and downloaded from the Internet. The content came from his research paper and included topics such as anti-semitism, the economy and solutions.

The second hyperlink launched another Microsoft *PowerPoint®* presentation containing eight political cartoons. After I reviewed Brock's presentation, I realized the political cartoons did not relate directly to Argentina. I did some research on the Internet in order to locate the origin of the cartoons. I found that some of the cartoons were from World War II and drawn by Dr. Seuss. I felt that Brock had made gross connections between the political cartoons and Argentina, using them out of context and without explanation. For example, anti-semitism against Jewish individuals in Argentina was one of the details Brock included in his research paper and other presentation. Two of the political cartoons dealt with anti-semitism against Jewish individuals from World War II but did not relate to Argentina's current plight. I asked Brock why he included the cartoons. He said, "Because the cartoons were funny."

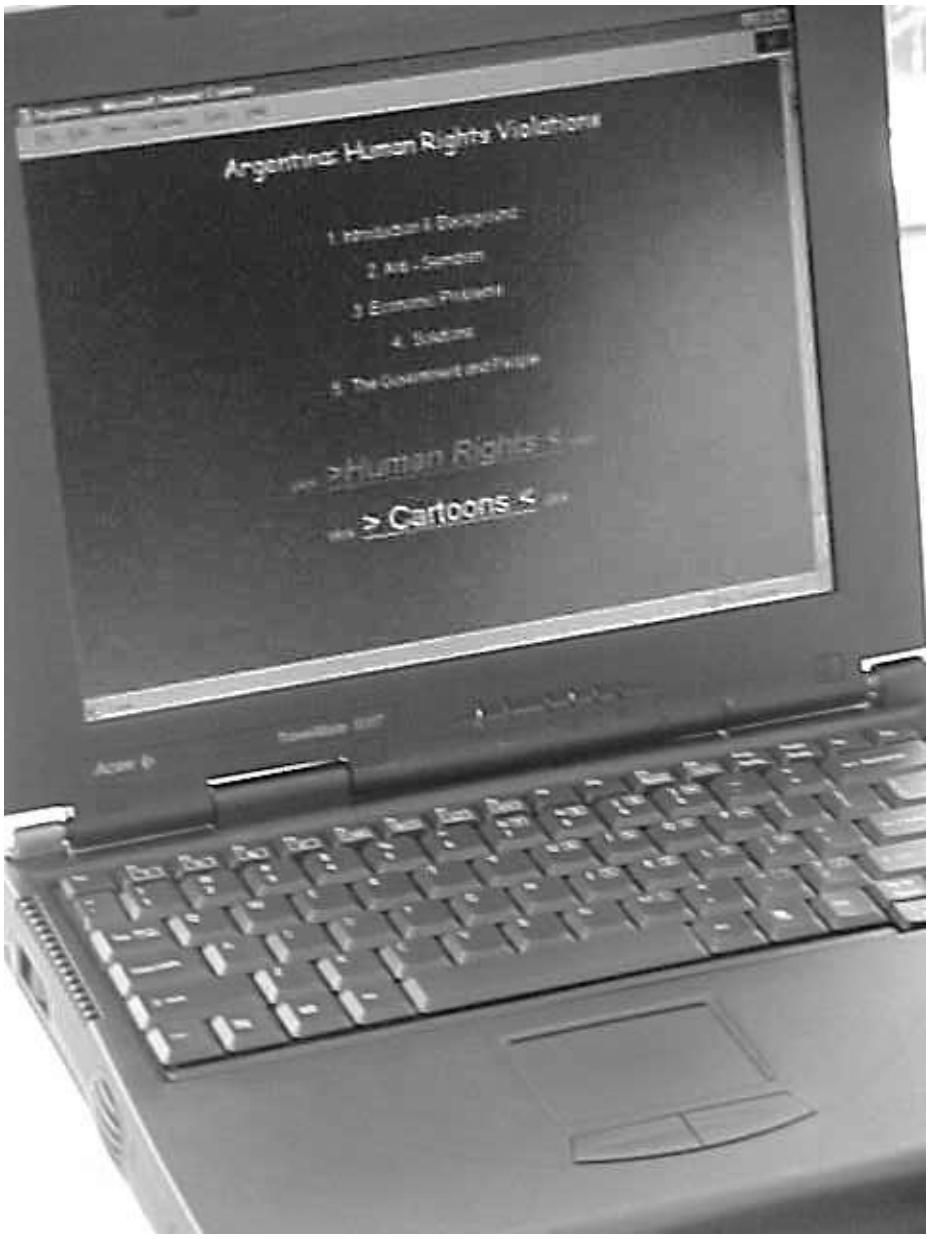

Figure 12. Brock's human rights exhibit with hyperlinks to two Microsoft *PowerPoint*® presentations at the bottom of the computer screen.

Working in constructionist learning environments. Brock felt project grades were usually weighted much like tests. So, he believed, "It's much easier to get a good grade. Easier than a test." Brock was disappointed in his grade with his human rights exhibit. The teacher

marked him low for lack of details and effort. He indicated the other students all received higher grades than he did, "like everyone got a good grade."

As mentioned above, Brock preferred to use computers when completing projects. He liked to create the different elements of the project on the computer. He particularly favored Microsoft *PowerPoint®*. He thought it was fun to choose from the different themes, fonts, animations and sounds.

The alternative to computers was not appealing to Brock. He didn't like to make posters for projects, because he didn't think he was good at it. He expected to "always mess up the writing." During an interview he demonstrated in the air how his writing slants on posters. He contributed this to why he was poor at making posters. He felt his poor handwriting would affect his grade.

Making connections. Brock rated himself highest in logical/mathematical skills and visual/spatial skills. However, the only skills he felt he used in his research paper or exhibit were computer skills. Brock failed to see how his abilities to think and solve problems, as he put it, were used in his paper or his exhibit.

Researcher: How did you think this project represents your ability?

Brock: It doesn't represent any of my abilities.

Researcher: Why not?

Brock: You know when I said my abilities were thinking things, it doesn't have anything to do with that.

Researcher: Why not?

Brock: Well, my abilities are a lot like solving things with Math. And this has nothing to do with thinking.

I asked Brock how he determined the structure for his research and subsequently one of his electronic presentations. He said, "From most important to least important." Brock never made the connection that he was performing problem solving and logical skills during the Human Rights unit in Geography class.

It was difficult to see whether Brock use visual/spatial skills in the production of his exhibit. His web page was simple and inconsequential. His electronic presentations were well created and not cluttered or flashy. However, the software application provides a structured template to generate well organized presentations for novices and experts, irrespective of their visual/spatial skills.

One of the abilities Brock mentioned that was not included as part of the Multiple Intelligences inventory was computer skills. Brock combined both a web page with two electronic presentations. As mentioned before, Brock preferred to use a computer to complete tasks. With his human rights exhibit, he could not see another way to do his project on his computer other than with "PowerPoint." His fascination with computers may have compelled him to view technology as content as opposed to a means to an end (see, for example, Lundeberg et al., 1997). His exhibit may in fact represent his comfort with computers and his acquired expertise with computers.

It appears that Brock did not use his other strong abilities, such as musical, interpersonal, intrapersonal and natural intelligences, nor his weaker abilities, verbal/linguistic and bodily/kinesthetic intelligences, in the construction of his exhibit.

Chapter Summary

This chapter presented the individual case profiles of five eighth graders — Allison, Bob, Brittney S., Brittney T. and Brock — in a Geography class at a private day school.

Allison was conscientious, articulate and reflective. Allison's human rights exhibit featured articles of clothing, so visitors could actually assume a Kashmiri identity. Allison revealed a preference and propensity for tactile learning experiences. Bob was articulate, but often comical and cynical at the same time. Bob's human right's exhibit featured a hyperlinked Microsoft *PowerPoint®* presentation. Bob used his logical skills in combination with verbal/linguistic, visual/spatial and interpersonal skills to produce an exhibit that reflected the needs of his audience. Brittney S. was empathetic toward the Sudanese. Her investigation into Sudan and slavery allowed her to become involved in the learning. Her exhibit was highlighted by two fictional diary entries from children in Sudan. Her interpersonal skills were the most visible abilities in her exhibit. Brittney T. was shy. She preferred not to present in front of the class to her friends. Despite this, her interpersonal skills coupled with her verbal/linguistic skills produced moving fictional accounts of individuals living in Argentina. Brock was from South Korea and was fascinated with computers. His human rights exhibit combined web pages and electronic presentations for visitors to view on his laptop. Brock failed to see how logic was used to produce his research paper, and subsequently, one of his presentations. His exhibit indicated his comfort with computers in addition to logical organization.

The participants' individual differences were discussed within the context of a Multiple Intelligences inventory and their daily activities. Their beliefs about computers and using computers for learning were presented to situate their work within a constructionist learning environment. The participants' computer mediated learning artifacts were described and then analyzed with respect to their individual differences. The data were organized and presented with respect to the research questions and literature review. The cross-case analysis in Chapter 5 will reference these data and explicate the themes across them.

CHAPTER 5

CROSS CASE ANALYSIS

The previous chapter described each of the individual cases for this study. Each participant profile explored identifying individual differences, using computers, building computer mediated learning artifacts and working within a constructionist learning environment. A final section in each of the profiles looked across all the parts of the profile in order to make connections among the sections.

This chapter presents a cross case analysis of the five eighth-grade participants. These data are presented within the structure of the research questions for this study. The research questions for this study were:

1. Within a constructionist learning environment, in what ways do computer mediated learning artifacts reflect individual differences?
2. In what ways do learning artifacts reflect a learner's knowledge?
3. How does the construction of learning artifacts allow learners to tap individual differences?
4. How do constructionist learning environments support individual differences?

Question 1: In what ways do computer mediated learning artifacts reflect individual differences?

Individual differences, more specifically abilities, are reflected in the computer mediated learning artifacts as a blend of abilities. Both abilities identified in a Multiple Intelligences inventory (National Dropout Prevention Center, 1995) and those identified by

the participants, such as creativity, organization and computer skills, are components of the artifacts the participants produced as part of a unit on human rights. This section examines how abilities were blended into the computer mediated learning artifacts, computer skills, as well as untapped and recognized abilities.

Blending abilities. Allison was a good writer, creative, visual and enjoyed hands-on activities. Her exhibit for the Human Rights Fair integrated all of these. She wrote first-hand accounts to place the visitors in the shoes of victims in Kashmir. Her display was well organized; she used large photographs and headings to gain the attention of visitors and direct their attention. She felt her abilities were a natural extension of herself. She explained how they became part of her exhibit:

> It is just that's who I am. So when I do a project like that, it just naturally, that's my tendency to do something that involves those, 'cause that's what I'm good at. So that's just my personality that goes into what my project is like. And also the part about being good at those, those certain abilities. That's one of the reasons that they got in my project because one of the abilities that I'm not very good at is not gonna be something that I want to put into my exhibit. So, I guess the things that I'm the best at usually show up in my projects.

Unlike Allison, Bob felt he had been stymied by the creative nature of the exhibit. Bob told me:

> Well, [my exhibit] definitely didn't show how creative I was because, you know, I can't — I can think of things pretty well, like when it actually comes to like drawing or creating. Sometimes I can't do it the way I wanted to, and it doesn't turn out too well. And I think that reflects on the PowerPoint because I just did like [pause] facts and you just switch the page. Because I'm not used to like drawing or figuring out like how to be creative and make it pretty and everything

While Bob's exhibit may not have expressed his creative nature, he focused his logical characteristics on organizing his process and product. In his electronic notecards, his

research paper and his exhibit for the fair, Bob divided his content, notes and thinking into sections. His notecards were organized by bibliographic sources, his paper as a timeline of ideas and his interactive exhibit by categories or information. He felt this structure made it easier to understand for himself and his audiences. He described this process as: "My papers kind of like go, you know, one, two, three. Nice and like, neat. I don't like to skip around to topics because it makes the paper more confusing. So that's just how I do it."

Coincidentally, Brittney S. and Brittney T. independently chose the same pseudonym. Their abilities were similar, as were their exhibits. Brittney S. and Brittney T. both liked to write and felt sympathetic toward the victims in their respective countries. They both imagined what it was like to live in countries where basic human rights were violated. They translated these mental images into fictional accounts for visitors to read. They blended their verbal/linguistic skills with their interpersonal skills. Brittney S., for example, described this process as it related to her own life:

> My abilities would relate to people, and understand, if I relate to people I can understand what people in my country are going through. 'Cause, I mean, that's a strong ability for me to, um, like to help my friends and relate to other people. So that helps my understanding of what people in my country are going through.

Brock's research paper and exhibit combined his interests and skills with computers and his logical nature. His research paper and exhibit were organized by topics "most important to least important." Brock's exhibit demonstrated his comfort with computers and software applications, because it combined web pages and electronic presentations. The union was not sophisticated, but the exhibit did execute well. Part of the polished look of the exhibit was aided by Microsoft Internet Explorer. As links on the home page launched the electronic presentations, the Microsoft *PowerPoint*® slides previewed in the Microsoft

Internet Explorer window, a default by the web browser. The web pages and electronic presentations were seamless. Brock's computer skill was most evident when at the end of the electronic presentations he provided links back to the home page for the visitors. He did not leave the audience without a choice of navigation.

The skills from across the participants that appeared to be used most often were interpersonal skills. Allison, Bob, Brittney S., and Brittney S. rated themselves highly in this ability. (Allison rated herself at 35 out of 40; Bob, 37 out of 40; Brittney S., 32 out of 40; and Brittney T., 39 out of 40.) This skill was integrated in two different ways. Allison, Brittney S. and Brittney T. wrote two to four fictional accounts to include as part of their exhibits. Their sensitivities to others' feelings were evident in the stories and diary entries. Described above, Allison indicated the stories were a "tool" to communicate the people and the violations without explicitly stating either. Brittney T. used the stories in order to give the audience a sense of what it was like to live in Sudan. She said:

> I spent a lot of time writing a personal story that would be really detailed and give people an understanding of what it would be like to be a slave. 'Cause I think you can relate more to, um, what, you can understand something better if you can relate to it. And kind of get involved and have, like, stronger feelings about it.

Bob's sensitivity to others was conveyed through how he organized the content and decorated his exhibit (c.f. Erickson & Lehrer, 2000). He considered his audience, and he used himself as a guide. In some ways, his high intrapersonal skills (33 out of 40) may have blended with his interpersonal skills (37 out of 40). He put himself in the place of a visitor to the fair and designed his exhibit around this perspective. Bob sought to make his audience understand what he had learned. He explained it as:

> You have to make it more — you have to make it less complicated, since you've been studying it for awhile. You have to make it easy for somebody who doesn't even know what human rights is to, to, uh, figure it out.

Bob also attempted to convey the gravity of the subject within his exhibit. The colors in his electronic presentation were not glitzy but reserved and consistent. He explained why: "Because I figured it is a pretty serious project, so I didn't put all of these colors everywhere."

Brock's exhibit lacked depth in interpersonal skills. In this ability, he rated himself the lowest of all the participants (30 out of 40). Brock's exhibit seemed centered more on his own satisfactions and desires. He liked computers, and his exhibit reflected his fascination with computers and software.

Computer skills. For Allison, Bob, Brittney S., Brittney T. and Brock, their various levels of computer skills were also evident in their exhibits. They all performed searches on the Internet to locate images, such as photographs and maps. Bob, Brittney S. and Brock created Microsoft *PowerPoint*® presentations. Bob's presentation was the most sophisticated of the three. He hyperlinked five electronic presentations together to segment the content.

Brittney T. and Brock created web pages. The pages were simple and unsophisticated. Brittney T.'s page include photographs that linked to her fictional accounts. Brock's, on the other hand, was only text that linked to two Microsoft *PowerPoint*® presentations. The fact that Brock's presentations launched inside the Internet browser window made the hyperlinking seem deceptively advanced.

Untapped and unrecognized abilities. Some abilities went untapped or were unrecognized by the participants. Allison, Bob, Brittney S., Brittney T. and Bob were all involved in athletics. However, these bodily-kinesthetic abilities were not use by any of the participants in their exhibits. As Allison explained: "I guess there wasn't really anything that I could do

that involved [athletics]. And athletics aren't usually included in schoolwork, and I guess I could have had a game but … it just didn't seem to fit with my topic."

Other abilities, like those used in math and science were also not used. Brock found no connections between solving problems and logical thinking in Geography. He failed to recognize where his abilities in one discipline, such as Math, could be translated into another discipline, such as Geography. Similarly, Bob missed the opportunity to see where math and science knowledge — two subjects he did well in — could be transferred to Geography. "Because they weren't needed," Bob explained. "I don't think I needed math or science in a geography report."

Summary. In this constructionist learning environment, computer mediated learning artifacts reflected individual differences through a blend of abilities and myriad levels of computer skills. Various abilities, such as interpersonal skills, verbal/linguistic skills and creativity, were combined to different degrees by the participants. Levels of computer skills were also used by the participants to search and retrieve data and images from the Internet, as well as produce electronic presentations and web pages. It is also important to note that the flexibility of a constructionist learning environment could have supported other untapped or unrecognized abilities by the participants. Abilities, such as bodily/kinesthetic skills and logic, along with knowledge and skills from other disciplines, such as Science and Math, identified by the participants were not adapted for use in the Geography context by the participants in this study.

Question 2: In what ways do learning artifacts reflect a learner's knowledge?

Question 1 examined how individual differences were reflected in the artifacts the participants created. Question 2 elaborates on this idea to look at how the artifacts represent the knowledge of the learners. Hill and Hannafin (1997) have suggested different forms of

knowledge are important to consider during learning with technology-based systems and open learning environments, including: system knowledge, subject or domain knowledge and metacognitive knowledge. These forms of knowledge were situated within an information research and retrieval context; however, they can be extrapolated to learning in other technology-rich environments as well, such as the one used in this study. These factors were used to code and analyze data related to learning.

System knowledge. System knowledge represents prior knowledge and recognition in information search and retrieval systems (Hill & Hannafin, 1997). Much of the information the participants collected would fall into this category. In a broader sense, the participants worked within a ubiquitous computing environment. Moving from information searching and retrieval to information organizing and use was also part of their system. For example, all the participants used search engines to perform a search, then copied and pasted this information into a word processing document, and finally, paraphrasing this information for use in a research report. System knowledge in this study was operationally defined as the learner's ability to use computer hardware and software to perform learning-defined tasks as they moved among applications, such as web browsers, word processors, presentation packages and web page editors.

