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Identifying Gifted Students in Science

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IDENTIFYING GIFTED STUDENTS IN SCIENCE

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Currently, there is no standard protocol to identify students who are gifted in science. If students are identified as gifted early on in elementary school, teachers and parents can foster their interest, increasing the students' knowledge, value, and affect as well as their willingness to re-engage science (Eccles & Wigfield, 2002; Gottfried & Gottfried, 1996; Häussler 1987; Neber & Schommer-Aikins, 2002; Osborne, 2003; Schunk, Pintrich, & Meece, 2008). In this study, a brief student identification form was developed for elementary school teachers to complete. The form was based on Hidi and Renninger's (2006) four-phase model of interest development. The form was one piece of a more comprehensive identification protocol.

Students in grades second, third, fourth, fifth, and sixth from six Warren County elementary schools were asked to participate in this study. However, due to insufficient data, grades two and six were not used after collection. Few sixth grade teachers completed the forms and second graders did not take the ITBS.

This study primarily focused on identifying students from underrepresented populations. These six schools, Cumberland Trace, Bristow, Lost River, Oakland, Richardsville, and North Warren, were chosen based on their larger population of students who qualify for free and reduced lunch.

In order to validate the identification form created for this study, the students' scores from the science portion of the Iowa Test of Basic Skills, an achievement measure, and the scores from each item on the student identification form were correlated. All correlations were found to be significant at the 0.01 level using a two-tailed test. Reliability was also assessed using coefficient alpha to evaluate internal consistency. Looking at grades three through five together, the Cronbach's alpha was .871, indicating a high rate of consistency among the seven items on the questionnaire. Thus, the teacher identification form created in this study was found to evidence reliable scores and demonstrate validity via significant correlations with students' scores on the science portion of the ITBS.

Overview of Project GEMS

This study is part of a larger grant entitled, Gifted Education in Math and Science (GEMS), led by Dr. Julia Roberts (Roberts, 2008). Project GEMS is a partnership between six Warren County Schools in Bowling Green, Kentucky and The Center for Gifted Studies at Western Kentucky University. This grant focuses on students who come from low-income families and are underrepresented in the disciplines of science, engineering, technology, and math. More than half of the students at the six chosen elementary schools qualify for free or reduced lunch. A goal of the grant is to develop a comprehensive identification protocol. This complete protocol includes ITBS scores, a non-verbal test of cognitive abilities (CogAT), self-report measures of student interest, and the student identification form developed for this thesis project. In addition to the development of the student identification protocol, Project GEMS will also provide professional development for 70 teachers on problem-based learning. Lastly, select students from two of the schools will attend a one-day magnet program each week (Roberts, 2008).

Literature Review

The State of Science and Gifted Programs in the United States

In 1999, the United States was ranked 17th out of 38 countries in science for the Third International Mathematics and Science Study (TIMSS) testing, which was also its ranking in 1995 (Shen, 2005). The conditions have hardly changed since 1983 when the National Commission on Excellence in Education declared the United States to be a "nation at risk." More recently, in 2003 the United States was ranked below the international average on the ability to apply scientific and mathematical concepts according to the National Science Foundation (2006), on the Program for International Student Assessment (PISA). Thus, in the United States science education is an area that needs improvement (Polzella, 1997). Before Public Law 107-110 (2002) or the No Child Left Behind Act in 2001, not many school districts assessed achievement in science. Even state and nationally mandated tests typically did not require testing in science (House & Senate, 2002).

Unfortunately, there has not been much focus on gifted programs or gifted students (Hoekman, McCormick, & Gross, 1999; Polzella, 1997). Researchers agree that the needs of gifted and talented students are not being met at school and that these students need special programs (Gittman & Koster, 2000). Due to the budget cuts and the focus on average and special needs students, there is not much time or funding left that can be devoted to gifted and talented students (Hoekman et al., 1999; Polzella, 1997). In fact, after 1981, gifted programs no longer received funding from the government (Adderholdt-Elliot, Algozzine, Algozzine, & Haney, 1991). Until the authorization of No Child Left Behind, it was not even mandated that schools should provide services for gifted students; it was left to the discretion of each state. There is no standard protocol for identifying children as advanced or gifted in general, especially when it comes to specific content areas such as science. Usually, the students chosen for gifted and talented programs are chosen by their scores on reading and mathematics; not many school districts assess achievement in science (Gittman & Koster, 2000).

Interest in a topic can play a major role in students' achievement, and Gottfried and Gottfried (1996) suggested that a measure of interest become a part of the selection process used for gifted programs. They found that gifted children had significantly higher academic intrinsic motivation than their same age peers, and suggested that gifted children enjoy the learning process more. In the study by Gottfried and Gottfried, the children they identified at age 8 as being gifted continued to display significantly greater academic intrinsic motivation through early adolescence. Additionally, Gottfried (1990) found that academic intrinsic motivation has shown to be positively related to achievement in school and intelligence. Gottfried and Gottfried (1996) as well as Hidi and Renninger (2006) reported that gifted children demonstrate higher curiosity for topics in their area of giftedness.

Moreover, Schiefele (1991) found that interest enhances learning in several ways. He found that interest enhances memory through the use of domain-specific learning strategies. It also improves the quality of the overall learning experience by influencing attention, goals, and levels of learning. Having interest for a topic leads the individual to create and use a variety of higher-level strategies in order to retain the information, which also leads to deeper learning and higher achievement (Csikszentmihalyi & Csikszentmihalyi, 1988; Lee & Brophy, 1996; Schraw & Lehman, 2001). Students tend to be higher achievers when they are interested in a subject because they put forth more effort compared to subjects that they find uninteresting (Hidi & Renninger, 2006).

