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An Investigation of the Reliability and Factor Structure of Four New Scales for Rating the Behavioral Characteristics of Superior Students

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Summary

Teacher rating scales have been used widely throughout the United States as part of a comprehensive plan for identifying potentially gifted and talented students. The Scales for Rating the Behavioral Characteristics of Superior Students (SRBCSS) are among the most frequently used teacher rating scales to assess the characteristics of and nominate high-ability students for gifted and enrichment programs. These scales have also been used to make decisions about identification and the range of services provided to these students. Four new SRBCSS subscales in mathematics, reading, science, and technology are introduced in an effort to guide teacher nomination of talent in each of these content areas. The reading scale measures accelerated reading, enjoyment of reading, advanced reading processing, and advanced language. The mathematics scale is designed to measure students' interest and approaches to solving mathematical problems and their ease in understanding mathematical concepts. The science scale is designed to measure students' interest in and approaches to solving problems in science and their ease in understanding scientific concepts. The technology scale examines four specific student characteristics: expertise using technology, interest and initiative in using technology, mentoring others in technology, and creative integration of technology. These scales can be used to identify high-ability students in specific content areas. These students may subsequently receive enriched and differentiated curriculum and instruction or acceleration within self-contained classrooms, cluster groups, or heterogeneous classrooms. Such learning opportunities are necessary in order for students to fully develop their talents in these specific content areas.

Teacher rating scales are among the most widely used instruments for screening students for identification and subsequent participation in programs for the gifted and talented. The Scales

for Rating the Behavioral Characteristics of Superior Students (SRBCSS; Renzulli et al., 2002) have been used widely throughout the United States (Davis & Rimm, 2003) as part of a comprehensive plan for identifying potentially gifted and talented students. Originally developed in 1971, the scales were subsequently translated into several languages (Kalantan, 1991; Srour, 1989; Subhi, 1997) and have been used widely in other countries. The first three scales in the series—learning, motivation, and creativity—were developed to guide identification of high-potential students based on a related theory, the Three-Ring Conception of Giftedness (Renzulli, 1978), that suggested that a broader range of students might be capable of developing gifted behaviors. As expanded conceptions of giftedness began to gain more flexibility (i.e., consideration of a broader range of talent areas *in addition to* cognitive ability), additional scales were added to examine high potential for talents and gifts in other areas, including leadership, art, music, drama, communication (precision), communication (expressiveness), and planning. A series of teacher training activities was also added to the manual that accompanies the scales in an effort to increase the reliability of teacher ratings.

Each scale was subjected to a standard instrument development research process to ensure technical characteristics such as validity, reliability, objectivity, and practicality. External reviews of the SRBCSS (Elliot, Argulewicz, & Turco 1986; Rust & Lose, 1980) suggest that the 10 factors used in the scales correlate favorably with other measures of the discrete constructs on which they load, providing support for the validity of this instrument. The SRBCSS are published in an electronic format as well as the traditional paper-and-pencil format. The electronic format enables the automatic calculation of class record sheets and a variety of local norms. The SRBCSS technical manual (Renzulli et al., 2002) includes a comprehensive list of studies about the original SRBCSS.

This article describes the development of four new SRBCSS scales—reading, mathematics, science, and technology. These new scales were developed to help both teachers and administrators obtain teacher ratings in these four content areas for students in grades 3–8. The scales were developed to guide teacher identification of students with talents in specific areas in an attempt to increase the likelihood that they will be identified for advanced academic services such as cluster or other forms of grouping (Gentry, 1999; Rogers, 1991); differentiated instruction (Reis et al., 1993; Renzulli, 1977; Renzulli & Reis, 1997a, 1997b; Tomlinson, 1995); or acceleration (Colangelo, Assouline, & Gross, 2004).