Participants often used their laptop computers in class. This was by design of the environment by the cooperating teacher and researcher in order to take advantage of the technology-rich environment. The participants were familiar with using the Internet and performing searches using search engines, such as *Google*®, and searching for images using *Google Images*®. For example, Bob described his process for searching:

> I usually went to *Google*® and things like that, just you know, search engines . . . . and then you got to kind of start thinking about when you find things on *Google*®, you gotta start thinking a little deeper like government research places like the CIA web site.

The information collected by the participants was interpreted in their research reports. All the participants included images they had searched from the Internet in their exhibits. Allison was especially proud of the images she had found on the Internet:

> I'm most proud of these pictures right here because even though I just found them on the Internet, some of them are really good pictures and they went perfectly with the accounts that I had, and I think that added a lot of stuff to my project. I mean, people would make comments about, "Where did you get those pictures and stuff?" And I think it drew a lot of people to my board, like with the pictures down the sides.

Allison's knowledge and comfort with web browsers and search engines, she felt, contributed to the success of her Human Rights Fair exhibit. Her ability to use the software to access and capture the images she needed to complement her exhibit was an important detail. Allison even mentioned how she had to use image editing software to manipulate the size of the images for her display.

Most evident from the participants' system knowledge was their comfort in switching between software applications to complete their work. During the research phase of preparing to write their reports, all the participants would multitask. The electronic notecards template, created in Microsoft *Word*®, would remain open while they conducted searches. As information was collected, it was simultaneously catalogued in the notecards file. Allison, Bob, Brittney S., Brittney T. and Brock all commented on how the electronic notecards were helpful and frustrating. The notecards were helpful, they felt, because it was easy to copy and paste from web pages. For example, Brittney T. commented, "It was easier

to just copy and paste different things. It's just easier, because it goes faster on the computer." But they were difficult to manage in Microsoft *Word*®. Allison's system knowledge tried to overcome this limitation:

> My friend had an idea, and we were trying this. It works really well if you had PowerPoint and you put [the electronic notecards] on PowerPoint slides. Because that way when you open up a PowerPoint presentation, you can just click the arrows to go back and forth and you can move . . . the slides.

Her comfort with Microsoft *PowerPoint*® led her to try reconstructing the template as slides, so she could use the slide sorting feature to move the notecards around.

Participant system knowledge about the technology-rich environment was not stagnant. Participants learned new skills as necessary to accomplish their goals. For example, Bob was interested in connecting multiple Microsoft *PowerPoint*® presentations together. With direction from the Geography teacher and a small amount of guidance from the researcher, Bob learned to hyperlink his presentations and use action buttons — two advanced features of Microsoft *PowerPoint*®.

Similarly, Brittney T. also learned new skills for her exhibit. She wanted to combine interactivity with fictional accounts she had written. The teacher suggested creating web pages. Brittney T. had never used Microsoft *FrontPage*® before. With the teacher's help, she inserted photographs she had collected from the Internet and linked them to additional web pages that contained the stories.

Domain knowledge. Domain knowledge represents the existing knowledge related to the subject in which one is searching or learning (Hill & Hannafin, 1997). When the participants began this unit on human rights, they held little prior knowledge of the countries they would be studying or on human rights. Stage 1 of the unit (physical and human geographies) and Stage 2 (defining human rights) were designed by the cooperating teacher and researcher to

build the prerequisite knowledge necessary to interpret information about their respective countries (see Table 3).

The environment was designed to transition the participants from novices to experts in human rights violations of a specific country. The acquired expertise of each of the participants is evident in each of their research papers and their exhibits. For example, Allison described the first-hand accounts she produced for her exhibit as a "tool."

> It's kind of like a tool, because if I tell about the person and what they've gone through, let's say their mom was kidnapped and killed, then that is introducing one of the human rights violations on its own. Or let's say they're really scared that, you know the human right to feel safe, and when its talking about the terrorists, but at the same time it's easier for the audience to get in touch with that, with what's actually happening there specific to the country . . . . Because it ties in the general human right and what's going on and also the specific, where it's happening and who it's happening to.

She combined the human geographies with the knowledge she had learned about human rights violations in Kashmir to weave a story that describes the plight of Kashmir without explicitly stating the problems Kashmiri individuals face.

Brittney S.'s investigation of Sudan led her to discover religious differences and economic factors contributing to violation of basic human rights. These were not topics she had considered previously. She said, "Talking about human rights and civil rights helped me get a better understanding of what I was going to be looking for and 'cause I really never thought that much about human rights and civil rights and so that helped me, like, know I was supposed to find information-wise [in my paper]." An excerpt from her research paper explains what she learned:

> Northern and southern Sudan have been at war since 1983. The eighteen-year civil war is the longest ongoing civil war in the history of the world and has produced a death toll of over two million people. The war started because the Sudanese did not want a religious government, the government would not accept differences, people were not sharing recourses, and the Arab-Muslim minorities dominated the politics. Citizens of Sudan are having their rights violated because so far four million southern Sudanese have been forced to flee their homes which makes the war a huge contributing factor to the violation of Human Rights. Most people affected are by oil fields where pro-government forces and opposition groups are fighting over oil. Also, this war has had the largest civilian death toll since World War Two.

Her discovery of slavery in Sudan led her to focus on slavery in her exhibit for the Human Rights Fair (see Figure 13). Her diary entries were powerful devices to convey her knowledge and opinions about slavery in Sudan, particularly the slavery of children.

Brock also discovered religious differences as one of the sources of violence in Argentina. An excerpt from his paper explains:

> Jewish people have long suffered from Anti-Semitism in Argentina. There are a number of reports of anti-Semitic acts and threats against Jewish organizations and individuals in the last ten years. In 1992, people bombed the Israeli Embassy in Buenos Aires, and in 1994, the city's Jewish Community Center was bombed. In April 1998, a court sentenced three Buenos Aires youths to three years in prison for a 1995 assault on a man whom they believed to be Jewish. Two Jewish families in Parana, Entre Rios province, received telephonic bomb threats in August 1999.

One of the presentations in his exhibit highlighted the anti-semitism as well (see Figure 14). Brock came to learn Argentina had been a harbor for Nazi war criminals after World War II, and these historical decisions were plaguing Argentina today.

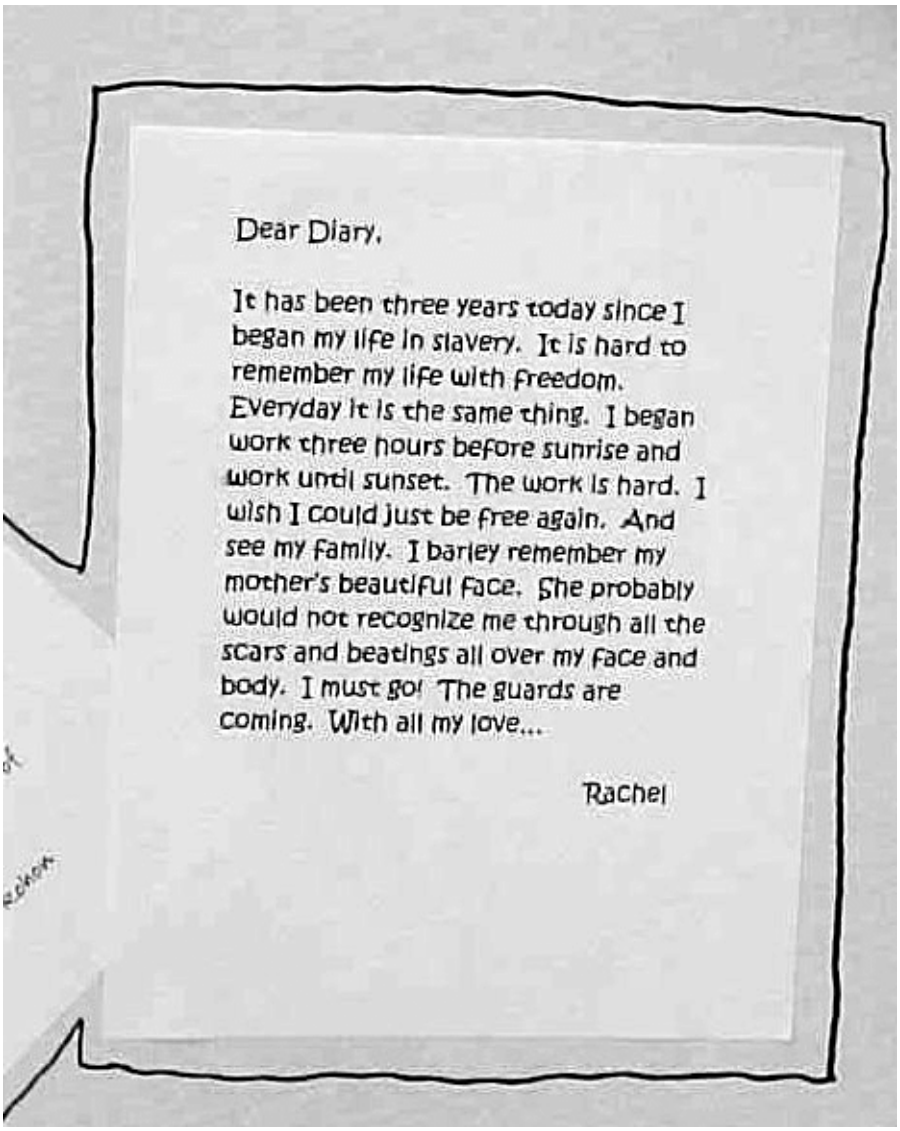

Figure 13. A diary entry from Brittney S.'s exhibit focusing on slavery in Sudan.

Figure 14. A slide focusing on anti-semitism from Brock's presentation about Argentina.

Metacognitive knowledge. Metacognitive knowledge reflects the awareness of one's own cognition (Hill & Hannafin, 1997). These processes include "scanning, searching, questioning, chunking, generating hypotheses and making decisions" (p. 38). This study did not specifically look to explore data on metacognitive skills. However, during analysis, data from interviews suggested that the artifacts reflected decisions the participants made about their own thinking and learning.

Bob was the most articulate of his metacognitive knowledge. He was aware of the decisions he was making based on his own thinking. His decisions affected the structure of his writing and his exhibit. For example, based on how he learned himself, Bob tried to follow this same process in his writing for his research paper. He explained:

> So that's just how I do it. I just do, you know, intro, leading up to present, and conclusion . . . . I don't know. I just, I figured, it was easier than most other ways, like: Who? What? When? Where? Why? And, most of my note cards were in that order from like past going into present.

This timeline structure continued into his research paper:

> At this time Sri Lanka is in a civil war. The war is basically the minority versus the majority. Both governments involved, picture themselves as the victims . . . . Although one could say that many factors contributed to the civil war in Sri Lanka one event was the catalyst for it. On July 20th, 1960, Sirimavo Bandaranaike was elected as the prime minister of Sri Lanka. On December 31, 1960, Bandaranaike passed a bill that made the Sinhalese language the official and only language of Sri Lanka. The Sinhalese may have primarily started the conflict but the Tamils reacted strongly to the situation. After the bill was passed the Tamils staged many protests and were later arrested for doing so . . . . The current situation that this war is in is abysmal. Over 16,000 deaths have occurred in this ongoing 16-year battle. Terrorist acts have become more and more frequent causing more bloodshed.

Bob also constructed decisions based his own thinking for his exhibit. Bob used his own impressions of visiting the Human Rights Fair to determine what his exhibit should include. He indicated how his exhibit reflected his thinking:

> I think you have got to think what people are going to want to see, if they are going want to have lots of pictures or lots of words…you'll probably not want to have lots of words because you don't want to be reading about Sri Lanka, a country that they've never heard of and if that happens, they don't know where it is.

Bob considered that if he were visiting the fair, he would not appreciate large amounts of text and instead would be drawn to images and pictures: "I did basically, you know, copied things I had on my paper and changed them a little, shortened them, and like put them into categories."

In contrast, Allison's awareness of her thinking shows the interaction that metacognitive knowledge has on domain knowledge. Land and Greene (2000) suggest

domain knowledge and metacognitive knowledge function concurrently to influence learning. Allison said when she started researching Kashmir, she assumed there was a "bad guy" — either Pakistan or India. Instead, the longer she worked and thought about the information, she began to think more about how this type of atrocity could happen. In an early interview, she explained her conflict:

> There are a lot of websites that some are sided on India's perception of it, like the Indian army has one website about that says we're peaceful and we're trying to bring hope to Kashmir. And then I went to this other website that was about Indian atrocities committed in Kashmir and all these horrible things that they've done to people there. And then there's some about how Pakistan is bad and living in terrorism, and it was hard to decide which side is committed more of the crimes against the people.

In a later interview, she clarified how her thinking had evolved:

> I just thought about it more because I am so used to…when I think about something like that, like a conflict, one country being right or one country being wrong [pause] and I guess I thought well, it must be the same. But really it wasn't. I mean it was just kind of both countries hated each other so much. I don't know if it was really more time, I just thought about it while I was writing the research paper and while I was doing my project.

Not a complete picture. The previous sections explicated how the learning artifacts produced by the participants reflected system knowledge, domain knowledge and metacognitive knowledge. It is important to recognize that the learning artifacts may not reflect all the knowledge the learner has acquired.

In his exhibit, Bob chose to reduce the number of facts and amount of text in order to produce a display that appreciated his audience. In comparison to his research paper, many details were omitted for the sake of the authentic context of the fair. Bob's exhibit alone — without the research paper — may have appeared to lack details or be shallow. The artifacts of his learning, included system knowledge, domain knowledge and metacognitive

knowledge. By examining only his final artifact, it may be impossible to discern all that he has learned. The products of learning, or learning artifacts, may be intangible elements as well.

Summary. Learning artifacts represented the learners' knowledge in three ways: system knowledge, domain knowledge and metacognitive knowledge. System knowledge was expanded from Hill and Hannafin's (1997) taxonomy to include the ubiquitous computing environment represented in this study. The participants multitasked among web browsers, word processors, presentation packages and web page editors. The development of domain knowledge was represented in research reports and the final human rights exhibits. Metacognitive knowledge was evident during Bob and Allison's interviews. The indications of their reflective thinking were apparent in their research papers, exhibits and their own thinking. Finally, the computer mediated learning artifacts may not represent all that has been learned by the participants. Elements that have been learned may not be present nor may they be visible in the physical artifacts. System knowledge, domain knowledge and metacognitive knowledge may be intangible products of the learning.

Question 3: How does the construction of learning artifacts allow learners to tap their individual differences?

The previous two research questions focused on the products created by the participants. This question, conversely, explores the process the participants experienced. The construction of the learning artifacts was a creative, generative process. The decisions made throughout the process were reflective of the participants and their individual differences. Halprin (1970) has suggested resources and project plans, or a score, affect decision-making in creative processes. Data were coded with these post hoc codes for decision-making.

Resources. Resources are the materials, knowledge and abilities available to the individual (Halprin, 1970). In this study, these resources also included hardware and software afforded in the technology-rich environment, along with the scaffolds provided by the teacher and researcher and collaborations with others. Allison and Brock's processes of constructing their exhibits were influenced by their decisions about the resources accessible to them.

Allison's decision making was based explicitly on her available resources. Allison's original plan for her exhibit was to create a "room" for visitors to walk into. After a conversation with her dad — one of her resources — she made alterations to the design because of practical matters. During one of our interviews she explained how she determined the direction to proceed with her exhibit:

> Well, when we first got assigned the project, I talked to my dad about it for awhile, just because, in case he needed to help me with any of the building or anything of it. Because the first thing I wanted to do was like a stall and it had a curtain and you walked into it and you're surrounded with pictures and things about it. But then I decided that was a little bit over-scaled and that was going to be really hard to do. So I kind of scaled it down to just having the tri-folds half way around. And I guess the tri-fold board idea was kind of a surrounding thing, but it was easier to do it with a tri-fold board because they fold around easier. And I also used it on a science fair project when I was younger, so I'm used to using those boards.

Allison analyzed her available resources, including her comfort with the materials, the complexity of the project and the time necessary to complete the project. Based on these parameters and the advice from her dad, she decided to modify the design of her exhibit. After the human rights fair, she explained:

> Well, at first, I've said this before, but at first I wanted to have a thing that surrounded you almost like a room but then I realized that — I mean, I could do something like that and get just as much — that was going to be pretty hard to do that surrounded someone and was high enough. But once I started thinking about this, it actually turned out exactly like I wanted it to. Because I wanted it to have those three sides just like that, and I told people I was going to have two put together, and they were like, "Is that going to work?" And I guess, it turned out not *exactly* how I wanted it to. I wanted to have a little bit more pop ups and that kind of thing on the actual board you could interact with, but I didn't have time to do that the night before. I didn't start early enough putting it together. But I had all of the resources that I needed to do it.

Brock also made explicit decisions about his exhibit based on his available resources. In fact, the resources, namely his laptop computer and the software installed on his computer, were the most noticeable in his exhibit. Brock wanted to use his computer for his exhibit and could not see another way to do so other than a web page and electronic presentations. He said, "I thought it was only way to do on my laptop. Yeah, so I made PowerPoint." Brock made decisions based on the features of the computer and the software. During one of our interviews, he indicated how the computer influenced which abilities he used in his exhibit:

> Researcher: What determined that you were going to use those abilities?
>
> Brock: The computer.
>
> Researcher: In what way? How did it determine that you were going to use those abilities?
>
> Brock: 'Cause it's, it's easy to write. It's easy to decorate and, um, yeah.

For both Brock and Allison, the resources available to them influenced their decision-making during the construction of their learning artifacts.

Score. A score, or project plan, describes what will be performed or created (Halprin, 1970). Like a conductor's score, it is the plan that evolves over the process of constructing the interpretation of the music. In constructionist learning environments and project-based learning, the score is often embedded in the task as a list of requirements the artifact must contain. In this study, the research paper contained a number of explicit requirements, such as page length, references format and deadlines. However, the human rights exhibit had very few requirements. The primary objective was to produce an exhibit like in a museum that highlights one or more of the human rights violations in the country under investigation.

Bob, for example, interpreted the score of the human rights exhibit with implicit requirements as well. Though no specific examples or conditions were given, Bob decided he had "to like make a board" to accompany his electronic presentations and the tri-fold board was something he "didn't really want to do." He began a tri-fold board, but he abandoned the work after "glue got everywhere and everything, so it didn't work too well. So, [he] just stuck with PowerPoint." It seemed his decisions about what was required were based on his prior experiences with projects and what the requirements were for those projects. He described projects that he had worked on previously. He said in fifth and sixth grade when they did not have laptop computers:

> You'd *have* to do your board. You wouldn't be able to do PowerPoint. It'd be, you'd have to get those stick-on letters or you'd have to have really good handwriting to do it. And you wouldn't be able to have pictures from the Internet unless you had a computer at home or something.