Overview of Interest

The study of the concept of interest dates back to the 1800s in Johann Herbart's and John Dewey's work. Johann Herbart, a German philosopher during this time, wrote about people having divided attention or lively interest. Which state the individual was in depended on whether the person saw the task as a means to an end or whether the individual put his or her whole self into the task (Herbart, 1901). Herbart also reported that interest in a subject could promote motivation and learning. He stated interest leads to meaningful learning, storing information in long-term memory, and providing motivation for reengaging in the subject.

In the 1900s John Dewey discovered that the individual and the environment interact to create or raise interest (Dewey, 1910). Dewey thought there were three key characteristics of interest: it is active, it is based on real objects, and it has high personal meaning. Dewey believed that a student's direct interest in an activity along with the end product demanded the student's attention. He described the outcome of this process as learning for the sake of learning.

When researchers define interest today, the term is usually divided into two different categories, individual interest and situational interest. Individual interest, also called personal interest, is conceptualized as being stable and enduring (Renninger, Ewen, & Lasher, 2002; Schraw & Lehman, 2001; Schunk, Pintrich, & Meece, 2008). Individual interest is usually related to one specific topic, in contrast to curiosity. Individual interest is the state in which interest interacts with things in the environment that grab the individual's attention leading to more heightened interest (Schunk et al., 2008). Individual interest can encourage motivation and learning, and has been shown to enhance attention, recall, and recognition (Hidi & Renninger, 2006; Schunk et al., 2008). In the past, people hoped that teachers would create situational interest for students in their classes, and that over time the situational interest would turn into individual interest (Osborne, 2003; Schraw & Lehman, 2001; Schunk et al., 2008).

Early in life, children are able to identify things that interest them, but it is not until the later part of elementary school that they are able to recognize which activities they value (Schunk et al., 2008). Battle (1966) defined attainment value as the importance of achievement in a particular task for an individual, which determines how persistent one will be when working to understand a topic or subject. This is similar to the way personal interest is viewed now. Attainment value or personal interest is something that develops through an individual's experience with many different tasks and activities. The more information and tasks students are exposed to, the more the children are able to identify their value for certain topics or reasons why they enjoy performing those tasks.

In addition, there are expectancy-value theories of motivation, which also discuss engagement in activities (Schunk et al., 2008). In these theories, it is believed that both expectancies and values play an important role in predicting students' future choice behavior, engagement, persistence, and achievement. This is also considered to be a part of individual interest. If students expect that they will perform well in a specific subject, then they will be more likely to persist and/or engage in that subject compared to their peers. However, even if they expect they will do well, if the students do not value the subject, they will typically choose to pay less attention to tasks related to that subject when compared to other subjects. Plus, researchers have found that students who have higher expectancies tend to develop more cognitive strategies that increase their understanding of a topic, which is a characteristic similar to those who have a well-developed individual interest in a content area (Fredrickson, 2001; Schraw & Lehman, 2001; Schunk et al., 2008). It was also found that expectancies are closely related to achievement and engagement, while values are more highly correlated with choosing a topic and the opportunity to achieve in the future (Schunk et al., 2008).

Situational interest is sparked due to a specific situation, environmental factors, or the intensity of the topic, and not necessarily a personal interest (Jetton & Alexander, 2001; Renninger et al., 2002; Schraw & Lehman, 2001; Schunk et al., 2008). Situational interest tends to be short term and is more related to the perception of completing a task; it is often viewed as a means to an end. A common belief about interest is that if someone is not interested in a subject, then the individual will not learn the necessary information needed to succeed because he or she will not be motivated to study. However, a student may not have interest in a subject, but may possess potential situational interest for completing the task in order to obtain a desired grade. Situational interest also involves having positive affect towards the subject matter, which is a crucial component in being motivated to learn (Ainley, 2006; Jetton & Alexander, 2001; Schunk et al., 2008).

Hidi and Renninger Model

Renninger (1992) created a four-phase model of interest. Hidi and Renninger (2006) modified Renninger's original model and divided interest into two main types, situational and individual, and described each type of interest as having two phases. The first phase of situational interest is *triggered situational interest*. Triggered situational interest is defined as being attracted to a topic (see Table 1). This interest can be initiated by environmental factors, the emotional intensity of the topic, or by how relevant the topic is to the individual. Triggered situational interest is generally supported by factors outside oneself, as the locus of control is external (see Table 1). Triggered situational interest always precedes and sometimes leads to maintained situational interest. For example, if a topic or activity sparks a student's interest and the topic keeps reappearing throughout the year, this can increase the student's willingness to reengage in order to be successful in the class. A few activities that spark triggered situational interest are puzzles, computer-adapted lessons, and group work (see Table 1). When individuals display triggered situational interest, they also have positive affect for the activity, but are low in meta-cognition and do not necessarily have value or knowledge about the topic yet (see Table 2).

After researching Hidi and Renninger's Four-Phase Model of Interest Development, Wininger (2008) created the two tables below summarizing his understanding of the components of Hidi and Renninger's (2006) theory to help clarify and organize the characteristics of each phase of interest

Table 1 summarizes only what was inferred from Hidi and Renninger's four-phase model of interest development, including defining characteristics, the locus of the interest, and the means of support that characterizes each phase of interest.

Table 2 is based on, but expands upon Hidi and Renninger's model of interest. Table 2 summarizes the potential states of interest, including indifference, triggered situational, maintained situational, emerging individual, well-developed individual, and noninterest. Table 2 summarizes which states students display positive emotions, value, knowledge, and meta-cognitive strategies. After creating Tables 1 and 2, Dr. Wininger, the thesis advisor, called Dr. Hidi to verify the interpretation of the four phases of interest development, and she did not suggest any changes (S. Hidi, personal communication, April, 27, 2009). This was done to ensure that the interpretation of Hidi and Renninger's model of interest was accurate, because the items on the teacher identification form were based these tables.