Background

Teacher Nomination for Gifted and Talented Programs

Many researchers suggest the use of multiple criteria as one way to help identify more students (Baldwin, 2005; Ford, 1998; Frasier & Passow, 1994; Maker, 1996; Plucker, Callahan, & Tomchin, 1996; Renzulli & Reis, 1997a, 1997b; VanTassel-Baska, Johnson, & Avery, 2002). The use of teacher nomination has been compared with other independent variables such as peer and parent ratings and evaluations of work samples (e.g., Harty, Adkins, & Sherwood, 1984; Singer, Houtz, & Rosenfield, 1992). Several researchers have investigated the effectiveness of teacher nominations of students for gifted programs during the last few decades (Borland, 1978; Gagné, 1994; Hoge & Cudmore, 1986; Hunsaker, Finley, & Frank, 1997; Johnsen, 2004;

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Pegnato & Birch, 1959; Renzulli & Delcourt, 1986; Rohrer, 1995; Siegle, Moore, Mann, & Wilson, in press; Siegle & Powell, 2004). Findings collectively suggest that when specific rating criteria exist, teachers were able to identify talented students in their classrooms. Other studies have examined the construct validity or criterion-related validity of teacher judgment instruments for high-ability students (Elliott et al., 1986; Fishkin & Johnson, 1998; Mathew, 1997; McCarney & Anderson, 1998: Oakland, Falkenberg, & Oakland, 1996; Ryser & McConnell, 2004; Schaefer & McDermott, 1999; Worrell & Schaefer, 2004). This research on construct validity has generally supported the instrument developers' assertions that the instruments do examine the hypothetical construct(s) being measured. Although techniques for providing construct validity evidence can be quite sophisticated, Popham (1995) emphasized that there is no single "settles-the-issue-once-and-for-all" investigation (p. 53), suggesting that the study of construct validity is a continual process.

Teacher Identification Nomination Instruments and Scales

Researchers have developed many different observation and nomination scales for teachers, parents, and others. These rating scales can provide valuable information about specific strengths of students such as a student's ability to generate innovative solutions to a problem or a student's motivation (Elliott, Busse, & Gresham, 1993; Feldhusen & Heller, 1986). The SRBCSS was first published in 1976 with available reliability and validity information on 10 scales to identify student strengths in the areas of learning, motivation, creativity, artistic, musical, dramatics, communication-precision, communication-expressive, and planning. The scales were developed for teachers and other school personnel to rate students for specialized programs using a 6-point rating: *never*, *very rarely*, *rarely*, *occasionally*, *frequently*, and *always*. The most widely used scales in the SRBCSS are those dealing with learning, motivation, and creativity and these three scales were subsequently revised (Renzulli et al., 2002). An early summary review of SRBCSS from the Buros Mental Measurements Yearbook explained that:

> The SRBCSS represents a significant advancement in the expansion of the methodology for identifying intellectually gifted, creative, or talented youth. . . . It's true potential, however, will only be demonstrated as additional empirical data becomes available. One promising area of research is the usefulness of the SRBCSS in identifying children from culturally different backgrounds. Another research possibility is its use as a dependent variable in evaluating programs designed for the gifted. (Argulewicz, 1985, p. 1312)

> The scales' strengths include their conceptual formation and their ease of administration. In addition, the scales are potentially very helpful in assisting teachers to consider the full array of characteristics associated with truly gifted children. The scales could also provide a useful framework for an inservice program on the nature and diversity of giftedness. (Rust, 1985, p. 313)

In recent years, several other scales have been developed to measure characteristics of gifted students. For example, the Gifted Education Scale, Second Edition (GES-2; McCarney & Anderson, 1998) can be used for the screening and identification of children and youth in kindergarten through grade 12. This scale includes 48 items across five areas: intellectual ability, creativity, specific academic aptitude, leadership, and performing and visual arts, with an

optional scale on motivation. "The reliability data for the GES-2 are quite strong and the validity data, although limited, are supportive of the validity of scores from the instrument" (Smith, 2001, p. 509). The Pfeiffer-Jarosewich Gifted Rating Scale (GRS; Jarosewich, Pfeiffer, & Morris, 2002) is also used to identify students in preschool through secondary school and includes subscales focusing on intellectual, academic, creative, and artistic talent and motivation. "The authors adhered to rigorous procedures and standards in the instrument's development. The GRS-P and GRS-S are well standardized" (Ward, 2005, p. 407). The Scales for Identifying Gifted Students (SIGS; Ryser & McConnell, 2004) include the following seven subscales: General Intellectual Ability, Language Arts, Mathematics, Science, Social Studies, Creativity, and Leadership. Both a school version and home version are available and those completing the form are asked to provide examples for any subscale with six or more high responses (Matthews, 2007). As with most rating scales, Ward (2007) suggested that the SIGS should not be the sole identification instrument, but "be used as a screening instrument as part of a comprehensive battery of assessment techniques" (p. 234).