During the construction of his exhibit, Bob's score changed. The explicit and implicit requirements for the project impacted his plan. Bob had to reconcile the success of his project with his own decisions.

Summary. The flexibility in the construction process allowed the participants to make decisions about their abilities, resources and plans. Allison and Brock made decisions based on their preferences and resources as they assembled their exhibits for the human rights fair. Bob's exhibit began with requirements he felt were explicit and implicit. During the construction process, he decided to alter his plan and continue along a different path. The generative process allowed Allison, Brock and Bob to tap their individual differences during decision-making about their exhibits.

Question 4: How do constructionist learning environments support individual differences?

The four stages of the unit on human rights were designed to build expertise and support individual differences of the learners through generative, or design, tasks. This unit was also designed to include the seven common elements of constructionist learning environments (see Table 2). As the participants progressed through the stages of the unit, they had a choice in the content defined by their own interests, a choice in the resources defined by their own needs and a choice in products defined by their own interests, preferences and abilities. The cooperating teacher and researcher designed and enabled a constructionist learning environment that was replete with resources, or resource-intensive environment, for the learners to choose from. The participants' individual differences were influenced by the resource-intensive environment and the participants' developing expertises.

Enabling a resource-intensive environment. By design, learning environments in formal settings are enabled by others. The classroom teacher determines resources, activities and learning goals. In constructionist learning environments, these are determined to a large degree by the learner (Harel & Papert, 1991; Kafai & Resnick, 1996b). In this study the

cooperating teacher and researcher outlined a constructionist environment to support the participants' learning and differences. A significant amount of time was exhausted developing, reviewing and consolidating resources for the learners.

Hill and Hannafin (2001) suggest resources include scaffolds, such as templates and outlines, productivity tools, such as word processors, and information seeking tools, such as web search engines. This study provided a robust repository of candidate resources for the participants. Based on a WebQuest (Dodge, 1995) design, the resources were assembled into steps to provide a management framework for the participants and reduce the amount of time spent searching for resources. These resources were used and valued to various degrees by the participants. Student-centered learning environments, like the one used in this study, complicate the identification and selection of appropriate resources for individuals (Hill & Hannafin, 2001). Resources were provided on an "if-needed" basis or "just in case" for the learners. The resources employed in the unit on human rights are summarized in Table 7 and included are the participants' views about the resources. These responses have been aggregated from interview questions related to "What has been easy?," "What has been helpful?" and "What types of handouts or worksheets have been helpful?" In addition, some responses have been taken from the human rights unit reflection and evaluation at the conclusion of the unit. These replies were in response to the question: "What would you change about the Human Rights Unit if you could? What would you keep the same?"

It is important to note that although this study did not seek to specifically explore the teacher's capacity in the learning environment, she played an invaluable role to many of the participants. To Allison and Brock, she was coach and facilitator. As mentioned in Table 7, she helped guide them through which information to collect and the direction to take with their projects. She also became a sounding board as Allison struggled with understanding

Table 7. Participants' views on resources, scaffolds and collaborations

Resources, scaffolds and collaborations	**Participants' views**	
Internet, search engines and WWW links	Allison:	I don't think so. I think it makes everything easier and faster. I can't think of anything it makes harder. You can go on the Internet and do your bibliography on Noodletools.
	Allison:	The Internet. Because that's the main thing that I've used to get all my pictures. Go to *Google*® and enter in some things, and I've gotten maps and, um, pictures of soldiers there and pictures of just, like, a little girl that lives there and her mom.
	Allison:	The Internet, because since the grid is on my computer, I can just open the Internet and get a table or something and type that in and get quick information about it. And Internet again because I think I went to dictionary.com and some other places and looked under the general definition of them, and then I just modified it a little bit.
	Brittney S.:	The Internet. . . . I think it was a lot easier though finding information on the Internet . . . . Getting pictures off the Internet, like I could never have drawn those pictures that I got.
	Brock:	How to make, how to make an endnote and how to organize when I turn in the entire paper.
	Brock:	I would say links and power point on the web [helped me].

Electronic notecards	Allison:	Um, I would say the hardest thing — not the research because it was easy to find a lot of different sites and not the writing or the outline — but probably the note cards, the electronic note cards. Just because it was kind of difficult. I liked the idea of having it on the computers, because you could just open up the document, and you always had then there, and you didn't have to, like maybe if you forgot them from home or something. But the only thing I like to be able to have something in front of you so you can look at them, and it got confusing with the topics. Then I had to go back and make topics for each of them, and the numbering and a little bit the information, but besides that everything's been great.
	Allison:	Um, probably being able to print them out. Like I wouldn't have minded, um, typing them so much as just being able to print them out, and I know it would have taken a lot of paper. But just because I would have liked to have been able to look at them separately and organize them and put them in order.
	Bob:	Uh, they worked real well. I mean, it's much easier than having to write them down. And there's no risk in losing them all at once but, you know, it's even with back up and stuff like that. It's really, it makes it a lot easier 'cause you can just copy the page format. . . . I did them, for every web site that I did, I separated the word document, so like I had, if I used Britanica, I had that document named Britanica and I did all the note cards there. And I compiled them all into one thing. . . . Easier in the long run because I could look back to them after awhile but having to do them was kind of a pain. . . . Because you had to write down a little summary of things and I didn't do very good on note cards. And sometimes it was unclear on how to do them in the beginning because you write like a summary...a jot list or something?

	Brittney S.: It was good in some ways. It was good because you could just copy and paste and reword and I was hoping it would save some time. If they got unorganized it was a real pain to try and reorganize them, because some of them might get erased or you had to an Undo and sometimes it would be hard to get them back where you wanted them. Like on paper, you could just set them out and organize them that way, but on the computer sometimes that can be harder. . . . I think one time my sources got out of order it was really hard to move some of my notecards up where they needed to be. Brittney T.: It was easier to just copy and paste different things. It's just easier, because it goes faster on the computer. Brock: 'Cause they were easier than, um, writing the information. I can just copy and paste it. That was easy.

Teacher support	Allison:	Well, it was pretty much outlined by Mrs. O'Neill. At first, it was more, the first websites I got were more on the war and just in general what was happening there, but then when she kept telling us it needed to be focused on human rights. I got more into human rights violations and who was violating human rights and how they were being violated. If she hadn't told us a topic to do it on, it probably would have been more on just what was going, like the war that was going on and the background of it and the conflict. So, I guess mainly it was just because that's what she told us to do it on. Mrs. O'Neill has helped a lot writing it . . . . Like I'll ask her questions about "is this — are these kinds of facts okay? Is this what you want the paper to be like? Is this sentence a good sentence? And whether she thinks it's a good thesis statement. And in general answering questions about my topic. Like I'll ask her which side do you think has done more things to the Kashmiri people or which side is the worst side?
	Brittney T.:	And then I'm gonna have my laptop and I'm gonna, [our geography teacher] told me to use FrontPage. I just, she told me to use my laptop. Or I might want to think about using my laptop. So I thought of doing that.
	Brock:	At first, [our geography teacher] told me what I needed to, what my exhibit has to have, so I found the details that she told me.
Email	Allison:	And, um, also e-mail because I've e-mailed, um, a man named Singh. He's been telling me about one of the religions because one of my first-hand accounts is on somebody who's that religion but I didn't really know about the Sihk religion. And he, uh, he e-mailed me long thing all about it, so that helped.

Countries grid	Allison:	Since the grid is on my computer, I can just open the Internet and get a table or something and type that in and get quick information about it.
	Brittney S.:	Well the grid helped me decide what country I wanted to do.
	Brittney T.:	And those grids just helped me learn a lot of stuff about different countries, and you know, it helped me decide which one I wanted to do my report on.
	Bob:	I would keep the countries grid, because it gives you a good idea of what country you want to choose.
WebQuest site	Allison:	And that, that web site did help because it was nice for me to be able to type in one site and click on the guidelines or something and check and make sure I got all the things.
	Allison:	I thought the website was fairly helpful. I liked being able to look at the guidelines, etc. However, I rarely used it unless told to in class.
	Bob:	The stuff, when, I forgot about how the project's supposed to be formatted. That helped with, like, the you know, the endnotes or whatever. And things like that, so . . . . Well, I didn't go to it a lot, but I liked having something I can see and I can make sure I'm doing it the right way at home. And so I don't have to, you know, like call somebody else or the teacher.
	Bob:	If I ever forgot what the format of something was, I could just go back to the website and look.
	Brittney S.:	The website was helpful, because if I ever had a question I could just go look it up quickly, and it was always there.

	Brittney T.:	She had links on the paper, I mean on the web site that helped to get a lot of information. And she had links on it that showed a lot of presentations of like, just different displays and that helped me think of like how I was going to present mine. And it just, it helped you like, 'cause it showed you how to do everything.
	Brock:	The step-by-step [helped me to be] more organized…
Exhibits brainstorm activity	Allison:	The brainstorm that we did kinda helped me. Because it made me think about what I liked and didn't like, didn't like about exhibits. Which makes it easier for me to know what other people are going to like and be interested in.
Informal peer support	Allison:	But I have two people that have my same country and topic that sit next to me. One girl sits next to me that helps me a whole lot with writing and we help send each other email, which also uses laptops, with websites and facts that we found and kind of help each other word sentences and that kind of thing. So that helps a lot, having someone right there that knows what you're doing to help you with the topic.
	Allison:	And the other thing, I mentioned this before, is when I was doing [the countries grid], I think I was sitting next to [a friend], who had my country that time. I think I had Sri Lanka or something like that, and that helped again because we would share information with each other. And, like, she might be looking at the population while I'm looking at the economic situation, and then we would just copy what we got since [our teacher] said it was okay for us to have the same grid.
	Allison:	The [friend] thing again [really helped] because we were still sitting next to each other. I think last week we changed seats. But, um, we created a definition together, I think. And we wrote it on the board. And we used her thoughts on human rights and civil rights and my thoughts on human rights and civil rights and made one definition.

Peer conferences	Bob:	I think the peer conferencing we did on the project didn't work too well . . . . Because, people are going to be — unless you have someone who is brutally honest, like for instance, [this classmate], and he'll be brutally honest with you — but other people will be, "It's good." And you can't bring in your whole project, because it's not done yet and a lot of people don't like to have change their projects because they have worked hard on it, and they don't want to do anymore work. It's done.
	Brittney S.:	I brought my power point to conferences and they just said, they gave me some like grammar comments and just to make it, like, colorful. And just like other, just kind of, make it more interesting . . . . Since I have been, like, since I read the paper over and over, I kind of like blocked out some information and they helped me to see stuff that I might not have seen. Like problems with my paper they did point out that I might have just been overlooking. They, they just gave me another point of view.
	Brock:	They did help me . . . . In grammar and writing. Yeah. And spelling.

the conflict in Kashmir. For Brittney T. she offered a suggestion that encompassed a complex evaluation of Brittney T.'s abilities. The geography teacher recommended Brittney T. consider using her laptop, and the teacher then scaffolded her to complete her exhibit. The geography teacher in this study seemed comfortable in this type of learning environment, and she did not seem to have difficulty negotiating the support for the participants (c.f. Brush & Saye, 2000).

Development of expertise. The unit on human rights was divided into four stages. At the beginning of the unit, the instruction was didactic and directed. As the participants progressed through the unit, the learning became more learner-centered and constructionist with the participants defining their own goals, choosing resources and content and constructing personally-meaningful artifacts. Jonassen, Mayes and McAleese (1993) have described this continuum in terms of knowledge acquisition and learning experiences.

During initial knowledge, prerequisite facts, rules and procedures are acquired. Learning experiences appropriate to these materials include teacher-centered and direct instruction. As learners progress to advanced knowledge, less structure is suitable. Guided learning, coaching and scaffolding help learners build on prior knowledge. Time to explore is useful for learners at this point on the continuum. Finally, when learners approach expertise, stronger personal perspectives are developed and can be afforded through learner-centered activities. Learners are aided with activities that encourage opportunities for reflection and articulation of cognitive reconciliation (Oliver & Herrington, 2001).

Allison seemed to articulate her development of expertise most explicitly. She felt her exhibit for the human rights fair reflected the processes she went through in the human rights unit. She explained:

> Well, it kind of [pause] shows how we learned it, because the way I did my project is a little bit like, like when we learned about human rights in general and what they were, and then we got a little bit more specific about learning information about the countries and looking at maps of countries and doing tables that were just kind of an outline of what happened. And then we wrote our own personal accounts of what happened and we read stories about people that were there, so I guess it kind of goes like what we learned in the class.

Allison also felt the time she spent coming to understand the conflict between Pakistan and India over Kashmir allowed her to resolve in her own mind who the "main bad guy" was. In one of our interviews, she discussed how her thinking had changed as she came to understand the situation in Kashimir:

> Researcher: Let's say one of the high school teachers came to the fair, and they wanted to know how does your project represent what you've learned about human rights over the whole time that you have been studying it, what would you say? What you tell them?
>
> Allison: Well, I guess [pause] it shows [pauses]. I learned how the [pause] people are affected by the personal accounts. [pause] I kind of saw both sides of the story about the people who are violating human rights and the people that are having the rights violated with the pictures of the soldiers and the victims. I can't think right now [laughs].
>
> Researcher: That's okay. Do you think you learned what you were supposed to?
>
> Allison: I think so. Actually, I think I may have gotten even more out of it, because [pause] I did end up, especially my country, when I couldn't decide between who I thought — we've already talked about this — but who I thought was the main bad guy, I guess, like Pakistan or India. And so I got a lot out of it, because I did get to read both sides of the story and see what happens: Why people start doing these kinds of things, instead of just what human rights are and how bad it is. Instead, why people commit these happenings or how they get so much hate built up.

> Researcher: Why do you think you were able to [pause] spend more time thinking about that?
>
> Allison: Well, it was kind of a something I had to do in my paper because [pause] I guess [pause] if I had more time to [pause] I just thought about it more, because I am so used to [pause] when I think about something like that, like a conflict, one country being right or one country being wrong [pause] and I guess I thought well, it must be the same. But really it wasn't. I mean, it was just kind of both countries hated each other so much. I don't know if it was really more time, I just thought about it while I was writing the research paper and while I was doing my project.

As Allison began to spend more time with her own learning goals, as she explained, she "had" to think about reconciling the complexities of human rights violations in Kashmir.

Brittney S. in a more subtle manner also expressed her development of expertise. Developing the fictional stories of the Sudanese helped her come to know what the individuals were experiencing and situated her own learning in her life. She told me:

> Well, how [pause] that I [pause] learned to draw pictures of the people who lived in Sudan, and it really let me see kind of, get a better understanding of what they were really going through and it made me feel, like realize how lucky I was that I didn't have to experience my human rights being violated everyday of my life.

The progress from didactic teaching to more student-centered learning gave Allison and Brittney S. the opportunity to reflect and grapple with such complicated issues.

Chapter Summary

The constructionist learning environment influenced the participants' individual differences with a resource-intensive environment and developing expertise. Based on their own needs, preferences and abilities, Allison, Bob, Brittney S., Brittney T. and Brock used

and valued the resources, scaffolds and collaborations to different degrees. The flexibility of the environment afforded them these options. The role of the teacher as a resource and scaffold was also significant to Allison, Brittney T. and Brock. Participants progressed through the unit on human rights developing expertise, moving from teacher-centered instruction to learner-centered activities. Allison and Brittney S.'s courses from novice to expert permitted them time to reflect on the difficult situation in Kashmir and Sudan as well as resolve their own learning.

The next chapter presents the themes that emerged from the cross case analysis. These themes are broader than the research questions and seem to make connections among many of the research questions.

CHAPTER 6

THEMES

The previous chapter looked across the five cases in order to answer the research questions that guided this study. In addition to the discoveries for the research questions, broader themes emerged that seemed to cut across all the research questions. The participants in this study not only discussed their individual differences and their computer mediated learning artifacts, they discussed the conditions that shaped their learning products. The emergent and sometimes ambiguous nature of qualitative research and case study method accommodates for this indistinct path (Merriam, 1988, 1998). From this study, in addition to the identification of individual differences, five themes emerged: (1) internal influences; (2) external influences; (3) beliefs about projects; (4) tools for technology-rich environments; and (5) learning outcomes and products.

Theme One: Internal Influences

The participants made decisions about their abilities, their work and their learning artifacts. These decisions were based on personal analyses and evaluations of their abilities, their motivations and the amount of effort the tasks would require. The evaluation of their abilities for these participants seems to be a seamless process. As Brittney T. observed, "It had always been that way," regarding her shyness and comfort with math. Others had similar comments about how their abilities were used:

Allison: Probably part of it is just that's who I am. So when I do a project like that, it just naturally, that's my tendency to do something that involves those, 'cause that's what I'm good at. So that's just my personality that goes into what my project is like. And also the part about being good at those, those certain abilities. That's one of the reasons that they got in my project because one of the abilities that I'm not very good at is not gonna be something that I want to put into my exhibit. So, I guess the things that I'm the best at usually show up in my projects.

Brittney S.: Like where your strengths are in something, your probably good abilities will show up. Like if you're strengths, let's say you're really good at dribbling, people are going to notice that more, and people who are good a shooting, people are going to notice that more. So I think your abilities will kind of show up in the strengths of whatever you're doing.

Motivations also seemed to contribute to their internal influences as well. The constructionist learning environment affords flexibility in interests and the construction of personally meaningful artifacts in order to encourage positive motivations. Elements of motivational theory (Turner & Paris, 1995) are integrated into the constructionist environment, such as choice of content and learning, control for learning and decisions and challenges to maintain interest. While internally motivating structures are in place, the participants' feelings about the duration of the project and the level of engagement of the activities seemed to affect the learning artifacts. Bob and Brittney S. had to say:

Bob: I did basically, you know, copied things I had on my paper and changed them a little, shortened them, and like put them into categories but like on the website, all of the steps and everything . . . well, the steps didn't help me that much, like the ones that had formulate your paper, that helped but other things, it seemed like it was repeating itself and the same thing over and over like Human Rights/Civil Rights I think, we got the point awhile back, but it was just like drawn out.

Researcher: So, what did you enjoy about completing your project?

Brittney S.: That when I realized I was done — that it felt really good just to be done with it.

Researcher: What did you not enjoy about completing the project?

Brittney S.: It just took a really long time. We had been working on it really long, and then I just had to do the poster and stuff. Just when is this going to be over.