Table 1

Key Characteristics of the Four Phases of Interest Development

Phase	Defining characteristics	Locus of interest	Means of support
Triggered Situational	Catching one's attention; "attraction"	External	Puzzles, computer-adapted lessons, group work
Maintained Situational	Sustained attention via meaningfulness or personal involvement	External	Project-based learning, cooperative learning, one-on-one tutoring
Emerging Individual	Positive feelings towards, knowledge of, and value for a topic; self-generated curiosity	Internal	Learning is typically self-motivated but still requires instructional support from teachers and encouragement when confronted with difficulty
Well-developed Individual	Positive feelings towards, knowledge of, and value for a topic; self-generated curiosity; "increased" knowledge	Internal	Learning is typically self-motivated and is characterized by effortless learning, more advanced learning strategies, and perseverance when confronted with difficulty

Table 2

Six Potential States of Interest

	Positive Emotions	Value	Knowledge	Meta-cognitive
Indifference	Absent	Absent	Absent	Weak
Triggered situational	Present	Absent	Absent	Weak
Maintained situational	Present	Present	Absent	Weak
Emerging Individual	Present	Present	Present	Moderate
Well-developed individual	Present	Present	Present	Strong
Noninterest	Absent	Absent	Present	Absent

The second phase of situational interest is *maintained situational interest*. Maintained situational interest develops from triggered situational interest, and it requires an extended amount of attention (Hidi & Renninger, 2006). Unlike triggered situational interest, maintained situational interest involves the individual having value for the topic (see Table 2). Maintained situational interest is continued through personal attraction to a topic, and is generally supported by factors outside the individual. For example, people have relied on teachers to use materials and lesson plans, such as field trips and more hands-on activities as opposed to readings and worksheets, to help students maintain interest regarding a particular subject or activity, or by modeling their own enthusiasm of the topic for their students (Osborne, 2003; Schraw & Lehman, 2001; Schunk et al., 2008).

Schools can provide group activities that can contribute to maintaining this interest, such as project-based learning, cooperative learning, one-on-one tutoring, group work, or clubs (Hidi & Renninger, 2006; see Table 1). Maintained situational interest may lead the individual to keep coming back to a particular topic over time (Renninger, 1992). For example, if the situational interest is maintained throughout the year in coursework, the individual has the potential to develop individual interest in the topic. The more an individual learns about a topic, the more one has the opportunity to find something about it that may develop into individual interest.

The second main type of interest is individual interest. Like situational interest, individual interest also has two phases. *Emerging individual interest* is the first phase, which is characterized by positive affect, stored knowledge, moderate use of meta-cognitive strategies, and value for a topic (Fredrickson, 2001; Hidi & Renninger, 2006; Jetton & Alexander, 2001; Schraw & Lehman, 2001). Based on previous exposure to a topic, an individual values re-engaging in tasks that are related to one's personal interest, and prefers these tasks to others (Fredrickson, 2001; Schraw & Lehman, 2001; Schunk et al., 2008).

When one is developing individual interest, the individual generally develops questions or curiosity that prompts the individual to go beyond the basic requirements for the task or assignment (Gottfried & Gottfried, 1996; Hidi & Renninger, 2006). For example, individual interest leads an individual to research a topic in more depth than what is required to complete an assignment. The individual may need encouragement from others to continue developing the interest when the difficulty of the task increases, but, unlike situational interest, the locus of interest for this state is internal (see Table 1).

The second phase of individual interest is *well-developed individual interest*, which is characterized by positive affect, as well as an increase in stored knowledge and value (Hidi & Renninger, 2006; Jetton & Alexander, 2001; Renninger et al., 2002;

Schraw & Lehman, 2001). Well-developed individual interest is exemplified by deeper level meta-cognitive strategies one uses to complete tasks and retain information (see Table 1). When an interest is well developed, one will display a preference for reengaging in tasks involving that topic more often than tasks or activities related to something else (Hidi & Renninger, 2006; Jetton & Alexander, 2001; Renninger et al., 2002; Schraw & Lehman, 2001). As with emerging individual interest, people who display well-developed individual interest often generate questions out of curiosity and search for answers about the specific topic of interest without being prompted to do so. When the answers are not simple, the individual does not give up easily, but persists and continues to search for the information. This persistence is the main difference between emerging individual interest and well-developed individual interest. Well-developed individual interest is generally self-generated. Self-regulation regarding individual interest often includes setting goals in order to measure one's progress, the more progress one makes; the more motivated the student feels (Jetton & Alexander, 2001; Schunk et al., 2008). Typically, more meaningful learning takes place when it is self-regulated, leading to higher achievement (Brophy, 2008).

Additional Models of Interest

Though the Hidi and Renninger Model has been chosen as the basis for the teacher identification form created during this project, there are several different models of interest. For example, Lee and Brophy (1996) created different categories for motivation; intrinsically motivated to learn science, motivated to learn, intrinsically motivated but inconsistent, unmotivated and task avoidant, and negatively motivated and task resistant. However, they did not explain each type of interest as having two phases (triggered vs. emerging interest and maintained vs. well developed interest).

Ainley (2006) acknowledged that Hidi and Renninger (2006) had developed a four-phase model of interest. However, in her own research, Ainley only talked about two phases of interest: triggered situational interest and well-developed individual interest, leaving out maintained situational interest and emerging individual interest. Moreover, neither of the models by Ainley or Lee and Brophy discussed the sequential order of the interest process. An individual may start in the stage of triggered situational interest and eventually develop well-developed individual interest. These models also failed to discuss the differences between each level of interest, such as perseverance and whether the locus of control is internal or external. Ainley's model also does not address the fact that personal interest rarely arises without possessing situational interest for the topic at some point.