The Gifted and Talented Evaluation Scales (GATES; Gilliam, Carpenter, & Christensen, 1996) were also designed to identify gifted students between the ages of 5–18. The GATES are based on the current federal and state definitions, including intellectual ability, academic skills, creativity, leadership, and artistic talent. Teachers, parents, and others who are knowledgeable about the child may complete the GATES for nomination for gifted and talented programs. Although the rationale and methodology of the scales is considerable, "the validity for all of its purposes and the value-added role of the GATES remain unclear" (Brody, 2007, p. 345).

The psychometric properties of teacher rating scales differ because each of these scales has been compared with differing assessments in validity studies. For example, the correlation between the SRBCSS and a traditional intelligence test such as the WISC or the Stanford-Binet may be low to moderate because SRBCSS was designed to identify characteristics that are not traditionally measured in intellectual assessments. Some instruments seem to load on only one factor. For example, reviews (Smith, 2001; Young, 2001) of the Gifted Evaluation Scale (GES) suggest that the five behaviors the test purports to measure load primarily on one "general academic" factor, with leadership and arts as subfactors (Young, 2001). Finally, only a few rating scales include individual content area scales to elicit teacher nomination information on specific areas such as mathematics or reading, which is one goal of the new scales we are presenting.

Identification of Specific Content Area Strengths

Few gifted and talented students excel in all academic areas at all times (Reis & Housand, 2007; Renzulli & Reis, 1997a, 1997b; Sternberg & Davidson, 2005). Rather, some students display different talents at different times and in different areas. A student who is a talented reader may not exhibit the same level of excellence in mathematics, and it is increasingly important to identify the particular academic strength areas of students in order to provide challenging and differentiated curriculum. Increased attention has been given to differentiated instruction in the classroom. This strategy attempts to address the variations among learners in the classroom through multiple approaches that enrich, eliminate, accelerate, modify, and adapt instruction and curriculum to match students' individual needs (Reis, Burns, & Renzulli, 1992;

Renzulli, 1977, 1988; Tomlinson, 1995, 2001). Tomlinson (1995) emphasized that when teachers differentiate the curriculum, they organize different learning opportunities based on content-area aptitudes, interests, and skills. Differentiation of instruction and curriculum suggests that students can be provided with materials and work of varied levels of difficulty through scaffolding, enrichment, acceleration, diverse kinds of grouping, and different time schedules in areas of their aptitude and interest (Colangelo et al., 2004; Gentry, 1999; Reis et al., 1992; Renzulli, 1977; Renzulli & Reis, 1997a, 1997b; Tomlinson, 1995). These procedures have enabled some teachers to adjust curriculum to meet the needs of talented students in certain content areas in both heterogeneously and homogeneously grouped classrooms. However, improved methods and simpler identification of students' aptitudes may result in better instructional matching in specific content areas. Because of the increased interest in expanded identification procedures and the need to identify students' strengths in specific content areas in classrooms, four new SRBCSS subscales were developed in the areas of reading, mathematics, science, and technology. The development of the new scales and the design of the validity and reliability studies were consistent with both the development of the previous SRBCSS and the recommendations for designing instruments by Gable and Wolf (1993).

Validation Procedures in This Study

Instrument

The goals of content validity are to clarify the domain of a concept and judge whether the measure adequately represents the domain (Bollen, 1989). To investigate content validity for each subject scale, a review of literature in the area of each new scale was performed by content-area specialists who conducted research related to the behavioral characteristics of students talented in the particular areas of reading, mathematics, science, and technology. A list of characteristics most frequently cited in each area was created and distributed for review to content experts who were professionals in the field (e.g., scientists and computer technology specialists); university professors (e.g., mathematicians); teachers; and resource specialists in schools (e.g., mathematics resource teachers and reading resource teachers). The characteristics were also reviewed and rated by experts in the specific field of education. For example, in addition to experts in gifted and talented education, mathematics educators also reviewed the mathematics items. This broad range of professionals with a variety of perspectives provided useful insights in defining the key characteristics of students who demonstrate talent in the particular content area.