Researcher: So, it sounds like you were a little burnt out on it?

Brittney S.: Yeah.

Comparable with motivation, self-management skills were evident in this study. Open-ended learning was inherent to this environment. The participants planned, organized and managed their resources and the scope of the learning contributed with varying degrees of success. They were frustrated with the amount of information, sometimes lack of information and resources to aid them. This is consistent with research on adolescents as they struggle to manage methods of learning and their academic performance (Dembo & Eaton, 2000). Bob and Brittney S. presented two examples of managing their learning.

Bob: I did [electronic notecards], for every web site that I did. I separated the Word document, so like, if I used *Britannica*, I had that document named *Britannica*, and I did all the note cards there. And I compiled them all into one thing, and I sent them to [our teacher].

Bob: Uh, my papers kind of like go, you know, one, two, three. Nice and like, neat. I don't like to skip around to topics because it makes the paper more confusing. So that's just how I do it. I just do, you know, intro, leading up to present, and conclusion.

> Brittney S.: Sometimes, I found some biased information, but I can usually identify that. Because it doesn't really affect my paper that much, because seeing other people's point of views opens me up to other ideas like, "Well, I've always thought this, but what they're saying is kind of true too." So, it makes me a little more biased toward my beliefs.

Another internal influence for the participants was their perceptions of transfer. The participants seemed to segment their abilities and learning into the activities and disciplines they were associated with. For example, when I asked Bob why he didn't use his other strengths, such as science and math, he replied:

> Because they weren't needed. I don't think I needed math or science in a geography report. You use some of those building abilities that's for something that is not so factual. For a factual report, it is like doing a newspaper article or something.

Similarly, Allison had difficulty in conceptualizing how other disciplines and abilities could be used in her geography projects. She said:

> I don't really know how to answer, maybe just because athletics don't have anything to do with geography or that topic? Math? The same, I guess. It doesn't really involve as much. I mean there are statistics in my paper, which I guess is math kind of.

Brock had similar comments:

> Well, the subject. The subjects are different and for science and maybe I need to observe more about anything. Yeah. More observing in science, and I don't have to observe anything in geography.

In another interview, Brock explained:

> Brock: You know when I said my abilities were thinking things, it doesn't have anything to do with that.
>
> Researcher: Why not?
>
> Brock: Well, my abilities are a lot like solving things with Math. And this has nothing to do with thinking.

Lave (1988) and the Cognition and Technology Group at Vanderbilt (1997) suggest content and skills are overcontextualized when taught in a single context, class or discipline. Gick and Holyoak (1983) reported when subjects are taught in multiple contexts, individuals are more likely to abstract the relevant concepts. The participants in this study seemed to have compartmentalized their learning and their abilities. Researchers (Bransford et al., 2000; Gick & Holyoak, 1983) have suggested instruction include opportunities for learners to develop models and flexible representations of knowledge to promote wide transfer of learning and skills.

Finally, the perceptions of the amount of effort activities will require also seemed to influence the learning artifacts. These preoccupations with less rigorous activities may seem inconsistent with other research on American adolescents' views of effort (Elliott, Hufton, & Hildreth, 1999). One possible reason for the participants' views on effort could be attributed to balancing effort with other internal influences, such as motivation, and other external influences, such as technology tools and access to resources. Decisions about what was "easy to do" or the amount of work a task demanded shaped how the eighth graders progressed. Allison, Bob and Brittney T. responded:

Allison: I think [a computer] makes everything easier and faster. I can't think of anything it makes harder. You can go on the Internet and do your bibliography on Noodletools.

Bob: I just, I figured, it was easier than most other ways like: Who? What? When? Where Why? And, uh, most of my note cards were in that order. From like past going into present.

Brittney T.: You have to put all your work and make it perfect and then present it , and I think it's easier to just like do little bits of things at a time.

Brittney T.: I printed [my notecards] out and then I [pause] when I was doing the outline for my paper, I just did the topics and I put like the different bullet points and I used my interpretations and I just put it like that . . . . I just thought it would be easier.

Brittney T.: I don't really know [pause] like I did a poster and then I did a PowerPoint stuff and that was like a lot of work and then one of my other friends did like a ball and (Did you see hers?) and that was really good, and she — and it wouldn't have taken as much work to do that, and it was more interesting so I would have tried to do something like that.

Theme Two: External Influences

The previous theme centered on elements within the individual. This theme looks outside the individual to factors that are external. One of the primary influences that is external to the individual but critical to the learning environment is the teacher. Other research (Brush & Saye, 2000) has reported the lack of teacher engagement has also influenced the learning environment. In this study, the teacher's unmistakably visible role appeared to influence the learning and learning artifacts.

Allison: Well, it was — you mean like topics and that kind of thing? Well, it was pretty much outlined by [our geography teacher]. At first, it was more [pause] the first websites I got were more on the war and just in general what was happening there, but then when she kept telling us it needed to be focused on human rights. I got more into human rights violations and who was violating human rights and how they were being violated. If she hadn't told us a topic to do it on, it probably would have been more on just what was going, like the war that was going on and the background of it and the conflict. So, I guess mainly it was just because that's what she told us to do it on.

Allison: I thought the website was fairly helpful. I liked being able to look at the guidelines, etc. However, I rarely used it unless told to in class.

Brittney S.: When I chose my country, the things [our geography teacher] had summarized to us about the countries kind of made me want to learn more about it. So pretty much everything about my country is kind of interesting.

Brittney T.: And then I'm gonna have my laptop and I'm gonna, [our geography teacher] told me to use FrontPage.

Brock: At first, [our geography teacher] told me what I needed to, what my exhibit has to had, so I found the details that she told me.

Grades are noticed even in classrooms where the learners are engaged in learning. Learners' perceptions of what is expected to achieve "good grades" affected their learning products. These perceptions were often discussed with respect to projects and in comparison with tests.

Bob: With the project for a grade, it's, you know, you have a set thing you have to do. It's like you have to do a paper and a poster and present it to the class or something.

Bob: Sort of, in a way [pause] like we had the freedom of how we wanted to do it, the big thing and the PowerPoint. The paper, we had the freedom of how we wanted to do it, but when she actually started grading, it looked like she graded the way she wanted to grade on, like if you did a poster board — just a poster board — I don't think she would have graded you as well unless it was good. As like if you had done a PowerPoint and a poster board and all that information and ways of presenting it.

Bob: See, we did it in ten weeks and . . . after that long a time, you figure it is going to be like a really serious, big project. If you do like one a week, you know, it is not so strenuous, and it doesn't determine your entire grade for that semester or season.

Brittney T.: You just have more freedom to put whatever you want on there. And you don't have to worry if it's wrong or not . . . . Like if you don't have it in the correct format or just like, if you have like extra bits of information that don't really like relate to your topic, it won't be counted off, probably.

Brock: And she took off a point about effort. I didn't understand it.

Allison: Well, at first, I've said this before, but at first I wanted to have a thing that surrounded you almost like a room but then I realized that — *I mean, I could do something like that and get just as much* — [emphasis added].

Time was also considered to be a factor in the decisions the participants made. Dembo and Eaton (2000) suggest difficulties with time management for adolescents as a conflict between academic goals and nonacademic goals. Time in this study was often discussed with other internal influences, such as effort and motivation, and external factors, such as grades. Two participants responded:

Bob: I actually like when projects take a long time, because you have more time to do them. You might have to get more information, but it's better than doing a bunch of little ones.

Brittney S.: [This project] just took a really long time. We had been working on it really long, and then I just had to do the poster and stuff. Just, when is this going to be over?

Brittney S.: I got a high B, which isn't bad. But if I had spent a little more time on it, I could have gotten an A.

Brittney S.: When, I pretty much enjoy everything about them, except when they go slow and it takes a long time, cause you expect them to be fast and I get impatient.

Finally, other more logistical considerations influenced the participants learning products. What was possible or what the participants had planned was sometimes modified because of practical reasons. The exhibits for the human rights fair were adjusted based on these decisions. For example, Allison and Bob discussed how their projects had evolved:

Allison: Well, when we first got assigned the project, I talked to my dad about it for awhile, just because, in case he needed to help me with any of the building or anything of it. Because the first thing I wanted to do was like a stall, and it had a curtain and you walked into it and you're surrounded with pictures and things about it. But then I decided that was a little bit over-scaled and that was going to be really hard to do. So I kind of scaled it down to just having the tri-folds.

Bob: Because glue got everywhere and everything so it didn't work too well. So, I just stuck with PowerPoint. And I didn't make a good a grade on it as I thought I would have.

Practical matters shifted the course of the participants' exhibits. These logistical considerations were weighed against the other external influences, such as time and grades, and the other internal influences as well.

Theme Three: Beliefs about Projects

How the participants defined projects also influenced their learning products. This definition seemed to be based on their previous experiences with projects and the requirements their teachers expected for projects. The intangible characteristics of projects, according to the students, were: projects could be fun and engaging and projects could offer freedom and autonomy. These are consistent with constructionist learning environments. Allison, Bob, Brittney S. and Brittney T. described these characteristics as:

> Allison: But I like projects I guess because it's more fun than regular class work to be able to put something together on your own and that's some of the reasons I sometimes I like not having a computer to do projects or PowerPoints or something, because I think it's fun to create the poster boards and everything and decorate it, because it uses art when you decorate it and that kind of thing. Since that's one of the things I like to do.
>
> Bob: Sort of, in a way [pause] like we had the freedom of how we wanted to do it, the big thing and the PowerPoint. The paper: we had the freedom of how we wanted to do it, but when she actually started grading, it looked like she graded the way she wanted to grade on. Like if you did a poster board, just a poster board, I don't think she would have graded you as well unless it was good. As like if you had done a PowerPoint and a poster board and all that information and ways of presenting it.
>
> Brittney S.: And the exhibit kind of helped me. Well, it didn't really help me, but it was kind of a fun thing to do. After all that research, to kind of make it into kind of like a fun thing other than a research paper kind of to show everyone else.
>
> Brittney S.: Because you actually get involved with it and you are doing something with the information, not just repeating it down on paper.
>
> Brittney T.: You just have more freedom to put whatever you want on there. And you don't have to worry if it's wrong or not.

Concrete qualities of projects were based on previous and current experiences. Projects were colorful, included pictures and images, involved the audience and often included a display board. During the unit on human rights, no examples of exhibits were given; the unit was new for the cooperating teacher, so there were no previous examples to show to the participants. One class period, however, was spent discussing existing museum exhibits and what the participants and their classmates liked and disliked about exhibits they had visited.

> Allison: And [pause] I knew I wanted to do a lot of pictures and bright colors because that's what I liked about existing exhibits, and I knew it would be a lot more interesting for somebody to look at if it had a lot of pictures and things that they can look at instead of just reading.
>
> Bob: When we go to PowerPoint, I like to include pictures and stuff. When I do a web site, pictures and stuff. When I do a paper, usually not.
>
> Bob: Having to write a paper and [pause] let's see, having to like make a board because [pause] trying to do something I didn't really want to do that much.
>
> Brittney S.: I usually just like to make it colorful and try to catch people's eyes to make them want to read it.
>
> Brittney T.: Yeah, they can, they go in and click it themselves. There's like little, um, like hyperlinks, like it says slavery and then there's hyperlinks around it for like different subtitles. Like life of a slave or becoming a slave and things like that.

Grades helped define what projects included, too. The participants held beliefs that projects were less rigorous. As Brock said, "Usually, project grades are like test grades. So, it's much easier to get a good grade." This may be in part derived from the enjoyment and freedoms they associated with projects. Brittney T. echoed Brock's sentiment. She said:

> Well, I think I kind of like...you know, not being tested over it because you won't get like a really bad grade unless you don't work on a project at all. Then if you learn the stuff that you are supposed to, and you get all of your information, they will probably get a good grade."

Bob agreed with Brock and Brittney T., but he felt there was a dichotomy: projects for fun and projects for grades.

> Bob: Like [pause] there's like, I categorize two different kinds of project. There's a fun project and there's, uh, there's a project for a grade. A project for a grade is something you'd write a paper or a report. A fun project is something you do on PowerPoint and you can have pictures and stuff. And you can do animation and be more creative. With the project for a grade, it's, you know, you have a set thing you have to do. It's like you have to do a paper and a poster and present it to the class or something. In my science class, we're doing PowerPoint so you can basically do them on PowerPoint how ever you want, and I think that like it'll probably be graded like a project for fun, but I also try to be creative with my word choice in my paper or something.

Projects were also compared and contrasted with tests. To the participants, tests were for the teacher. The teacher tested to determine whether the learners knew the information. Projects were like tests in that they tested the participants, but they were different because they gave the participants an opportunity to use their knowledge in a variety of formats.

> Allison: It was much better because [pause] I mean, you didn't have to study for it. You did have to work on it but it wasn't [pause] since I liked to do this kind of stuff, it wasn't like studying or anything for me. I enjoyed putting it together and figuring out how I was going to do it so it wasn't near as bad as a test. And also, even though I was kind of nervous about how I was going to do this part, how I was going to present it to people, I wasn't near as nervous as I sometimes get before tests. So, it wasn't near as [pause] it was just as good a way to learn and sum everything up without near as much [pause] studying and getting nervous about. It was a fun way to make everything come together.

Bob: I think in some ways yes because it's being graded, but you have the ability to do whatever type of project you want and there is no right answer. I mean, you have got to facts down, the right facts, but the way you present it, there's no right answer. How well you work and like that.

Brittney S.: Yeah, but I think it is different than a test because [pause] you. — like in a test you just memorize information but this you actually learn it and you teach it to other people. So, I feel like in a different way it is different from memorizing it.

Researcher: Do you think this project was like a test?

Brock: Yes.

Researcher: In what way?

Brock: It took a long time and the teacher had pressure on it. It had pressure to finish, and I think it was hard to finish it.

Theme Four: Tools for Technology-rich Environments

The design of the learning environment by the cooperating teacher and researcher sought to take advantage of the technology-rich environment of the day school. As described in Chapter 5, the environment was resource intensive. The resources, including productivity tools, scaffolds and collaborations were used and valued to different degrees by the participants. See Table 3 for a list of the resources developed and integrated for the unit on human rights. See Table 7 for a review of the resources used by the participants and their views about the value of these resources.

Hill and Hannafin (2001) suggest environments that rely on resources are complicated by the degree to which they are more closely learner-centered. The more individualized the

resources are, the more difficult they are to be reused or repurposed for other learners. The resources used in this environment to a large degree were consolidated in hyperlink lists to reduce searching; they were developed to scaffold the learners beyond their current skills; and they promoted collaborations and sharing of information and critiques. As can be seen in Table 7, the resources were used by the participants "as needed" and the resources were not all used by all the participants. This seems consistent with Hill and Hannafin's description of resource-based learning in learner-centered environments.

The technology-rich environment also relied on the ubiquitous computing available to the participants. The participants did not use the computers to extend their thinking (c.f. Jonassen & Reeves, 1996). Instead, the computers were used primarily as a tool for productivity (Taylor, 1980a). Allison, Brittney S. and Brittney T. said:

> Allison: Can I include computers in general? Okay. It made it a lot easier because I didn't use my laptop as much as I used my home computer. But I had my research on the laptop so I could just take little pieces of it and load them on here instead of having to rewrite something. It looks a lot neater because I typed everything instead of having it handwritten. I could find my pictures on the Internet and blow them up and resize them. I ended up blowing up the [something] to like 600, which really helped.
>
> Brittney S.: I think that they're good, because they make a lot of shortcut. You don't have to go check out books or find, you can just type something in and it does it for you.
>
> Brittney T.: It was easier to just copy and paste different things. It's just easier, because it goes faster on the computer.
>
> Brittney T.: I could find all of the information on the there and it looks neater when you print stuff out of the printer instead of hand writing it. And it was a lot easier, and I couldn't have done those PowerPoints without it.

The participants relied on their laptop computers to accomplish their tasks for this unit on human rights. During this unit, the school's network crashed; it remained unavailable for over a week. As Brock explained, the only negative he had about computers was "when the Internet server was down." Other technical problems associated with their computers punctuated the participants' dependence on their computers. Bob, Brittney S. and Brittney T., for example, explained their frustrations.

> Bob: When I'm doing projects and sometimes the computer will shut and you're doing a project going. It's only happened like once or twice, but it's really annoying.
>
> Bob: Sometimes they're really slow. And when they freeze up. Because I'll get frustrated with the computer and especially these laptops. Cause my laptop, the screen broke, and I have to go through and clean out the disk space. And I have to do stuff like that and I can't figure out how to do it, it kind of gets annoying
>
> Brittney S.: When, I pretty much enjoy everything about them, except when they go slow and it takes a long time, cause you expect them to be fast and I get impatient.
>
> Brittney S.: Sometimes, it's like well we've had some problems getting information and the Internet has been down and that's kind of been frustrating.
>
> Brittney T.: They freeze, then you can lose your work and all that stuff.

Theme Five: Learning Outcomes and Products

The previous four themes centered on influences. This final theme represents what is shaped by these influences. It is the learning outcomes and products that have been molded by the internal and external influences, beliefs about projects and tools for technology-rich environments. It was argued earlier that the learning artifacts may not represent all the

learning that occurred by participants. Parsons (1998) describes the limits of assessing and recognizing the concrete examples of learning. He says, "Educators today are challenged to find ways for students of diverse abilities, cultures and ways of knowing to express learning, much of which is not confinable to a 'product' " (p. 29).

To embrace the complexities of this finding, learning outcomes and products in this theme represent the intentional and incidental learning that is and is not reflected in the learning artifacts. Learning products, then, are the learning represented in the tangible artifact and the learning acquired during the unit that may not be reflected in the artifact.

The primary objective for this unit was to analyze, evaluate and synthesize current human rights violations in countries from around the world into a research paper and museum exhibit. This was achieved by the participants' abilities to communicate their understanding of the situations in their respective countries. The exhibits produced by the participants exposed these inhumanities well (see Figures 4, 6, 8, 10, & 12). Their research papers and exhibits covered complex issues such as religious beliefs and anti-semitism, economies and governments along with murder, torture and existing slavery. Bob explained the difficulty these small countries face:

> Bob: I've got a lot of information in [my research paper]. It's not that I didn't leave out some, but it's basically "big picture" types of things. It's kind of certain events. You couldn't really find that type of information. Like with the American Revolution, that was kind of like a turning point. But, Sri Lanka is having a civil war, but it's not affecting too many people. It's affecting some of their trade partners, but other than that, it's the people in that place.