Despite the different models, researchers tend to agree on two main types of interest (situational and individual) and that students who are interested in a specific topic will display positive affect toward the topic or activity (Ainley, 2006; Lee & Brophy, 1996; Schiefele, 1991). Hidi and Renninger's (2006) model is found to be the most comprehensive, because it describes interest as a process. Both types of interest grow over time through learning more about the subject by re-engaging in activities related to the particular subject. While most researchers only talk about the two main types of interest, Hidi and Renninger describe both situational and individual interest as having two phases and a sequential order. Moreover, Hidi and Renninger's model incorporates classroom suggestions to help educators increase and encourage their students' interest.

Existing Measures of Individual Interest

Researchers that have studied individual interest in the past have typically used self-report methods, such as questionnaires and checklists in which the individuals rated their own interest on different topics using a Likert scale (Gottfried & Gottfried, 1996; Häussler, 1987; Jetton & Alexander, 2001; Neber & Schommer-Aikins, 2002; Osborne, 2003; Patrick, Mantzicopoulos, Samarapungavan, & French, 2008; Renninger, 1992; Schunk et al., 2008; Wicker, Brown, Wiehe, & Shim, 1990). A downside to self-report measures is that some students may lack the self-awareness to be able to identify which subject interests the individual the most (Schunk et al., 2008).

Wicker et al. (1990) stated that free-choice time, the amount of time participants spent on a task during free time, is another common method of measuring interest. A limitation of free-choice time measures is that the researcher may not be getting an accurate measure of what the individual is actually interested in. If an individual is given the choice between two or three activities, the individual will most likely pick the activity that he or she is most interested in out of the given choices. But if an activity that reflects the individual's true interest is not one of the choices made available for the individual to choose, then the researcher still does not know which topics the individual is truly interested in. The student may simply be choosing the more tolerable choice.

No teacher rating scales for individual interest in science were found during the review of the literature; however, they can be more valuable than self-report forms (Gittman & Koster, 2000; Kolo, 1999; Schunk et al., 2008; Tuan, Chin, & Shieh, 2005). Teachers spend a lot of time with their students and are able to recognize when students are enthusiastic about an activity, even when the students may lack self-awareness.

Gittman and Koster (2000) and Tuan et al. (2005) found that using teacher checklists and achievement tests tend to be more reliable than just achievement tests alone when identifying gifted and talented students. Tuan et al. created a teacher checklist measuring student motivation which had a 0.41 correlation with junior high students' current science achievement, and a 0.40 correlation with the students' achievement from the previous semester.

Purpose of Current Study

The purpose of this study was to develop a teacher identification form that will help with the early identification of underrepresented students who have higher levels of interest in science. Hidi and Renninger's (2006) four-phase model of interest guided the creation of the items for the teacher identification form. In order to validate the teacher identification form, scores from the form were correlated with the students' scores on the science portion of the Iowa Test of Basic Skills (ITBS). The same students who were identified as interested in science by their teachers should be the same students who scored higher on the ITBS.

The identification form is being used in elementary schools, which is an additional benefit because as students age, they are losing interest in science (Eccles & Wigfield, 2002; Gottfried & Gottfried, 1996; Häussler 1987; Neber & Schommer-Aikins, 2002; Osborne, 2003; Schunk et al., 2008). Using the identification form created, students will have the opportunity to be identified early on in school, allowing them the chance to be placed in gifted and talented programs that will foster their interest throughout their schooling.

Method

Participants

Six of the 13 elementary schools in Warren County, Kentucky participated in this project. For the six schools participating, the identification form was administered to the third, fourth, and fifth grade teachers. Between the six schools, there were 26 teachers who completed the forms, 12 third grade teachers, eight fourth grade teachers, and six fifth grade teachers. In total, 1,392 students were rated, 497 third graders, 479 fourth graders, and 416 fifth graders.

Materials

Teacher identification form item development.

The four-phase model of interest developed by Hidi and Renninger was used to guide item development. After reviewing the literature about interest, the four-phase model was found to be the most comprehensive. Based on factors identified in Tables 1 and 2, seven items were developed to identify students who displayed the characteristics of being interested in science. Initially one item per characteristic was created, but four items did not seem to provide enough information to obtain accurate student ratings. These items are targeting the characteristics displayed in students who have personal interest for science, such as, positive emotions, knowledge, value, and meta-cognitive strategies (see Table 2). Particularly, Item 1 assesses positive emotion, a component of all forms of interest (see defining characteristics in Table 1 & emotions in Table 2). Item 2 assesses knowledge, a component of emerging and well-developed individual interest (see defining characteristics in Table 1 and knowledge in Table 2). Item 3 assesses value, a component of maintained, emerging, and well-developed interest (see defining characteristics in Table 1 and value in Table 2). Item 4 assesses confidence, an aspect of meta-cognitive characteristics with predictions of higher levels of confidence for persons in higher stages of interest development (see Table 2). Item 5 assesses curiosity, which is a defining characteristic of both emerging and well-developed individual interest (see Table 1). Item 6 assesses learning strategies employed, which is another aspect of meta-cognitive characteristics with predictions of more sophisticated strategies for persons in higher stages of interest development (see "means of support" in Table 1 and meta-cognitive in Table 2). Item 7 assesses perseverance in the face of difficulty for subject related tasks; this is a defining characteristic of persons with well-developed individual interest (see means of support in Table 1).