To facilitate this process, the Experts' Rating Form for Teacher Judgment of Behavioral Characteristics of Superior Students was developed in each area to provide the primary support for the instrument's content validity. This form was distributed to the aforementioned experts who examined the relationship between the operational and conceptual definition of the items. The experts indicated how strongly they felt that each item was descriptive of the behavioral characteristics by selecting the category: 1 (*highly appropriate/include*); 2 (*appropriate but needs editing or clarification, please include suggestions*); or 3 (*not important/exclude, please include comments*). In addition they circled the appropriate grade-level grouping for each stem: E (*elementary, K–6*); M (*middle, 5–8*); or S (*secondary, 9–12*). They were also asked to choose the top 10–15 items they would use if they could use only a limited number to help identify talent in

the particular content area. A minimum of 25 different experts in each domain reviewed the behavioral characteristics for that domain. Results were compiled and the stems that received mean strength ratings of 2 or above from 80% of the raters were used to create the field test instrument.

Following this content validation, an initial set of scales was developed in each content area. Teachers rated students on each characteristic based on how frequently they exhibited evidence of the characteristic on a 6-point Likert scale from *never* to *always*. The four scales were merged and items were distributed randomly in a single instrument that included 73 items (20 mathematics stems, 24 science stems, 9 reading stems, and 20 technology stems). This instrument was mailed to 140 elementary schools across the county. Using a systematic sampling procedure, teachers were asked to rate every fifth student on their class roster. The use of this type of sampling procedure, which included students of all abilities, enabled the researchers to determine which characteristics of each content area were rated consistently the same. If teachers considered students strong in a particular content area, the characteristics from that particular scale should have been consistently high. Conversely, if teachers perceived students as weak in a particular area, the characteristics associated with that content area should have been consistently low. The use of this sampling procedure ensures greater variability in responses, an important characteristic in confirmatory factor analysis (the statistical procedure we used to determine the final behavioral characteristics in each new scale). Confirmatory factor analysis was appropriate because we were testing a "theory about latent processes" with variables that had been "specifically chosen to reveal underlying process" (Tabachnick & Fidell, 1996, p. 637).

Sample

Schools in which the sampling took place were primarily public schools with the following demographic breakdown: 26% urban, 64% suburban, and 10% rural. One hundred eighty-seven teachers completed ratings on 726 students, from grades 4, 5, and 6; 48% of the students were male and 52% were female. Eighty percent were Caucasian American, 8% were African American, 7% were Hispanic American, and 1% of the students were Native American. One hundred twenty-two schools offered gifted programs, and when a gifted program was available in the school, 31% of the students sampled were enrolled.

Analysis Procedures

A confirmatory factor analysis was conducted using Amos 4.0 to assess the latent structure (the four domains of reading, mathematics, science, and technology) of a set of variables. The model fit was evaluated using the common fit indices of chi-square (x^2), the ratio of chi-square to degrees of freedom (x^2/df), root mean square error of approximation (RMSEA), Comparative Fit Index (CFI), and Tucker Lewis Index (TLI). Initially, separate confirmatory factor analyses were conducted for each of the four domains and the number of items was reduced in each scale to create the best fit model. Once the four content area scales were established, a confirmatory factor analysis was conducted of a model that included all four scales.

Results

Reading

Finding research-based methods to identify the characteristics of talented readers is challenging, as mostly anecdotal publications such as checklists are used to define this group. Talented readers are usually defined as having exceptional reading ability and the capacity to understand textual information well above what would be expected of other students in their age group (Reis et al., 2004). Work in the last 2 decades has focused on identifying some of the characteristics of this group, but this was the first data-based study to develop a scale for this purpose. Based on extant literature, 30 possible items were reduced to 9 items focusing on examining accelerated reading, enjoyment of reading, advanced reading processing, and advanced language (Reis et al., 2004). The reading scale model was able to be reduced to six items (see Table 1) for the best fitting model, $X^2(9) = 26.270$, RMSEA = .052, CFI = .996, TLI = .993.

Table 1
Corrected Item-Total Correlations, Item Means and Standard Deviations, and Cronbach Alpha Reliability Estimates for Each of the Four Rating Scales

Item		Corrected Item-Total Correlation	*M*	*SD*
Reading (Cronbach alpha = .964)				
R1.	Eagerly engages in reading related activities	.955	4.37	1.415
R2.	Applies previously learned literary concepts to new reading experiences	.958	4.35	1.285
R3.	Focuses on reading for an extended period of time	.955	4.40	1.442
R4.	Demonstrates tenacity when posed with challenging reading	.958	4.11	1.477
R5.	Shows interest in reading other types of interest-based reading materials	.960	4.33	1.311
R6.	Pursues advanced reading material independently	.956	4.19	1.488
Mathematics (Cronbach alpha = .977)				
M1.	Is eager to solve challenging mathematics problems (a problem is defined as a task for which the solution is not known in advance)	.873	4.10	1.344
M2.	Organizes data and information to discover mathematical patterns	.903	3.84	1.382
M3.	Enjoys challenging mathematics puzzles, games, and logic problems	.899	4.07	1.451
M4.	Understands new mathematics concepts and processes more easily than other students	.914	3.91	1.528