Affective goals were also reached. During reflection, the participants expressed their appreciation for freedoms and security they have in the United States. Brittney S. and Brittney T. commented:

> Brittney S.: Well, how [pause] that I [pause] learned to draw pictures of the people who lived in Sudan, and it really let me see kind of, get a better understanding of what they were really going through and it made me feel, like realize how lucky I was that I didn't have to experience my human rights being violated everyday of my life.
>
> Brittney T.: I just liked having [pause] it was an eye-opener and a lot of a stuff about Argentina . . . . Just like about [pause] the economy and the way they treat people and about the Dirty War.

Along with coming to understand the human rights violations individuals face in their respective countries, the participants developed emotional bridges with these countries. The compassion the participants expressed regarding their countries was remarkable. These changes in thinking were accentuated in the stories Allison, Brittney S. and Brittney T. authored.

> Allison: I just kind of thought that the first-hand accounts would be really neat to do because the people can learn a lot of stuff about Kashmir but they might not really know what it's like to be there but if they read the first-hand accounts and they get assigned to be a person, then it's almost as if they actually get put in somebody's shoes that lives there. So that's how they can really learn about it. Not like a personal account. And also instead of just learning facts it's usually more personal for someone to actually learn about a specific person that lives there instead of just what's happening there.
>
> Brittney S.: By having my own opinions and feelings about the people in my country are experiencing, I kind of, like my paper reflects that. If something in, some topic in my country interests me, it kind of makes me want to learn more about it and write more about and tell other people about it, like through my paper.

Researcher: What were you trying to do by having a story?

Brittney T.: Just show the lifestyles of the people and how bad they were, when all this happened during dirty war and how the government is unstable and what the government has done.

Chapter Summary

From across the data collected to answer the research questions, five themes emerged: (1) internal influences, (2) external influences, (3) beliefs about projects, (4) tools for technology-rich environments, and (5) learning outcomes and products. The first four themes describe the conditions that influence individual differences to shape the fifth theme, learning products. The term *learning products* was used to describe both the learning garnered by the participants and the learning artifacts the participants produced as part of this unit on human rights. Internal influences included the participants' abilities, motivations, self-management and their perceptions about effort. External influences included teacher expectations and directions, grades, time and practical considerations. The intangible characteristics of projects, such as enjoyment, freedom and autonomy, and the concrete qualities, such as images, color and interactions, contributed to the participants' beliefs about projects. Tools for technology-rich environments used in the unit on human rights were comprised of resources, scaffolds and collaborations. Computers as a resource in the learning environment were used primarily as a productivity tool. Finally, learning outcomes and products encompassed the intentional cognitive goals of the unit in addition to affective goals.

CHAPTER 7

DISCUSSION AND IMPLICATIONS

Chapters 4, 5 and 6 interpreted the results of this study. Chapter 4 depicted the five eighth-grade participants as individual cases, looking at their individual differences, their computer mediated learning artifacts and their views about using computers and working in a constructionist learning environment. Connections are made across all of these categories in order to find links through each participant's life as an eighth grader. Chapter 5 presented a cross case analysis of the participants. The research questions for this study guided this analysis. Chapter 6 presented five themes that emerged from the cross case analysis. The themes reflected elements from all the research questions and represented the highest level of abstraction about the ways in which contextual factors influence student artifacts in constructionist learning environments.

This chapter situates the results within the literatures about individual differences and learning. Concentrating on the highest level of abstracted themes presented in Chapter 6, these results will be positioned within the research on biology, abilities, cultural influences, developing expertise and learning environments. A more concrete version of these abstracted themes is proposed in a model, the ecology of learning products. This representation clearly locates the results of this study within existing literatures. The implications of these results should inform practically all educators, but the implications should be particularly important for inservice and preservice teachers, instructional designers and curriculum developers and, finally, for researchers.

Situating the Results

This study sought to explore how individual differences were reflected in the construction of computer mediated learning artifacts within a constructionist learning environment. The results also indicated the conditions that shaped the participants' learning products. It is important to locate these results with a larger context, where the focus is on examining the relationship between the individual, his or her culture, developing expertise, the contexts for learning and learning products.

The individual. Flynn with his colleagues (for example, 2001) have in recent years begun to examine the traits genetics are playing on individual differences. Notably, Flynn's work has been concentrated on IQ. Much of the data within differential psychology has been constrained to IQ, because of the abundance of data and the high correlations among intelligence tests. Dickens and Flynn (Dickens & Flynn, 2001) suggested that genes of individuals may not respond alone but may in fact react to differences in the individual's environment. As additional research in this area continues to grow and extend beyond IQ, for example the Human Genome Project (http://www.ornl.gov/hgmis/) and the protein project (Folding@Home, http://www.stanford.edu/group/pandegroup/Cosm/), we may come to understand more about the role genetics plays in individual differences. However, caution should be exercised with generalizations related to the role of genetics in learning because of the complexity of learning environments and the vast amounts of unknown information regarding human capacity and adaptability.

Bentley (1967), Gardner (1983), Eliot and Hauptman (1981) and Olson (1984) have investigated and identified specific individual differences. Gardner (1983, 1999), distinctively, has composed a list of discrete abilities based on biological and cultural determinants. This list is strengthened by its foundations in psychological and neurological

research, including brain injuries and autism. However, this classification may be limiting, excluding other abilities such as creativity and organization. The results of this study suggest logic may be distinctive from mathematical skills. In addition, creativity and computer skills are distinctly a function of the individual.

The culture. Gardner (Gardner, 1983, 1999) used cultural factors to support the distinctiveness of his classes of abilities. Through the values, beliefs and symbols systems of various cultures, individuals acquire and exhibit differing abilities. Scarr (1998, 1983) agreed that environment influences the abilities individuals express. Scarr has examined the influences parents have on children's academic achievement and abilities. Erisson, Krampe and Tesch-Romer (1993) found that expert abilities are often initiated by parents. Support, praise and rewards cultivated the habits to continue practicing the ability.

Nelson (1996) in contrast has proposed a more active approach by the individual. The individual with his or her different abilities accesses the cultural systems available to shape his or her development. Nelson's work has been focused on language acquisition and concept formation, particularly in young children. Nelson's research in concert with Gardner, Scarr and Erisson et al's works suggests an individual is both reacting to and acting upon the cultural systems in which he or she is involved.

Developing expertise. Meichenbaum and Biemiller (1998) suggested individuals differ in their declarative, procedural and strategic knowledges, in addition to their motivations as important roles in developing the expertise of individual abilities. Declarative knowledge is reflected in the "rich vocabulary and extensive information about the rules, strategies, alternative hypotheses and varied ways to proceed" (p. 15). Experts use declarative knowledge as a way to understand their abilities and the factors that influence their performance. Procedural knowledge allows experts to link declarative facts into scripts of

"if-then" statements. These scripts are automatized into memory, freeing cognitive resources (Anderson, 1982). Strategic knowledge comprises the knowledge about when, where and why to apply specific procedural knowledge. This type of knowledge is closely related to metacognition, where an individual is aware and can control his own cognitive processes. Learners who are high achievers attribute their successes to their own efforts and poor performances to their lack of effort or not choosing the right strategy. High achieving students are confident in their ability to overcome tasks. Low achieving students ascribe their successes to luck, teacher moods or external aids (Meichenbaum & Biemiller, 1998).

Erisson, Krampe and Tesch-Romer (1993) have reported that opportunities to develop expertise and the amount of practice of the ability contribute significantly to the distinctions between experts and novices. They report that experts began at an early age, often at the prompting of parents. As described above, parents actively supported and rewarded the developing experts throughout their practices. Individuals continued practice throughout their adolescence under the direction of an advanced teacher or coach, and they often reduced their leisure activities in order to devote more time to their developing expertise. These results suggest that opportunities to develop expertise, motivations to practice and support contribute to an individual's growth of ability.

Learning contexts and products. Proponents of constructionism posit that individuals learn best when constructing personally meaningful artifacts that are sharable (Harel & Papert, 1991; Kafai & Resnick, 1996b). Constructionist learning environments typically include an introduction, a task, an investigation, resources, scaffolds, collaborations, plus opportunities for reflection and transfer (see Table 2). As individuals work through and use these elements, their individual abilities, ones that have been developed and ones that have not been developed, are influenced. The results from this study suggest that individuals working

within constructionist learning environments are influenced by internal factors, external factors, their beliefs about projects and the available tools for a technology-rich environment. These influences shape the individual's learning products.

The term *learning products* reflects the learning represented in the tangible artifacts created in constructionist learning environments, as well as the learning that *may not be* represented in the artifact but was acquired during the process of constructing the artifact. Based on the results of this study, an individual employs his or her abilities to make decisions (either consciously or unconsciously) about the influences of the learning context. These decisions affect the learning products.

Ecology of learning products

The sections above have described particulates: the individual, the culture, developing expertise and learning contexts and products. In an effort to understand how these elements fit together, a model is proposed for how individual differences are influenced in constructionist learning environments (see Figure 15). This model represents the highest level of abstracted themes from this study and situates these results with related literatures. Interestingly, this model is an artifact of my learning. Like the participants' artifacts in this study, this model does not reflect all that I have learned as a result of completing this research. I believe, again like the participants, that the context of this learning has shaped my decisions, and subsequently, has shaped this model.

This model began as a theory of intelligence constructed as part of a class assignment for Dr. Martha Carr approximately two years ago. Derived from the literature on intelligence, only the first three layers were defined: a genetic substrate, abilities and a cultural filter (then called contextual filter). As data collection for this study continued, it

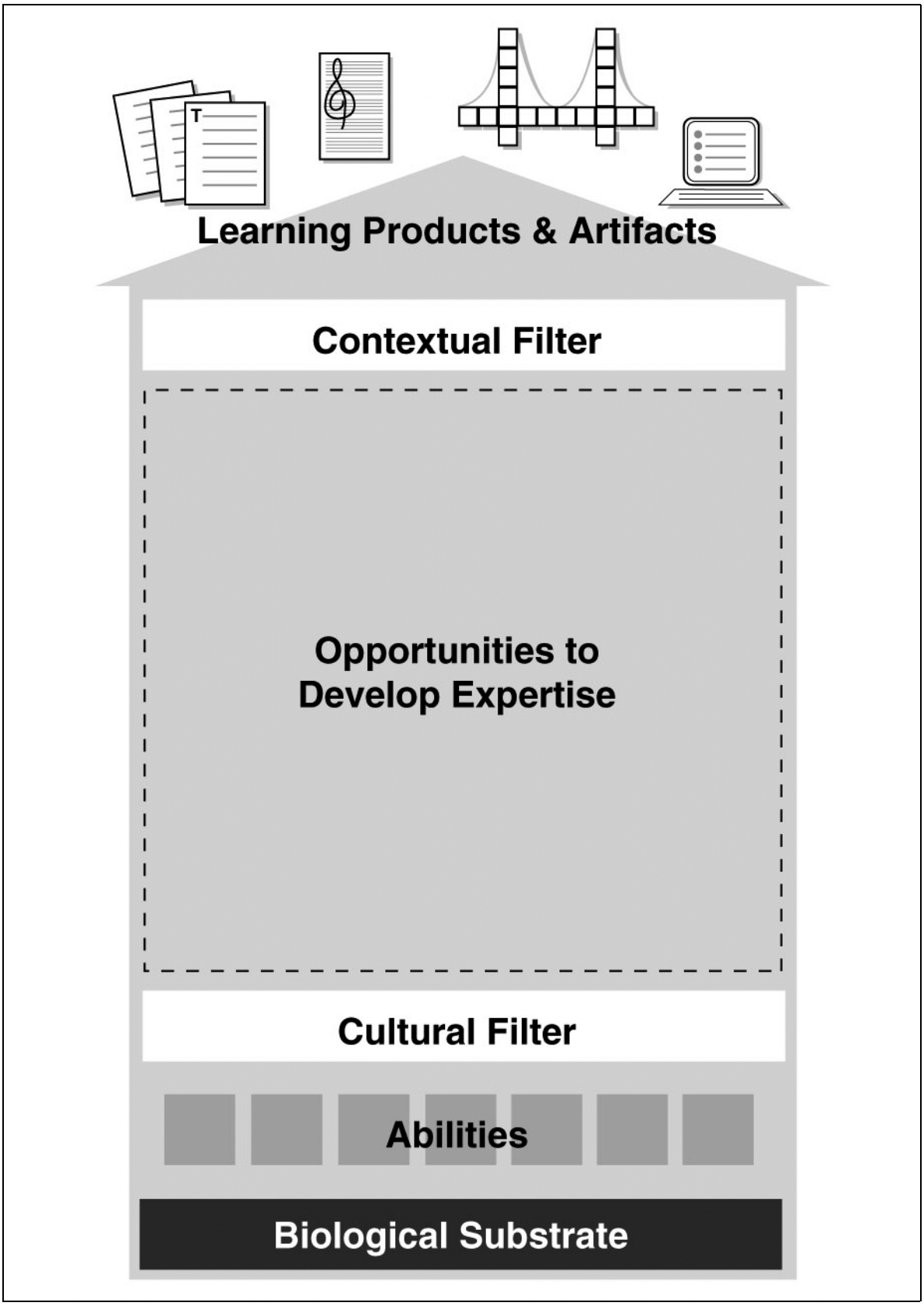

Figure 15. Ecology of learning products

became clearer that the participants were making decisions that affected their learning artifacts. These decisions were initially influenced by factors such as the discipline, prior knowledge and experiences, motivations and the teacher. With consultations with members from my advisory committee, this decision-making layer began to take shape. After data collection and as themes were developed, these factors were shaped into a contextual filter. Other literature searches into developing expertise and self-directed learning led to including the large middle layer of opportunities to develop expertise. Revisions during data collection and data analysis have led to the current model.

Six layers are identified within this model: (1) biological substrate, (2) abilities, (3) a cultural filter, (4) opportunities for developing expertise, (5) a contextual filter and (6) learning products and artifacts. Each one is discussed below. Empirical support for this model is summarized in Figure 16.

Biological substrate. The biological substrate represents the genotypes and phenotypes the individual has. These may be as visible as long fingers that may be useful for playing the piano, or as hidden as good eyesight. The biological substrate is the raw materials with which individuals are born. It is important to recognize that the biology of individuals is not a predetermined path. Instead, the inherited characteristics of individuals react to the individual's environment (Scarr & Ricciuti, 1991).

Abilities. This layer subscribes to the modular view of individual differences, treating each ability as if it were a separate domain (Gardner, 1986). Abilities in this respect resist the united perspective of a single general intelligence. Instead, individual abilities attempt to identify the unique abilities that are distinct from one another. Gardner (1983, 1999) has

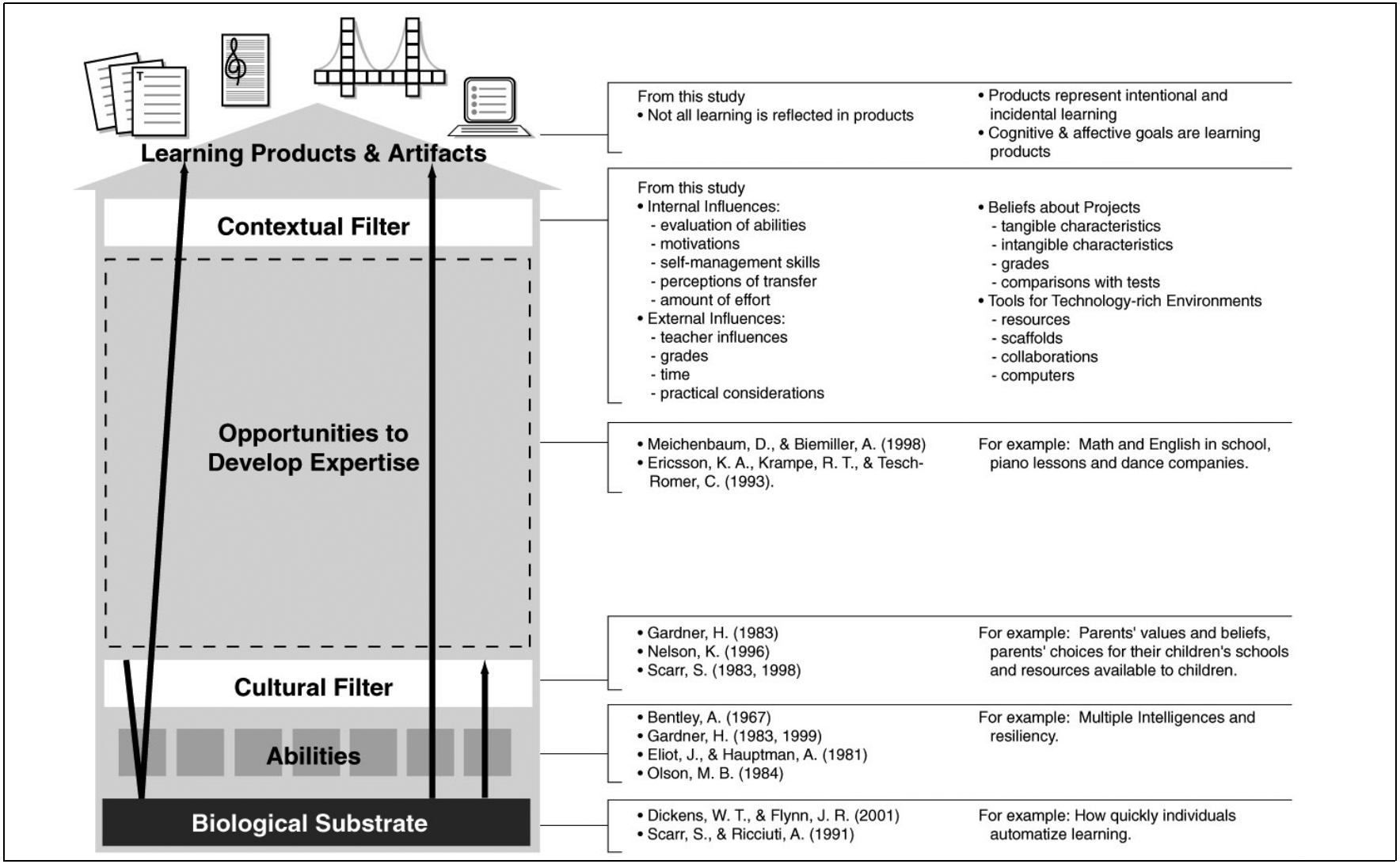

Figure 16. Summary of empirical support for ecology of learning products

distinguished nine abilities, including verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical, interpersonal, intrapersonal, naturalist, and existential skills. Though this list is robust with empirical support, other abilities, such as creativity, organizational skills and computer skills, may be additional candidates to include as abilities. While these abilities are discrete, they often are used in combination with one another to accomplish tasks; for example, in writing poetry, verbal/linguistic skills may be allied with intrapersonal skills to produce the prose.