Scoring

The student identification form follows a five-point scale, teachers are asked to identify the top five students in their class for each item who are perceived as being interested in science (see Appendix A). A student will receive five points every time he or she is rated as number one or is perceived as the most interested for the quality being assessed. Ratings of five will also be given to any student who is in an accelerated science class, meaning that the students were enrolled in lower grades but were in a higher grade for science class, as an advanced placement. A student will receive four points if the teacher rated the student number two, three points if the teacher rated the student number three, two points if the student was rated number four, one point if the student was rated number five, and zero points if the student's name did not appear on the form. There are seven items on the form, thus composite scores can range from 0, if the student's name does not appear on any of the items, to 35, if the student is listed as number one on every item.

Piloting

Before collecting data in October 2009, pilot data were obtained in the spring of 2009 on both the science portion of the ITBS and the student identification form using the same six schools that will be used in October 2010. From the pilot results, a few things were changed that caused problems with the data. For instance, all of the items are now on one page. The items were previously listed on two pages, and some of the teachers did not realize there were more items on the back of the form, leaving them unanswered. The teachers are now being asked to write "UTA" if they are unable to answer a question, instead of just leaving it blank. This indicates that the question was not simply overlooked.

Another problem with the original version was that teachers were identifying students who were advanced a grade level in science, and even though the student was in that science class, he or she was not technically in the grade taught by that teacher. Sometimes both the primary teacher of the student and their science teacher would rate the student on their forms. On the revised form, a letter was attached to the identification form instructing the teachers who have advanced students in their science classes to list them below on the instruction sheet itself, instead of considering those students on the rating form (see Appendix B). This way, the student is not being overlooked or being rated twice on the same questions by two different teachers. Because these students have been placed in advanced science classes, they are automatically given a score of five points for each item on the teacher identification form.

An additional problem with the forms was the number of students chosen per classroom. Initially, teachers were asked to only name the top three students of their classes, which limited the selection of students since the aim is to identify the top 15 students of each grade. Plus, some of the elementary schools group their classes by ability. In these schools, it seemed unfair to ask the teachers of high ability classes to only name the top three students from their class, as this would limit the variety of students who are high achieving. Thus, the number of students teachers were asked to identify was changed from three to five.

Iowa Test of Basic Skills- Science

The ITBS is an achievement test that measures aspects of earth, life, space, and physical science as well as scientific inquiry, and is published by the Riverside Publishing Company (Hoover, Dunbar, & Frisbie, 2006; Iowa Testing Programs, 2009). Within these subjects, the ITBS tests both the principles of the topics as well as the scientific processes. The ITBS is normed for use in kindergarten through the eighth grade. It yields information about the specific student's achievement and how it compares to the 2005 national norms.

Both the reliability and validity for the ITBS are good. Lane (2004) noted that the ITBS was developed to correspond with instructional goals common within the nation, which contributes to the test's high content validity. Using the Kuder-Richardson formula, the total internal consistency reliability coefficient for the ITBS is .943 (Gonzalez & Tinajero, 2005). The total test-retest stability coefficients over an interval of one year for the Iowa Test of Basic Skills range from .70 to .90, and both alternate forms and internal consistency coefficients ranged from .80 to .90 (Canivez, 2000).

Procedure

After gaining the approval of the Human Subjects Review Board (see Appendix C), the first step was to give the teachers the student identification form and a cover page with directions. On the cover page, there is a statement explaining that by completing the identification form, the teachers are giving implied consent for this study. The instructions ask each teacher to rate no more than the top five students for each item, and to write "UTA" if the teacher was unable to identify a student. Forms were collected in October 2009. A rating was computed for each student that ranged between 0 and 35. These scores were correlated with the students' ITBS Science scores from the spring of 2009.

Results

Data were collected from six elementary schools in Warren County for students in grades two through six. However, for the purpose of this project, only the data for grades three through five were included in the data analysis. The second grade data were excluded because there were no reported Iowa Tests of Basic Skills (ITBS) Science scores for students in that grade, and as a result, there was nothing to compare the data against. Only three schools reported teacher interest questionnaire scores for their sixth grade students, making the data set for that grade level incomplete. This could be due to the fact that teachers were aware that the questionnaire was going to be used for identification purposes, and the sixth grade students would not have the opportunity to participate in the magnet school or problem-based learning groups set up by Project GEMS the following year.

One school reported data for three third grade classes and then data for only one teacher for the fourth through sixth grades. Another school reported data in a similar fashion, three third grade classes and then one fourth and one fifth. These differences are due to the fact that some schools group their students by ability and others maintain mixed ability grouping through all grade levels. There are even differences within the schools, for the grades that used ability grouping; students were broken down into groups by ability, resulting in more classes for the third grade as well as smaller class sizes. Three teachers from Oakland, three from Cumberland Trace, eight from Bristow, six from Lost River, three from North Warren, and six teachers from Richardsville Elementary school participated in this study.

As indicated in the instructions to the questionnaire, teachers were supposed to list students who were accelerated in their class on the bottom of the instructional page, separate from the other student ratings. One third grade student was rated as accelerated by a fourth grade teacher and was also rated on his third grade teacher's form. The 3rd grade teacher's ratings were discarded and this student was given ratings of 5 on all of the items; the protocol for students identified as accelerated. The other students in the third grade class were given their original ratings by the third grade teacher. It is hard to argue that what is being rated when a student is listed as accelerated is a complete and valid indicator of interest. This is not assessing all of the components of a student's interest in science, and is more heavily weighted for classroom achievement and aptitude. It is important to note though, that one objective of the GEMS project is to identify gifted and talented students to attend problem based learning classes and/or a magnet school. Thus, it is important to provide some mechanism for providing scores for accelerated students who are not in class with their same grade peers and for whom the grade level teacher does not have direct subject-specific experience with on a daily basis. It may be important to note that accelerated ratings did not affect the present study to a large degree, because there was only one student rated in all three grades who was rated as accelerated.