Item		Corrected Item-Total Correlation	M	SD
M5.	Has creative (unusual and divergent) ways of solving mathematics problems	.890	3.85	1.364
M6.	Displays a strong number sense (e.g., makes sense of large and small numbers, estimates easily and appropriately)	.903	4.06	1.488
M7.	Frequently solves mathematics problems abstractly, without the need for manipulatives or concrete materials	.881	4.05	1.454
M8.	Has an interest in analyzing the mathematical structure of a problem	.880	3.52	1.426
M9.	When solving a mathematics problem, can switch strategies easily, if appropriate or necessary	.898	3.94	1.420
M10.	Regularly uses a variety of representations to explain mathematics concepts (written explanations, pictorial, graphic, equations, etc.)	.860	3.68	1.397
Science (Cronbach alpha = .947)				
S1.	Demonstrates curiosity about scientific processes	.852	4.16	1.252
S2.	Demonstrates creative thinking about scientific debates or issues	.846	3.72	1.334
S3.	Demonstrates enthusiasm in discussion of scientific topics	.877	4.04	1.312
S4.	Is curious about why things are as they are	.807	4.21	1.276
S5.	Reads about science-related topics in his/her free time	.769	3.37	1.432
S6.	Expresses interest in science project or research	.837	3.84	1.429
S7.	Clearly articulates data interpretation	.771	3.68	1.386
Technology (Cronbach alpha = .959)				
T1.	Demonstrates a wide range of technology skills	.892	3.61	1.319
T2.	Learns new software without formal training	.872	3.47	1.398
T3.	Spends free time developing technology skills	.850	3.30	1.320
T4.	Assists others with technology related problems	.881	3.49	1.342
T5.	Incorporates technology in developing creative products/assignments/presentations	.774	3.24	1.497
T6.	Eagerly pursues opportunities to use technology	.865	3.72	1.378
T7.	Demonstrates more advanced technology skills than other students his or her age	.866	3.36	1.424

Mathematics

The mathematics scale was designed to measure students' interest and approaches to solving mathematical problems and their ease in understanding mathematical concepts. Through observation of students in the process of problem solving and analysis of their written work, teachers rate students' creativity, flexibility, and critical thinking in mathematics (Gavin, 2005). For example, students who develop an unusual and divergent way of solving a problem and are "thinking outside the box" show signs of creativity in mathematics. When students recognize that their approach to solving a problem is not working and are able to switch to a new strategy with ease, they are displaying flexibility in mathematical thinking. Using a variety of representations to solve problems also contributes to the identification of creativity and flexibility in mathematical thinking. Finally, teachers can find evidence of critical thinking in mathematics when students: (a) are able to organize data and information easily to find patterns and make generalizations; (b) are able to solve problems abstractly without the use of manipulatives; and (c) have a strong number sense (i.e., facility with very large and very small numbers and strong estimation skills). An 11-item mathematics scale proved to be the best fitting model, $X^2(44) = 260.545$, RMSEA = .084, CFI = .978, TLI = .972.

Science

The science scale was designed to measure students' interest in and approaches to solving problems in science and their ease in understanding scientific concepts. Through observation of students in the process of problem solving and analysis of their work, teachers rate students' creativity, flexibility, and critical thinking in science. For example, students who are able to reframe a scientific problem in a variety of ways by asking questions with different foci or innovatively drawing upon content or process knowledge to engage in scientific discussions demonstrate flexibility and creativity in science. Critical thinking and creativity allow the science student to extract relevant information from content knowledge, allowing the student to generate multiple possible approaches to examining a variable, such as a physical or chemical feature or a biochemical process, within a research paradigm. Students with such critical thinking and creativity in science demonstrate interest in and enthusiasm for research. Scientists synthesize curiosity, creativity, and critical thinking in the generation of new knowledge; students who exhibit scientific curiosity (e.g., choosing to read about science, dedicating time to thinking about why and how things work) represent a potential pool of those who have the capability and desire to leverage critical thinking and creativity upon the raw material of science knowledge (Isaak & Hubert, 1999; Lederman, 1992). Please refer to Table 1 to see items directly related to these characteristics. The final science model consisted of seven items, $X^2(14) = 67.195$, RMSEA = .074, CFI = .987, TLI = .981.