Cultural filter. A cultural filter represents the values, beliefs and symbol systems an individual lives and works within. Different cultures value different abilities, interests and personality traits (Gardner, 1983; Scarr & McCartney, 1983). The views of parents, teachers, relatives and religious leaders may contribute to the cultivation of specific abilities, traits or characteristics.

The biology of an individual and the culture and environment of that individual play a reciprocative role with one another (Scarr & McCartney, 1983; Scarr & Ricciuti, 1991). The environment and the biology of the individual act and react to one another. Environments evoke different responses for an individual, and the interests, abilities and personality of an individual engender preferences for different environments or cultures (Scarr & Ricciuti, 1991). Thus, the individual is not passive in a culture, reacting to the systems of the culture. Scarr (1991) suggests, in fact, "that people make their own environments based on their heritable characteristics" (p. 20). This model portrays the role culture in the ecology of learning artifacts as beginning to the development of some abilities, such as when parents encourage children to begin piano lessons. Culture is also depicted as interruption in the development of abilities, such as when parents discourage a child's interest in dancing or sports.

Opportunities to develop expertise. This layer is developed over time. Through different experiences and practices, individuals develop expertise with specific abilities. Verbal/linguistic and mathematical/logical abilities are the core of the educational curriculum in the United States (Gardner, 1983). Individuals who continue to progress through school have extensive opportunities to practice and develop these skills. Other less valued abilities, such as musical talent, are often extra-curricular activities in schools, or they are absent. Parents, who support these devalued abilities, prompt children to begin music lessons or provide occasions for children to experience and develop these skills (Ericsson et al., 1993).

Contextual filter. The contextual filter depicts the conditions that surround the individual's learning and his individual differences. In formal education settings, these conditions are the teachers, classrooms and the disciplines. The results from this study suggest four factors comprise this contextual filter: (1) internal influences, (2) external influences, (3) beliefs about projects and (4) tools for technology-rich environments. Internal influences include the individual's analysis and evaluation of his or her abilities, motivations, usefulness of knowledge and skill transfer and the amount of effort task would require. The classroom teacher, grades and practical considerations constitute the external influences to the individual. The individual's beliefs about projects, how projects are defined and what should be included with a project are another set of considerations. The tools individuals use in the learning environment such as resources, scaffolds and collaborations are a final influence within the contextual filter.

This list of factors begins to consolidate the influences individuals negotiate in learning environments. This list is comprehensive but not exhaustive. Additional research is needed to explicate specifics about the teacher's influences, including explicit and implicit, directions,

preferences and roles in learning environments (c.f. Brush & Saye, 2000). Understanding what developmental factors adolescents face when negotiating self-directed learning would also strengthen the internal influences elucidated above.

Learning products and artifacts. These are the results of learning. Learning products and artifacts may be tangible reports, electronic presentations, science experiments or dioramas. Learning products may also be less physical outcomes, such as affective and metacognitive aims. This study suggests it is important to acknowledge all of these learning products — not only the final tangible artifacts. We are challenged to resolve approaches to encompass the diverse abilities of individuals, their cultures and representations of knowledge (Parsons, 1998). Assessment of learning products that accounts for the influences in the contextual filter will continue to remain important. Formative and summative assessments that document the learning process may encompass more of the intangibles of learning.

Summary. This model, ecology of learning products, offers one way to look at how individuals' differences are influenced. The contextual filter, particularly, encompasses themes derived from this study, aggregating influences within a learning environment. The learning products and artifacts layer is also informed by the results of this study. The biological substrate, abilities, cultural filter and opportunities to develop expertise layers represent work within the literature related to abilities and individual differences in order to understand how they are engendered, stunted and influenced. This model is not exhaustive, and modifications are expected. As we come to understand better how individual differences are played out in learning contexts, we will garner a clearer awareness of the factors that influence learners. Consequently, this model will evolve.

Applying the Model

This model has implications for research, design and implementation and pedagogy. A single participant has been selected as an example of an individual as he moves through the model. Bob, for example, entered the unit on human rights with high abilities in verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, interpersonal and intrapersonal skills. Bob also thought he was strong in Science, Geography, English and Math and he enjoyed woodworking, welding and athletics. He was very comfortable using computers for his schoolwork. English (verbal/linguistic), Math (mathematical/logical), Science and Social Studies were elements of school. These abilities had been valued and cultivated since kindergarten. Woodworking and welding were activities Bob often did with his father. Athletics (bodily/kinesthetic) were practiced after school. (From the data Bob provided in his interviews and during observations, it is not possible to determine if or when Bob practiced visual/spatial, interpersonal or intrapersonal skills.)

Internal influences that Bob considered were motivations, self-management and transfer. Although elements of motivation were integrated as part of the constructionist learning environment, Bob felt the learning became redundant, and it had taken too long. He was less excited about learning, and he was concerned about the relevancy to himself, since he was more interested in the conflict in Afghanistan than Sri Lanka. While collecting notecards, Bob managed his files differently by separating the sources into a logic he determined. His research paper followed a similar management scheme. Finally, Bob felt that Science, Math, woodworking and welding were not needed for this unit. He may also have felt similarly about athletics and bodily/kinesthetic skills.

Externally, Bob was influenced by grades and practical considerations. Bob considered the length of the unit as indicative of its importance. He also felt even though

the students had freedom to create their exhibit, the teacher had expectations for grading the projects. Bob's human rights exhibit included a board in the beginning, but because it became too messy with glue, he decided to proceed only with the electronic presentations.

Bob's beliefs about projects also influenced his learning products. Bob believed there were projects for fun and projects for a grade. With a project for fun, he could include pictures and images, animations and could be more creative. Projects for a grade had requirements and were more restrictive. For this exhibit on human rights, he thought his project was like a test in that he was being graded. But it was different, because there was not one correct method. However, as mentioned before, he felt the teacher compared all the exhibits, looking for a display board. He felt his grade suffered because he was not creative enough. Bob also thought the audience and gravity of the topic influenced his exhibit.

Though his laptop sometimes frustrated him, he used tools in the technology-rich environment. Bob referred to the project website as needed, and he used a number of search engines and web sites to seek information. Bob modified the electronic notecards to suit his process, but he felt the peer conferences were not helpful because his classmates were reluctant to be critical.

Bob's learning products included his artifact, computer skills and "big picture" ideas. His solemn exhibit (described in detail in Chapter 4) integrated verbal/linguistic, logical, visual/spatial and interpersonal skills. He learned additional computer skills, specifically with hyperlinking and action buttons in Microsoft *PowerPoint*®, and making better searches with Internet search engines like *Google*®. Bob also learned broader themes in relation to Sri Lanka. For example, he felt Sri Lanka's small interaction and trade with others prevented other countries from taking action.

Implications

As with all qualitative research, the extent to which the results can be applied in other contexts is situated with the reader. The results of this study are significant to inservice and preservice teachers, instructional and curriculum designers and to researchers. Understanding how the adolescents in this study interacted with the constructionist learning environment and how they used their abilities in various ways to construct their representations of their knowledge are valuable elements in creating engaging and effective learning. The results of this study included a self-report instrument that has not been validated and a group of participants with many privileges and resources. While these results should be interpreted with caution as is necessary with all qualitative research, this study provides directions for other educational research.

Inservice and preservice teachers. This research presented the voices of five eighth graders as they moved through a unit on human rights. The voices of learners are sometimes lost in the preparation of lesson plans. The internal and external influences the participants spoke of in this study highlight the challenges these individuals faced. Though the environment included elements of motivational theory, the duration of the project may have been too long for the participants. Bob, Brittney S. and Brittney T. made remarks about being "burnt out" on the topic. Bob felt the content was redundant. Teachers should vary the length of projects to determine the appropriate length for their students. It may also be helpful for teachers to vary the length of projects in order for students to experience different project durations. Bob commented that this was the longest project he had worked on. If teachers want to include in-depth investigations over extended period of time, such as 10 weeks in this study, then additional research is needed for teachers in order to support the internal influences learners grapple with, such as motivations.

Another internal influence that concerns teachers is the participants' perceptions of domain transfer. Bob, Allison and Brock segmented their abilities. They felt their strengths in one domain were inappropriate for another. Gick and Holyoak (1983) reported that when subject domains are taught in multiple contexts, individuals are more likely to transfer the relevant concepts. This suggests that teachers make connections among disciplines, such as English and social studies. This also suggests that teachers explore interdisciplinary projects that involve more than one domain, so students see and use knowledge across disciplines. Team teaching may offer one method to manage interdisciplinary units and pool expertise.

Possibly the most consequential result from this study for preservice and inservice teachers is the influence the classroom teacher had on the participants. In this study, the participants reported that the teacher shaped which resources they used, which content they pursued, and to some extent, which elements were included in their learning artifacts. While the learning environment afforded the participants choice, challenge and control of content, resources and types of artifacts, the participants relied on the teacher to guide their learning. I agree with Brush and Saye (2000): as teachers include more elements of learner-centered environments, such as constructionist learning, additional research is needed on the changing teacher's role and ways to support learners as they take on more responsibilities for their learning.

Instructional designers and curriculum developers. As designers develop units of instruction for classroom teachers, it is important for them to place a renewed emphasis on assessment. In this study, previous literature suggested to allow the students to contribute to the development of the grading rubric (Stephens, 1996). One participant, Bob, felt the teacher used her own judgement to grade the exhibits. The expectations for "good grades" by the participants influenced the construction of their learning artifacts. Drake and McBride

(1997) have presented one rubric for assessing learning artifacts. It may also be necessary for designer to develop contracts for learners, so students can individualize the assessment, as well as their learning.

It is also important for designers to undertake the challenge of including all the learning products, tangible and intangible elements, in assessment. Portfolios offer one alternative. Arter and Spandel (1992) have described portfolios as "a purposeful collection of student work that exhibits to the student (and to others) the student's efforts, progress or achievement is (a) given area(s)" (p. 36). Parsons (1998) cautions that portfolios, while encouraging learners to be critical of their abilities and progress, may conflict with the teacher's authority and grading, may continue to limit potential artifact contributions and may not work in all institutional settings. Scardamalia and her colleagues (1989) have also worked to use intentional reflection and metacognition. This type of articulation of learning and learning strategies may support intangible elements acquired during the process of learning.

Additional research is needed concerning how learners reconcile grades with their learning, along with research in assessment strategies. Efforts to capture process and products, formative and summative evaluations and blending tangible and intangible elements in assessment is worthwhile for instructional designers and curriculum developers to consider as their develop units of instruction.

Educational researchers. Finally, researchers can use this study as a springboard for additional investigations. This study was completed in a private school with a unique technology-rich environment. It would be beneficial for subsequent research to explore how students in public schools feel their individual abilities are integrated into artifacts they create. These students may provide the adjunct influences, such as teacher influences and

developmental factors suggested above, to bolster the contextual filter proposed in the model. Public schools may also offer a different perspective on the use of technology tools. The technology-rich environment in this study was unique with ubiquitous computing. Other technology-enhanced environments may offer insight into other methods to support learning with technology. As well, other teachers may cultivate more robust techniques for learning with technology (c.f. Jonassen & Reeves, 1996; Taylor, 1980a).

This study involved eighth graders. Other case studies would be wise to consider a younger sample, where students have less experience with school norms, or an older sample, where individuals may be able to direct more of their learning decisions. Additional research is also needed with other adolescents as they work with learner-centered environments. Meichenbaum and Biemiller (1998) offer a wealth of techniques to support learners in becoming self-directed.

Research that includes self-directed techniques and augments them with technological tools, scaffolds and resources would also valuable. Erickson and Leher (2000) have examined the role of hypermedia as cognitive tools in learner-centered environments. They also suggest further study with how students represent their learning within hypermedia environments, such as web pages and electronic presentations. It would also be beneficial to improving the design of learning environments to understand further what influences learners' uses of specific tools, scaffolds and resources.

This research began with an action research component. The cooperating teacher and researcher teamed to design a learning environment to support individual differences and constructionist learning. Other researchers would benefit from this collaboration to improve classroom instruction and effect educational change. Working with teachers to develop instruction and implement research-based initiatives are worthy lines of research for

university faculty. These collaborations offer teachers a support system for employing new pedagogy.

Recommendations. A few specific recommendations for further research are listed below. I would advocate researchers:

1. Conduct further study with the model, ecology of learning products, proposed in this chapter. It may be useful to test this test against other contexts and participants in order to strengthen its elements, and it may be worthwhile to use this model as a conceptual framework in additional studies.
2. Investigate atrophy of individual abilities. More empirical data are needed about whether abilities are inaccessible once they have been unpracticed, or do abilities remain dormant for our use at later times.
3. Explore ways to represent students' voices in learning environments. This study looked to understand how learners individualize learning for themselves when learning goals are varied. Additional research should explore how learners may contribute to the design of learning environments.

Chapter Summary

This chapter attempted to situate the results from Chapters 4, 5 and 6 into the existing literature. The results were positioned within the individual, his culture, developing expertise, the contexts for learning and learning products. The results, specifically the broader themes from Chapter 6, were identified as influences on the learning context. A model was proposed that suggested the conditions an individual's abilities experience as they are used in a constructionist learning environment. Six strata were described: (1) a biological substrate, (2) abilities, (3) a cultural filter, (4) opportunities to develop expertise, (5) a contextual filter and (6) learning products and artifacts.

The purpose of this research was to explore how individual differences were reflected in computer mediated learning artifacts within a constructionist learning environment. Individual abilities were reflected in the learning artifacts as a blend of abilities. Various levels of computer skills were used, and some individual abilities went untapped or unrecognized. This study also illuminated the conditions that shaped the participant's learning artifacts, including internal influences, external influences, beliefs about projects and tools for technology-rich environments.

Implications for the results of this research were presented for inservice and preservice teachers, instructional designers and curriculum developers, as well as researchers. Teachers may be interested in influences on learners' abilities, as well as coming to understand the persuasive role teachers have on learners. Instructional designers and curriculum developers may integrate additional methods of assessment that include process learning and learning products. Portfolios and intentional reflections were offered as two alternatives. Finally, researchers may use this study as a point of departure for further investigation. Subsequent research in the teacher's role in learner-centered environments, different samples and contexts and collaborative action research were recommended.

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APPENDIX A:

GEOGRAPHY AND HUMAN RIGHTS WEBQUEST


Geography and Human Rights - Netscape 6
[geography and human rights]
The struggle for human rights has been an ongoing battle. From the Civil War in our country to the Holocaust in Europe to Apartheid in South Africa, many peoples' rights have been subjugated. These violations continue today in many parts of the world, including Africa and Asia. Physical geography and human geography are at the heart of these abuses.
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YOUR TASK
Since many of the violations of human rights are extended across the globe, it is difficult for students at Athens Academy and at other schools in our community to understand what is occurring in these countries and to grasp why these events are happening. You will create an exhibit to be displayed in a Human Rights Fair to be held just before Spring Break for your friends and younger students to experience.
In order to create an authentic exhibit, you will construct a series of artifacts that represent elements of the violations on human rights. These elements will include:
a research paper,
a first-hand account and
an editorial/opinion piece
With these elements as background material, you will build an exhibit like you would experience in a museum about your specific human rights violation.
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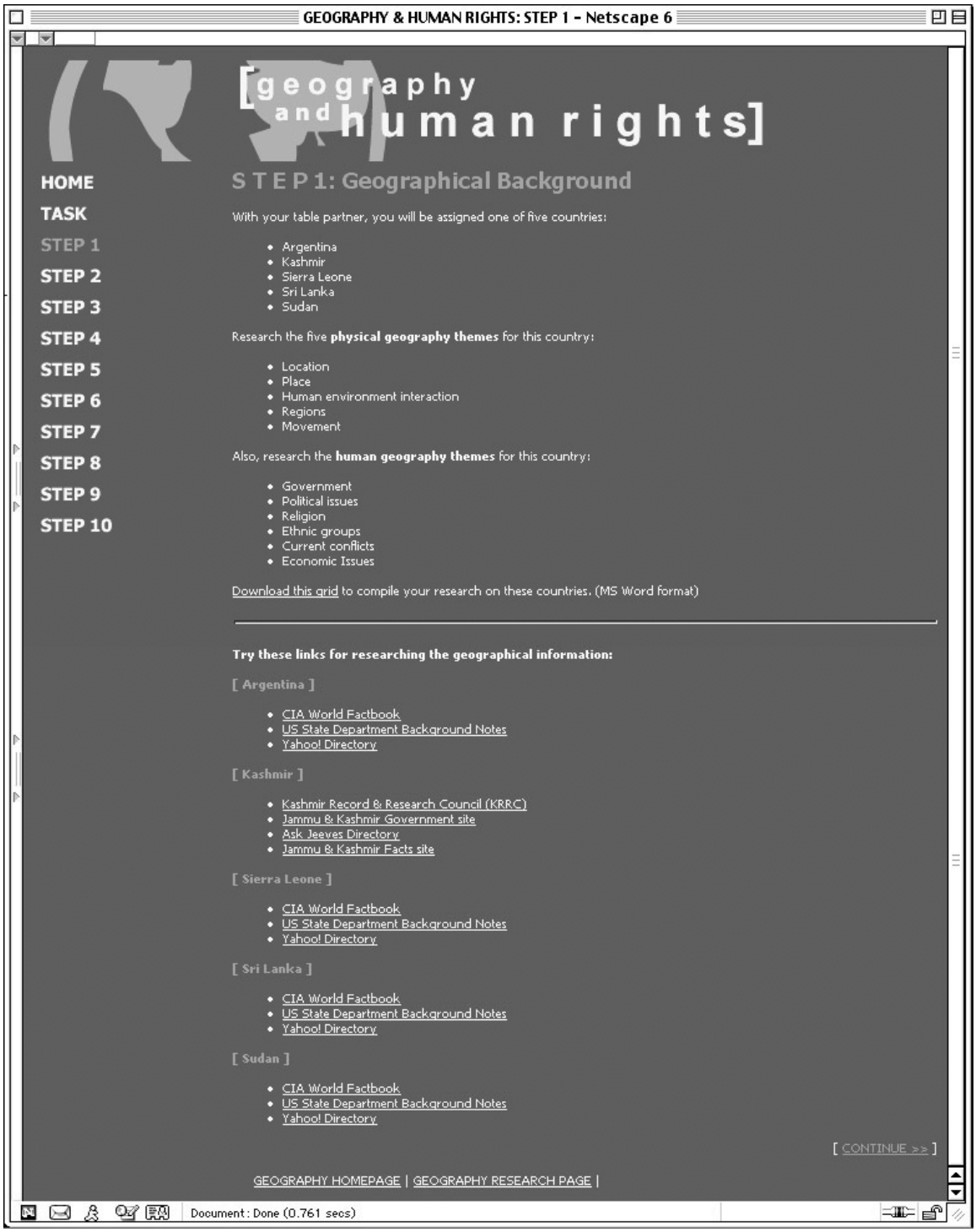
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STEP 1: Geographical Background
With your table partner, you will be assigned one of five countries:
Argentina
Kashmir
Sierra Leone
Sri Lanka
Sudan
Research the five physical geography themes for this country:
Location
Place
Human environment interaction
Regions
Movement
Also, research the human geography themes for this country:
Government
Political issues
Religion
Ethnic groups
Current conflicts
Economic Issues
Download this grid to compile your research on these countries. (MS Word format)
Try these links for researching the geographical information:
[Argentina]
CIA World Factbook
US State Department Background Notes
Yahoo! Directory
[Kashmir]
Kashmir Record & Research Council (KRRC)
Jammu & Kashmir Government site
Ask Jeeves Directory
Jammu & Kashmir Facts site
[Sierra Leone]
CIA World Factbook
US State Department Background Notes
Yahoo! Directory
[Sri Lanka]
CIA World Factbook
US State Department Background Notes
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S T E P 2: Geographical Background con't
Now that you and your table partner have compiled your physical and human geography themes on your specific country, you can compare and edit your ideas with another pair in class that also researched the same country.
Make sure you have the most complete information about the country.
A question to ask yourself is:
How has the physical geography contributed to the human geography of this country?
When you have completed compiling your research, you will turn in your work.
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STEP 3 : Discussion
After all five of the countries have been researched with their physical and human geography characteristics, we will discuss in class what the similarities and differences across these countries mean.
Questions to think about in our discussion:
What characteristics do these countries have in common?
What are the main problems that each country is experiencing?
What factors have contributed to the current conflicts and problems?
Download the compiled grid of all five countries (MS Word format).
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STEP 4 : Defining Human Rights
The term "human rights" is used by many organizations, many activist groups and many governments. However, it is used ambiguously and in different ways. Before you can begin to investigate violations of human rights in Argentina, Kashmir, Sierra Leone, Sri Lanka, and Sudan, you need to have a firm understanding of what's being violated.
You will create your own definition of human rights. Use the links below to help you.
It might be help to ask yourself these questions as you draft your definition:
How are human rights different from civil rights?
Are human rights different for men and women? children and adults?
How would human rights be different from animal rights?
Try these links for help with defining "human rights":
[Human Rights]
United Nations-Universal Declaration of Human Rights
United Nation-Universal Declatation of Human Rights Abbreviated
Human Rights, Religious Conflict, and Globalization: Ultimate Values in a New World Order (specifically Section 2)
International Human Rights Law and Practice: Implications for Women (specifically section on "Concept of Human Rights")
Legal Rights for Migrant Workers
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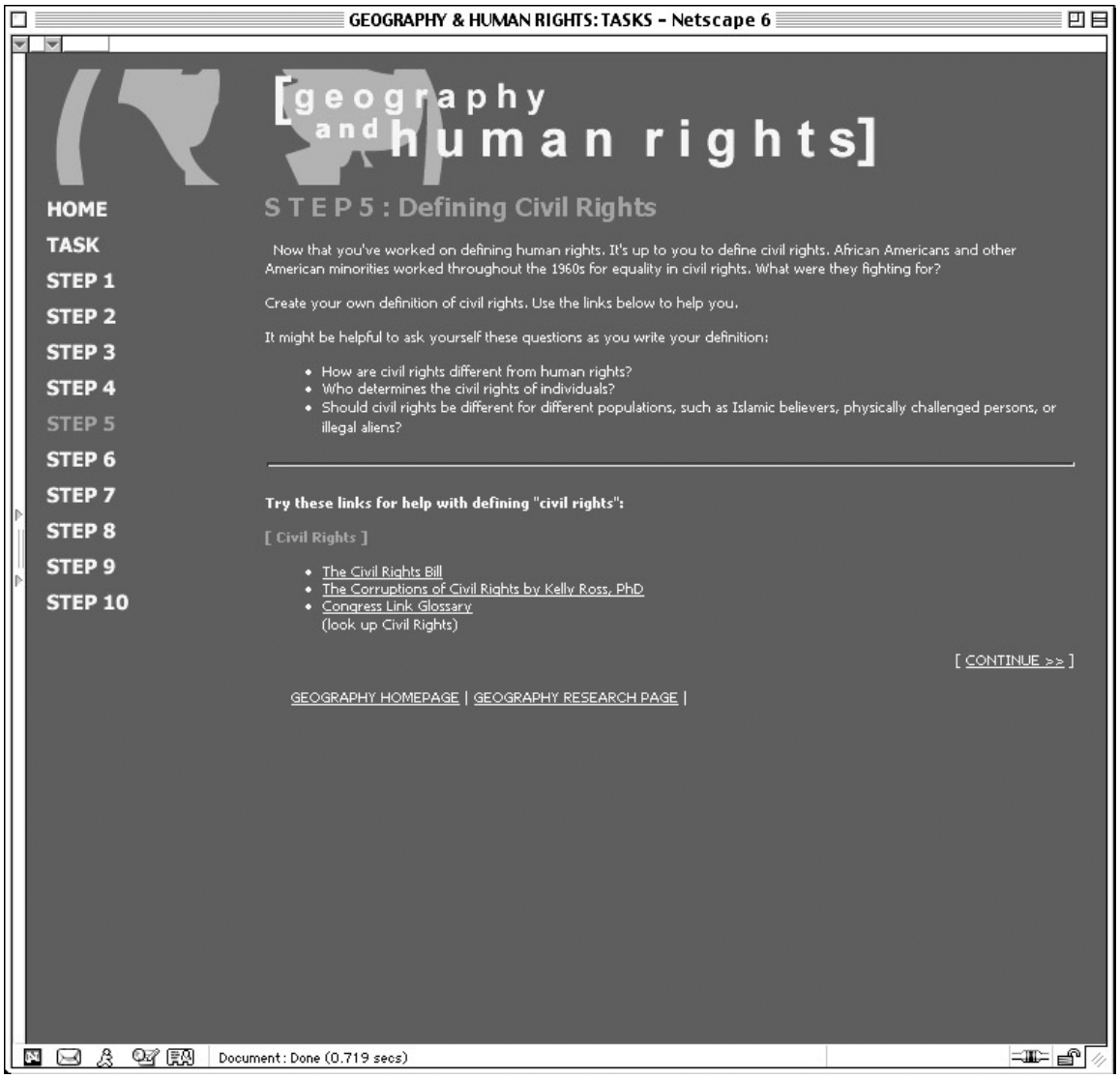
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STEP 5 : Defining Civil Rights
Now that you've worked on defining human rights. It's up to you to define civil rights. African Americans and other American minorities worked throughout the 1960s for equality in civil rights. What were they fighting for?
Create your own definition of civil rights. Use the links below to help you.
It might be helpful to ask yourself these questions as you write your definition:
How are civil rights different from human rights?
Who determines the civil rights of individuals?
Should civil rights be different for different populations, such as Islamic believers, physically challenged persons, or illegal aliens?
Try these links for help with defining "civil rights":
[Civil Rights]
The Civil Rights Bill
The Corruptions of Civil Rights by Kelly Ross, PhD
Congress Link Glossary
(look up Civil Rights)
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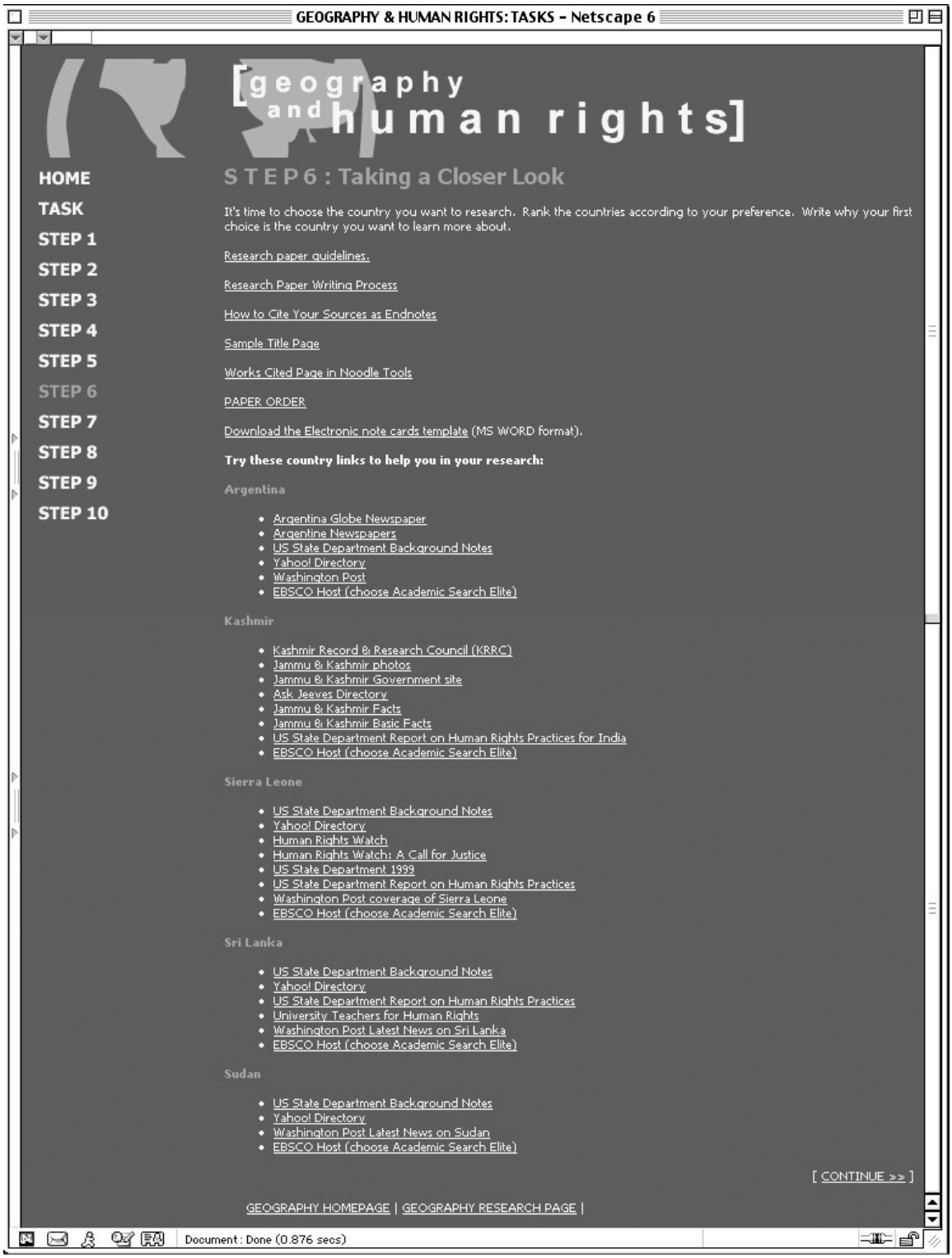
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STEP 6 : Taking a Closer Look
It's time to choose the country you want to research. Rank the countries according to your preference. Write why your first choice is the country you want to learn more about.
Research paper guidelines.
Research Paper Writing Process
How to Cite Your Sources as Endnotes
Sample Title Page
Works Cited Page in Noodle Tools
PAPER ORDER
Download the Electronic note cards template (MS WORD format).
Try these country links to help you in your research:
Argentina
Argentina Globe Newspaper
Argentine Newspapers
US State Department Background Notes
Yahoo! Directory
Washington Post
EBSCO Host (choose Academic Search Elite)
Kashmir
Kashmir Record & Research Council (KRRC)
Jammu & Kashmir photos
Jammu & Kashmir Government site
Ask Jeeves Directory
Jammu & Kashmir Facts
Jammu & Kashmir Basic Facts
US State Department Report on Human Rights Practices for India
EBSCO Host (choose Academic Search Elite)
Sierra Leone
US State Department Background Notes
Yahoo! Directory
Human Rights Watch
Human Rights Watch: A Call for Justice
US State Department 1999
US State Department Report on Human Rights Practices
Washington Post coverage of Sierra Leone
EBSCO Host (choose Academic Search Elite)
Sri Lanka
US State Department Background Notes
Yahoo! Directory
US State Department Report on Human Rights Practices
University Teachers for Human Rights
Washington Post Latest News on Sri Lanka
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Sudan
US State Department Background Notes
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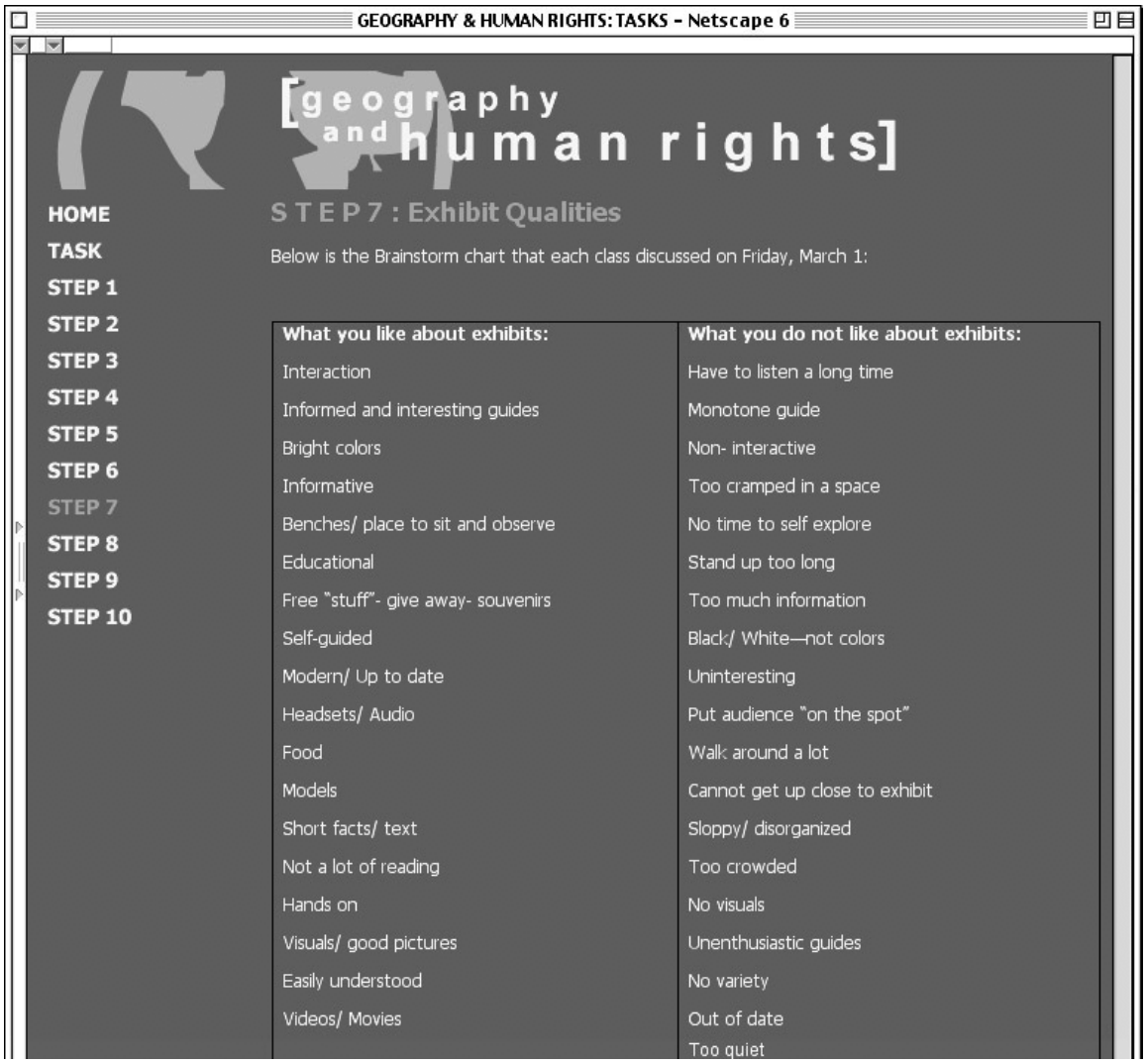
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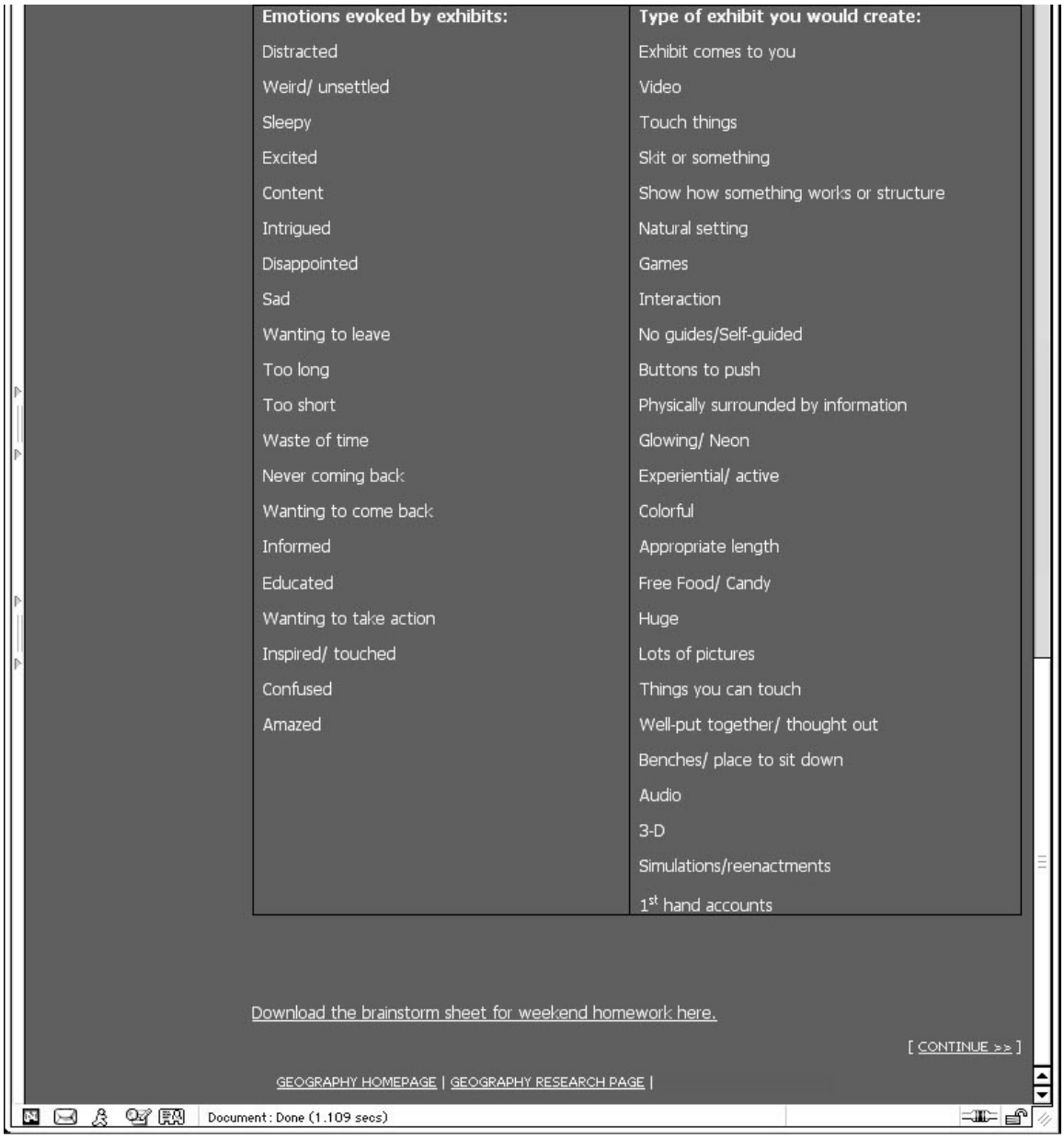
STEP 7 : Exhibit Qualities
Below is the Brainstorm chart that each class discussed on Friday, March 1:
What you like about exhibits:
Interaction
Informed and interesting guides
Bright colors
Informative
Benches/ place to sit and observe
Educational
Free "stuff"- give away- souvenirs
Self-guided
Modern/ Up to date
Headsets/ Audio
Food
Models
Short facts/ text
Not a lot of reading
Hands on
Visuals/ good pictures
Easily understood
Videos/ Movies
What you do not like about exhibits:
Have to listen a long time
Monotone guide
Non- interactive
Too cramped in a space
No time to self explore
Stand up too long
Too much information
Black/ White—not colors
Uninteresting
Put audience "on the spot"
Walk around a lot
Cannot get up close to exhibit
Sloppy/ disorganized
Too crowded
No visuals
Unenthusiastic guides
No variety
Out of date
Too quiet