The data were grouped by grade in order to complete the data analysis. This was done for several reasons. There was a different form of the ITBS for each grade level to account for developmental differences and the differences in material the students were learning. The data were also grouped by grade level to see if there were some grades in which teachers were better able to identify students who were gifted and talented in science. Interest in science looks different at different ages and there may be several grades where the teacher identification form and the ITBS scores were more highly correlated than others. Looking at the correlations between the teacher identification forms and the students' scores in the science portion of the ITBS, Grade 4 had the highest correlation, followed by Grade 5, and then Grade 3. However, all correlations were relatively high.

A frequency analysis was performed with data from all grades, and a logical sequence emerged; that is, more students were ranked on the number one item than the number two item and so on. While it would be ideal for the frequency analysis to be identical across the items and grades, this was not the case because some teachers did not fill out all five blanks provided for each item. Also, because adjustments were not made for the other students' scores in the third grade class in which one student was rated on several of the items and then again as accelerated by his fourth grade science teacher, this particular grade's frequency analysis did not follow the same sequence. Specifically, this impacted the frequency analysis of items one and four. For example, on Item 1 there were 30 students given a score of 5, 27 students given a score of 4, 28 students given a score of 3, 26 students given a score of 2, and 24 students given a score of 1. This particular student was given a ranking of 4 on Item 1 and when we used his accelerated ranking instead, it threw off the sequence here as well. Additionally, accelerated students who were given scores of 5 across all items made the frequency analysis of scores of 5 appear inflated, because there were more students with a rating of 5, than of 4, 3, 2, or 1.

Table 3 shows means and variance of ITBS science scores for students from the six schools in Warren County based on grade level. According to the University of Iowa website, standard scores reported by the test represent a student's achievement level along a continuum and should be interpreted in reference to other students' scores in the same grade. The University of Iowa also reports that standard scores were developed by assigning a score of 200 to the median performance of students in the fourth grade, and a score of 250 to the median performance of eighth grade students (Iowa Testing Programs, 2009). The scores from the ITBS are primarily used for educational interpretations, focusing on grade equivalent scores and percentile ranks. Riverside does not provide standard deviations for the normative sample, and the standard scores listed above are the only standard scores Riverside gives for the ITBS. This makes it difficult to compare the students from Warren County to the norm sample in terms of standard scores.

Item correlations with the item total composite for the third grade data ranged from .407 to .750, indicating relatively high consistency among items. The only item that did not correlate as well with the others was Item 5. When all items were included, the overall Cronbach's alpha was .875 for the third grade data. A Cronbach's alpha this high indicates that the questionnaire was a reliable measure of student interest in science. Comparing the correlations from the "Cronbach's Alpha if Item Deleted" column to the overall third grade Cronbach's alpha of .875 shows that the deletion of Item 5 would increase the overall alpha to .889. If Item 5 were deleted, it would improve the form's internal consistency, but the item was kept because the increase would have been minimal.

Table 3

Students' ITBS Science Scores for Warren County Students

Grade	Mean	Std. Deviation
3	171.97	19.52
4	182.22	21.36
5	202.43	26.47

In Tables 4, 5, and 6, two types of correlations are presented for individual items. The corrected item-correlation refers to the degree to which each individual item relates to the other six items. The heading, Cronbach's Alpha if Item Deleted, indicates what the impact of removing a specific item would be on the total reliability of the form. The tables are divided by grade level.

Table 4

Third Grade Item Analysis Statistics (Overall $\alpha = .875$)

Item Number	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
1	.615	.863
2	.732	.847
3	.750	.845
4	.748	.845
5	.407	.889
6	.727	.848
7	.628	.861

When looking at the composite score including all items for fourth grade students, the Cronbach's alpha was .872, indicating that overall, the seven items together on the questionnaire were reliable for the intended purpose. The deletion of Item 5 would increase the overall alpha slightly to .886. The item was kept because the increase in internal consistency would be minimal.

The range of corrected item-total correlations for the fifth grade was from .465 to .767. These correlations were similar across items, and all were in the mid to high range, indicating consistency among items. The overall Cronbach's alpha for the fifth grade was .876. Once again, Item 5 slightly lowered the reliability. The overall reliability for all seven items across all three grades was .871, indicating good internal consistency across the three grades.

Table 5

Fourth Grade Item Analysis Statistics (Overall α = .872*)*

Item Number	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
1	.684	.849
2	.707	.846
3	.544	.867
4	.735	.842
5	.401	.886
6	.754	.840
7	.737	.842

Table 6

Fifth Grade Item Analysis Statistics (Overall α = .876)

Item Number	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
1	.603	.865
2	.767	.843
3	.722	.849
4	.708	.851
5	.465	.882
6	.617	.863
7	.723	.849

Table 7 displays the correlations between each individual item from the teacher identification form with the students' ITBS science scores by grade. All correlations in Table 7 were found to be significant at the 0.01 level using a two-tailed test. All correlations across the grades were similar in strength, except for the correlations with Item 5, which varied across the grades.

A composite teacher rating score was computed, which included the scores from all seven items on the questionnaire. This composite score was correlated with the students' ITBS science scores for each grade to obtain an overall picture of how well the teacher rating form correlated with science achievement. All three of these correlations were found to be significant at the 0.01 level using a two-tailed test.

Table 7

Individual Item Correlations with ITBS Science Scores

Item Number	Grade 3	Grade 4	Grade 5
1	.210	.231	.255
2	.309	.376	.346
3	.301	.294	.316
4	.272	.339	.273
5	.081	.206	.163
6	.288	.402	.313
7	.294	.293	.337
Composite Teacher Rating	0.341	0.413	0.382

Discussion

There was previously no current protocol for identifying students who are gifted in science. Through this study a student identification form for teachers to complete was developed. This form is part of a more comprehensive protocol, which includes a self-report measure of interest, a science achievement measure, and a nonverbal cognitive assessment. This process was used to ultimately select students to attend a magnet school one day each week.

Before the actual administration of this form, it was piloted the semester before. Using the pilot information, several changes were made prior to collecting data because some teachers misinterpreted the directions and did not properly complete the forms. The final version of the form included an instructional letter along with the one page form.

Data revealed that the form yielded reliable scores and that scores from the form demonstrated evidence of validity via relationships with science achievement. The reliability of the scores was examined through corrected item correlations and Cronbach's alpha if item deleted statistics, broken down by grade level. The high corrected item correlations indicated a high level of consistency between most of the items with range starting at 0.401 and going to 0.767. Item 5 is the only item that did not correlate as high with the other items. This was true across grade levels. This is most likely because Item 5 requires teachers to rate the curiosity of students, which is more of an intrinsic trait and is harder to directly observe than the traits rated on the other six items. When examining the Cronbach's alpha for each grade, the third grade had a Cronbach's alpha of .875, .872 for the fourth grade, and an alpha of .876 for the fifth grade. Looking at grades three through five together, the Cronbach's alpha was .871, indicating a high rate of consistency among the seven items on the questionnaire.

With regards to validity evidence, all correlations between each item and the scores from the ITBS science subtest were found to be significant at the 0.01 level using a two-tailed test, ranging from 0.081 to 0.402. All correlations across the grades were similar in strength, except for the correlations with Item 5 which varied across the grades ranging from 0.081 to 0.206. Additionally, the composite teacher rating score, which included the scores from all seven items on the form, was correlated with the students' ITBS science scores for each grade to obtain an overall depiction of how well the teacher rating form correlated with science achievement. All three of these correlations were found to be significant at the 0.01 level using a two-tailed test, ranging from 0.341to 0.413.

When examining the data, a logical sequence in the frequency analyses was expected to emerge. It was anticipated that the number of students who received five points would be higher than the number of students who were awarded four points and so on. However, there were several reasons why the sequence did not follow this order. First, some teachers did not fill out all of the blanks. Second, two teachers rated one particular student differently. In this case, even though the student was taken off one of the forms, the other students' scores were not adjusted. Additionally, the scores of students who were given all scores of five seem magnified because there were several students rated as accelerated and there is not an even number of students who received all fours, threes, twos, and ones.

The literature stated that teachers are a valuable resource when examining giftedness. Gottfried and Gottfried (1996) suggested that a measure of interest become a part of the selection process used for gifted programs, because interest in a topic can play a major role in students' achievement. Teachers spend a lot of time with their students and are able to recognize when students are enthusiastic about an activity, even when the student may lack self-awareness. When researching giftedness in the areas of reading and mathematics, Gittman and Koster (2000) found that using teacher checklists and achievement tests tend to be more reliable than just achievement tests alone when identifying gifted and talented students. This is confirmed in the study conducted by Tuan et al. (2005). Hence, a teacher identification form is used in the present study as one indicator for identifying students who are gifted in a specific subject area.

Moreover, other researchers found that interest in a topic leads the individual to create and use a variety of higher-level strategies in order to remember the information, leading to deeper learning and higher achievement, and improves the overall quality of the learning experience (Csikszentmihalyi & Csikszentmihalyi, 1988; Lee & Brophy, 1996; Schiefele, 1991; Schraw & Lehman, 2001). Students tend to be higher achievers when they are interested in a subject because they put forth more effort compared to subjects that they find uninteresting (Hidi & Renninger, 2006). These assertions are consistent with the high correlations found in this study between student scores on the science portion of the ITBS and scores from the teacher identification forms.

A downside to self-report measures is that some students may lack the self-awareness to be able to identify which subject interests them the most, but a teacher may be able to see the enthusiasm through the student's participation in class (Schunk et al., 2008). However, one strength of this form is that it is completed by teachers, and not completed by students. As mentioned earlier, teachers spend a lot of time with their students and are able to recognize when students are interested in an activity through their behaviors and affect. Additionally, the seven dimensions used in this study are tapping into the behaviors that teachers are better able to assess simply because of their knowledge of how all the students in their class are reacting to the material in science class as opposed to just one student.

Another strength of this form is that it is based on Hidi and Renninger's (2006) model of interest. The self-report Likert forms previously mentioned were not based on a specific theory of interest, but on the researcher's perceptions of interest.

An additional strength of this form is the high correlations between the teacher identification form and the ITBS scores. When the teachers completed the identification forms, they had known the students for less than three months. The consistency between the teacher's responses and the ITBS scores allows teachers who have not known students long an accurate way to identify someone who is interested in science, and possibly gifted in the area, when using the form created in this study.

One limitation of this study is that the teacher rating forms are based on teachers' opinions. The items do not ask cut and dry, objective questions. However, the correlations between the student identification form and the ITBS indicates that this identification form is highly reliable. Another limitation of the study is that Item 5 in particular seems to be asking teachers to rate something that is hard to directly observe. For example, if a student is very curious about the topic, but too shy to ask questions in class, the teacher's observation of that student's curiosity may not be accurate. Teacher and student self-report forms might be used together in the future to gain a better overall picture of a student's interest. It would also be interesting to determine whether scores of the student self-report forms and the scores from the teacher identification forms would be positively correlated on Item 5.

Another limitation is the generalizability of this form. It was only used with a small population of students in Warren County, Kentucky and should be tested in other counties and states to determine whether it would be valid for identification purposes and whether it would yield reliable scores with different populations. Also, it would be beneficial to examine whether this form would perform equally well for other elementary grade levels.