Emotions evoked by exhibits:	Type of exhibit you would create:
Distracted	Exhibit comes to you
Weird/ unsettled	Video
Sleepy	Touch things
Excited	Skit or something
Content	Show how something works or structure
Intrigued	Natural setting
Disappointed	Games
Sad	Interaction
Wanting to leave	No guides/Self-guided
Too long	Buttons to push
Too short	Physically surrounded by information
Waste of time	Glowing/ Neon
Never coming back	Experiential/ active
Wanting to come back	Colorful
Informed	Appropriate length
Educated	Free Food/ Candy
Wanting to take action	Huge
Inspired/ touched	Lots of pictures
Confused	Things you can touch
Amazed	Well-put together/ thought out
	Benches/ place to sit down
	Audio
	3-D
	Simulations/reenactments
	1st hand accounts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STEP 8 : Planning and Creating Your Exhibit
Explore websites using these links.
Download the Exhibit Design Form from class Monday.
Use this checklist to help you organize your exhibit.
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STEP 9 : Evaluating the Exhibit
These are the categories that you felt were important to evaluate. Look them over and give your feedback to during class Tuesday, March 12.
All of the following categories are out of 10 points:
_____ Creativity/ Originality
_____ Information (Complete, accurate, and concise)
_____ Effort
_____ Clarity/ Organization
_____ Interactivity
_____ Visuals
_____ Quality/ Appearance
_____ Preparation
_____ Interest Level
_____ Overall Presentation
_____ Total (Grade)
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STEP 10 : The Human Rights Fair
Today's classes will be abbreviated, so that we have time to set up in the Media Center for the Fair. You will set up your exhibit during Geography class.
During the Fair you will need to stay with your exhibit as visitors come around.
Smile and have fun!
You have worked hard and done a great job!
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APPENDIX B:

ASSESSING MY MULTIPLE INTELLIGENCES INVENTORY

Assessing My Multiple Intelligences

INSTRUCTIONS: Complete each sentence below by filling in the blank with the number that best indicates your **degree of expertise** in each. Enter the number in the blank before the statement. Total the score for each intelligence in the box at the bottom of the column.

4 exceptional expertise	3 high expertise	2 moderate expertise	1 minimal expertise	0 no expertise

Verbal/ Linguistic

__ I read and understand what I've read with—
__ I listen to the radio or a spoken-word cassette and understand with—
__ I play word games like Scrabble, Anagrams, or Password with—
__ I make up tongue twisters, nonsense rhymes, or puns with—
__ I use words in writing or speaking with—
__ In my English, social studies, and history courses in school, I displayed—
__ Others have recognized that my writing shows—
__ I often convince others to agree with me with—
__ I speak in public with—
__ I use words to create mental pictures with—

☐ Total

Logical/ Mathematical

__ I compute numbers in my head with—
__ In my math and/or science courses in school, I displayed—
__ I play games or solve brainteasers that require logical thinking with—
__ I identify regularities or logical sequences in things with—
__ I think in clear, abstract concepts with—
__ I find logical flaws in things that people say and do with—
__ I categorize and analyze information with—
__ I piece together patterns from separate pieces of information with—
__ I use symbols to manipulate data with—
__ Others have recognized that my deductive ability shows—

☐ Total

Visual/ Spatial

__ I am able to use color with—
__ I use a camera or camcorder to record what I see around me with—
__ I do jigsaw puzzles, mazes, and other visual puzzles with—
__ I format and layout publications with—
__ I find my way around unfamiliar territory with—
__ I draw or paint with—
__ In Geometry classes in school, I displayed—
__ I understand what a shape will look like when viewing it from directly above with—
__ I design interior or exterior spaces with—
__ I recognize shapes regardless of the angle from which I view them with—

☐ Total

Bodily/ Kinesthetic

__ I play tennis, golf, swim, or engage in some similar physical activity with—
__ I sew, weave, or engage in some similar creative activity with—
__ I build models, do woodworking, or construct things with—
__ In activities or courses requiring physical or manual dexterity in school, I display—
__ I use gestures or other forms of body language to convey ideas with—
__ My physical coordination displays—
__ I dance with—
__ I express my feelings through physical activity with—
__ I am recognized as having physical or manual abilities that exhibit—
__ My dramatic ability shows—

☐ Total

Continued on back ☛

205 Martin Street, Clemson, SC 29634-0726 (864) 656-2599

Assessing My Multiple Intelligences

INSTRUCTIONS: Complete each sentence below by filling in the blank with the number that best indicates your **degree of expertise** in each. Enter the number in the blank before the statement. Total the score for each intelligence in the box at the bottom of the column.

4 exceptional expertise	3 high expertise	2 moderate expertise	1 minimal expertise	0 no expertise

Musical

__ I sing with—
__ I can tell when a musical note is off-key with—
__ I can sight read and sing or play a difficult musical piece with—
__ I play a musical instrument with—
__ I can hear a melody once and reproduce it with —
__ I reproduce or create intricate rhythms with—
__ I create new musical compositions with—
__ I am recognized by others as having musical talent with—
__ I direct others in creating musical selections with—
__ I "hear" the patterns of relationships within a musical piece with—

__ Total

Interpersonal

__ I provide advice or counsel to others with—
__ My ability to facilitate group work shows—
__ I make friends with—
__ I play social games such as Pictionary or Charades with—
__ When teaching another person or groups of people, I display—
__ In leading others, I exhibit—
__ My involvement in social activities connected with my work, church, or community displays—
__ I am able to understand the needs and emotions of others with—
__ I work together with others to achieve a common goal with—
__ I sense other people's motives or hidden agendas with—

__ Total

Intrapersonal/ Introspective

__ I reflect on ideas or events with—
__ I achieve personal growth by using new information with—
__ I achieve a resilience to setbacks with—
__ I have developed a special hobby or interest with—
__ I set important goals for my life with—
__ I recognize my strengths and weaknesses (borne out by feedback from other sources) with—
__ I use solitude to strengthen my inner resources with—
__ I am strong willed or independent minded to a degree that exhibits—
__ I keep a personal diary or journal to record the events of my inner life in a way that displays—
__ I seek to understand my own motivation with—

__ Total

Naturalist

__ I can see variations in leaves with—
__ I am able to identify a wide variety of insects, birds, or rocks with—
__ Using a microscope, I can see very small differences between plants or animals with—
__ I can identify the tracks and spoors of an animal with—
__ I am able to tell the difference between harmless and poisonous plants or animals with—
__ Using a telescope, I am able to identify stars, planets, and galaxies with—
__ I can plan an attractive garden that has color during all four season of the year with—
__ I am able to work with animals with—
__ I am able to classify such things as rocks or aquatic life or clouds with—
__ I am able to grow plants with—

__ Total

205 Martin Street, Clemson, SC 29634-0726 (864) 656-2599

APPENDIX C:

INTERVIEW PROTOCOL

Student Interview Protocol

Open Interview #1

1. What kinds of subjects at school do you think you're really good at?
   1.1. Which of those do you really enjoy?
2. What kinds of other activities do you think you're really good at?
   2.1. Which activities do you really enjoy?
3. What do you think are your strongest abilities?
   3.1. What do you think are your weakest abilities?
4. Tell me how you feel about using computers?
   4.1. What do you enjoy about using computers to create projects?
      4.1.1. What do you not enjoy about using computers to create projects
5. How do you feel about creating projects in general?

Open Interview #2

1. How do you feel about your project?
2. Last time you said you really enjoyed ___[insert response from Interview 1, question 1], how have you thought about incorporating that into your project?
   2.1. Why or Why not?
3. Last time you said ____ [insert response from Interview #1, Q3] were your strongest abilities. Which of those abilities are being used in your project?
4. How did you determine in what direction to go with your project?
5. Are there things you usually like to include with projects you make?
   5.1. Why?
6. What do you think determines how much of your abilities are reflected in your projects?

Open Interview #3

1. How are things going with your project?
2. You had high score in [insert areas from Multiple Intelligences Inventory]. Have you been able to use any of these abilities in producing your project?
   2.1. Can you give me an example?
   2.2. What do you think has prevented you from including these abilities?
3. Previously, you said ____ [insert response from Interview #1, Q3] were your strongest abilities. Which of those abilities are you able to use in your project?
   3.1. What has prevented you from including those abilities into your project?
      3.1.1. If so, how?
4. Last time you told me you like to include [insert response from Interview 2, #4]. Have you been able to include that?
   4.1. Why or Why not?
   4.2. Do you have any plans to try to work that in?
5. How have you incorporated what you've learned into your project?
6. If you couldn't have used a computer, what would your project have looked like?

Open Interview #4

1. What did you enjoy about completing the project?
   1.1. What did you not enjoy about completing this project?
2. What did you learn by completing this project?
   2.1. In what way or ways do you feel like the [insert artifact] that you produced reflects what you learned during this project?
   2.2. What was difficult about producing the [insert artifact]?
   2.3. What was easy?
3. How do you think this project represents you and your abilities?
4. Were you able to do what you wanted with this project?
   4.1. What things prevented you from doing what you wanted to do?
5. Why do you think you didn't use [insert abilities not mentioned]?
6. Did using the computer make it easier or harder to construct your artifact?
   6.1. Can you give me an example of why it made it [easier or harder]?
7. What would you do differently if you were to do it all over again?
8. What parts are you most proud of?
   8.1. Why?

APPENDIX D:

OBSERVATION PROTOCOL

Observation Protocol

Date: _____

Participant: _____

Observation Length: _____

Student Activities (activity occurs for at least 5 minutes)	**Computer used?**
What is the participant working on? (taking notes, collecting information, building presentation, etc.)	❑ Yes ❑ No

Observable Abilities		**Computer used?**
❑ Verbal-Linguistic (V/L) ❑ Mathematical-Logical (M/L) ❑ Visual-Spatial (S) ❑ Bodily-Kinesthetic (B) ❑ Musical (M) ❑ Interpersonal (IE) ❑ Intrapersonal (IA) ❑ Natural (N) Others: ❑ _____ ❑ _____ ❑ _____	**How is the participant exhibiting the ability?**	❑ Yes ❑ No

Student Groupings		**Computer used?**
❑ Whole class ❑ Individual ❑ Small Groups	**How is the participant interacting?**	❑ Yes ❑ No

Observation Log

Complete for each consecutive 5-minutes of observation.
Check whether the participant is working on-task or off task and which activities are being done.

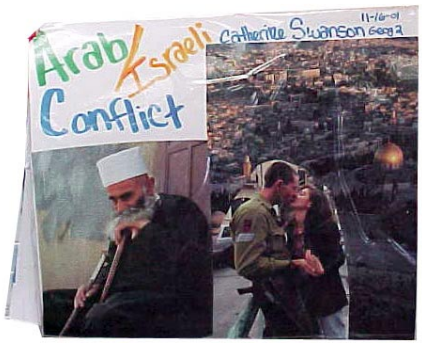
Student Activities										
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
On-task										
Off-task										
Reading										
Writing										
Completing Worksheets										
Note taking										
Research										
Information Seeking										
Data Analysis										
Problem Solving										
Project-based Work										
Delivering Presentations										
Assessment										
Discussion										

Review										
Other:										
Other:										

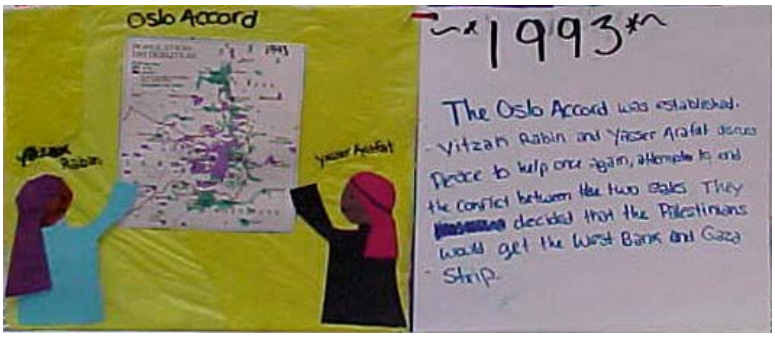
APPENDIX E:

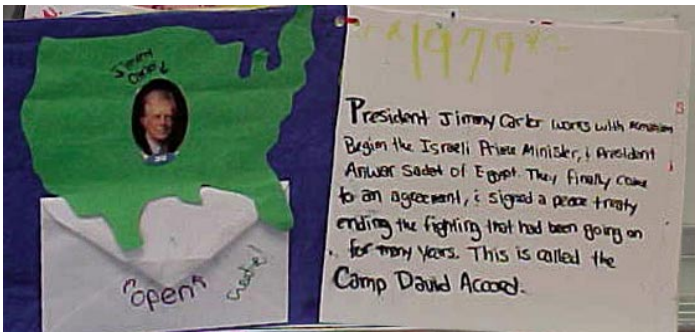
EXAMPLES OF COMPUTER MEDIATED LEARNING ARTIFACTS

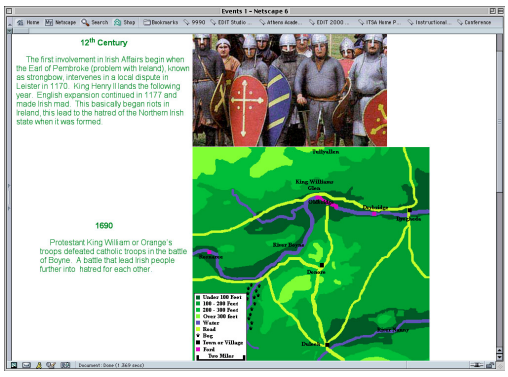
FROM PILOT STUDY



Participant 1: Sara







Participant 2: Scott

APPENDIX F:

APPROVAL FROM INSTITUTIONAL REVIEW BOARD

The University of Georgia
Office of The Vice President for Research
DHHS Assurance ID No. : M1047

Institutional Review Board
Human Subjects Office
606A Graduate Studies Research Center
Athens, Georgia 30602-7411
(706) 542-6514; 542-3199
Fax No. (706) 542-5638

APPROVAL FORM

Date Proposal Received: 2001-10-12 **Project Number:** H2002-10286-0

Name	Title	SS Number	Dept/Phone	Address	Email
Mr. Michael M. Grant	MI	250656985	Instructional Technology Aderhold Hall +7144		mgrant@coe.uga.edu
Dr. Robert Maribe Branch	CO	099482849	Instructional Technology Aderhold Hall +7153 542-9909		rbranch@coe.uga.edu

Title of Study: Individual Differences in Constructionist Learning Environments

45 CFR 46 Category: Expedite 7

Modifications Required for Approval and Date Completed:
Revised consent form.

Approved : 2001-10-26 Begin date : 2001-10-26 Expiration date : 2002-06-01

NOTE: Any research conducted before the approval date or after the end data collection date shown above is not covered by IRB approval, and cannot be retroactively approved.

Number Assigned by Sponsored Programs: **Funding Agency:**

Form 310 Provided: No

Your human subjects study has been approved as indicated under IRB action above.

Please be aware that it is your responsibility to inform the IRB . . .
. . . of any adverse events or unanticipated risks to the subjects or others within 24 to 72 hours; . .
. . . of any significant changes or additions to your study and obtain approval of them before they are put into effect; . . .
. . . that you need to extend the approval period beyond the expiration date shown above; . . .
. . . that you have completed your data collection as approved, within the approval period shown above, so that your file may be closed.

For additional information regarding your responsibilities as an investigtor refer to the IRB Guidelines.
For your convenience in obtaining approval of changes, extending the approval period, or closing your file, we are providing you with a blue Researcher Request form. Detach this blue form, complete it as appropriate, sign and date it, then return it to the IRB office. Keep this original approval form for your records.

Copy:
Dr. Lloyd P. Rieber

Chris A. Joseph, Ph.D.
Chairperson, Institutional Review Board