A third limitation of this study is that the students took the ITBS the spring before the teacher identification form was given for the teachers to complete. It is nearly impossible to know whether the teachers had knowledge of the ITBS scores. However, the teachers were never told that the scores from their forms were going to be correlated with the students' scores on the ITBS, so other than curiosity or classroom performance, the teachers did not have incentive to look at the students' scores, and it is unlikely that they referenced the ITBS scores when completing the form. Additionally, it would have been impossible for us to wait and correlate the scores from the teacher identification form with the scores from the students' ITBS scores from the spring of 2010, because this is when the chosen students began going to the magnet school one day each week.

A fourth limitation if this study is that teachers were asked to complete the student identification forms in October. Teachers had known the students for less than three months when they were asked to complete this form, which did not allow much time to get to know the students, their behaviors, and their interests.

Future research may want to focus on inter-rater reliability using these forms. Even though the teachers' ratings correlated highly with the students' science scores, the consistency of ratings between teachers was not measured. Another suggestion for future research would be to offer a brief instructional training for teachers on how to complete this form. As seen in this study, even when an instructional letter was attached to the teacher identification form, there were still a few teachers who did not follow the directions exactly as requested. A training session would hopefully alleviate this confusion so that teachers complete it consistently.

Another idea of future research would be to conduct a similar administration of the ITBS and teacher identification forms and to test reliability using re-test correlations of the teacher identification forms. This would determine whether the correlation between the teacher identification form and the ITBS would be even higher if teachers were given more time than just two to three months to get to know their students before asked to complete the identification form. Correlations are already high between teacher identification forms and the students' scores on the ITBS, and it would be interesting to see how the correlation would change if the teachers were given more time with their students before completing the form.

Previously there was no standard protocol for identifying children who are gifted in science. Through this study, one piece of a larger identification protocol was developed. A theoretically driven student identification form was created and found to evidence reliable scores and to correlate at a significant level with students' scores on the science portion of the ITBS. Using this measure, teachers will be able to identify students who are gifted and talented in science earlier and more accurately, allowing the students to receive specialized instruction in science that will foster their interest, ultimately leading to increases in academic achievement.

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APPENDIX A

Teacher Identification Form

Student Identification Form: Science

1) Which students demonstrate the most positive affect (enjoyment or excitement) towards Science?
1.______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

2) Which students know the most about Science?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

3) Which students value learning about Science most (the importance or usefulness of)?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

4) Which students are most confident in their Science abilities?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

5) Which students demonstrate the most curiosity about Science?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

6) Which students demonstrate the most advanced learning/problem-solving strategies for Science?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

7) When confronted with difficulties (i.e. challenging problems), which students are most likely to continue working on the Science problem?
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

APPENDIX B

Cover Letter

Dear Teacher:

The attached forms are part of the identification process for the GEMS project.

For the questions on the attached form, please list in order no more than the top 5 students from your class(es). Only include students who are currently enrolled in the grade you teach. If you have any accelerated students in your class from lower grades please list their names at the bottom of this form; do **not** include them in identification questions 1-7.

Please be as objective as possible. Try not to allow any positive or negative biases you may hold for specific students to interfere with your evaluations. If you are unable to answer a question please indicate with **UTA**, rather than guessing or putting names just to complete the question.

Grouping scenarios and how to use the identification forms

1) If your school uses ability grouping to assign students to classes, then only the teacher for the upper ability group class should complete the form(s).
2) If your school has heterogeneous classes but one teacher teaches all of students in a specific grade, then only that teacher should complete the form. In addition, this teacher should only complete one form considering all students in a specific grade.
3) If your school has heterogeneous classes and multiple teachers teach the classes, then each teacher should complete a form considering all of the students they teach that subject to in that specific grade.

Your willingness to complete this form indicates your implied consent.

Your time and participation is appreciated!

Steve Wininger, Ph.D.
GEMS Evaluator

List accelerated students in your class from lower grades:

	Circle subject(s) for acceleration
______________________________	Math Science
______________________________	Math Science
______________________________	Math Science
______________________________	Math Science

APPENDIX C

HSRB Approval

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HUMAN SUBJECTS REVIEW BOARD

In future correspondence, please refer to HS10-042, September 18, 2009

Dr. Steve Wininger
Psychology
WKU

Dr. Steve Wininger:

Your revision to the research project, *GEMS Teacher Instrument Development*, was reviewed by the HSRB and it has been determined that risks to subjects are: (1) minimized and reasonable; and that (2) research procedures are consistent with a sound research design and do not expose the subjects to unnecessary risk. Reviewers determined that: (1) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (2) selection of subjects is equitable; and (3) the purposes of the research and the research setting is amenable to subjects' welfare and producing desired outcomes; that indications of coercion or prejudice are absent, and that participation is clearly voluntary.

1. In addition, the IRB found that you need to orient participants as follows: (1) signed informed consent is not required; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data. (3) Appropriate safeguards are included to protect the rights and welfare of the subjects.

This project is therefore approved at the Expedited Review Level until September 18, 2010.

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Sponsored Programs at the above address. Please report any changes to this approved protocol to this office. A Continuing Review protocol will be sent to you in the future to determine the status of the project. Also, please use the stamped approval forms to assure participants of compliance with The Office of Human Research Protections regulations.

Sincerely,

Paul J. Mooney, M.S.T.M.
Compliance Coordinator
Office of Sponsored Programs
Western Kentucky University

cc: HS file number Wininger HS10-042

HUMAN SUBJECTS REVIEW BOARD WKU APPROVED

HSRB APPLICATION # 10-042
APPROVED 9/18/09 to 9/18/10
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The Spirit Makes the Master

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