Technology

"Technologically gifted students can usually be identified by the technology products they produce, the way they assist others with technology, and the technology-related questions they ask" (Siegle, 2004, p. 30). The SRBCSS technology scale is the first data-based scale measuring four specific student characteristics: expertise using technology, interest and initiative in using technology, mentoring others in technology, and creative integration of technology.

Technology giftedness is an emerging construct. This scale represents an early attempt at operationally defining technologically gifted students and asking teachers to identify them. Because this is a relatively new construct, we expect that it will need further refining. Technological giftedness appears to manifest itself in three distinct ways: those who excel at writing computer code (programmers); those who excel at using software (interfacers); and those who excel at working with the actual technology equipment (fixers; R. Friedman-Nimz, personal communication, April 23, 2006). This scale measures only one type of technology giftedness, the interfacers. Statistical analyses of the items we propose in the technology scale support the viability of the unidimensional technology gifted construct. A trimmed model with seven technology items (see Table 1) exhibited the best fit, $X^2(14) = 45.940$, RMSEA = .060, CFI = .993, TLI = .990.

Combined Analysis

After the individual items on each of the scales were reduced for an acceptable model, we combined the selected items for each scale into one measurement model. We specified a priori that each question was an indicator for only one of the four domains. An examination of the modification indices revealed that the removal of one mathematics item would produce a better fitting model. The reason for eliminating this item was that the modification index suggested that the item behaved as an indicator for more than one factor. This item was removed for the final model, and the fit indices indicated that the model exhibited adequate fit for the hypothesized factor structure in the validation sample, $X^2(371) = 1541.22$, RMSEA = .070, CFI = .945, TLI = .949. The X^2 was significant ($p < .001$); however, the X^2 significance test is highly sensitive to sample size.

Separate Cronbach alpha internal consistency reliability estimates were calculated for each of the four scales in the final model. Measures involving attitude ought to have internal consistency estimates greater than .70 (Gable & Wolf, 1993). All of our reliability estimates easily exceeded this recommendation with our lowest reliability estimate being alpha = .947. The reliability estimates and corrected item-total correlations, item means, and item standard deviations for each of the four rating scales are summarized in Table 2.

Table 2
Correlation Between Students Grades and Teacher Ratings in Bold and Correlations Among the Four Rating Scale Factors

	Reading	Mathematics	Science	Technology
Reading	**.681*****	.816***	.804***	.684***
Mathematics		**.731*****	.874***	.778***
Science			**.573*****	.844***
Technology				**.453*****

Note. ***p < .001.

To further investigate the validity of the new rating scales, we explored the relationship between students' grades in each of the domains and the ratings they received from their teachers

using the new scale for that domain. Grades were recorded on a 12-point scales with $A = 12$ points and $F = 1$ point (e.g., a grade of a *B-* equaled 8 points). The relationship between the students' earned grades and their teachers' subject rating with the new SRBCSS was significant for each of the four scales. The strongest relationship was for mathematics, $r = .731$, and the weakest relationship was for technology, $r = .453$. Unlike the reading, mathematics, and science areas, approximately one third of our sample did not report technology grades, and what constituted a technology grade was not well defined. One would expect the moderate to strong relationships between grades and teacher ratings that we found. We would not expect perfect relationships because the rating scales are designed to measure students' giftedness in the specific domains, which, while related to student academic achievement, still differ because of factors such as student motivation and homework completion.

The correlations among the factors ranged from .874 to .684 (see Table 2). Correlations above .85 are indicative of possible discriminant validity problems. The relationship between the science factor and the mathematics factor did exceed the .85 standard. Because these two constructs are related, this relationship was not unexpected, although the strength of the relationship was higher than expected. Future refinement of the scales may help to further discriminate between these two constructs. The strong correlations between earned grades and the teacher ratings for each domain, as well as the relationships among the factors, are summarized in Table 2.

In addition, to improve the reliability of teacher ratings and to enable teachers to gain a better understanding of the specific behaviors and key concepts for each domain, a training exercise was developed for each scale. This activity was designed to promote discussions among teachers about student behaviors. In the first part of the activity teachers are asked to match key concepts with specific scale items. After comparing responses, discussion about the variability in the answers occurs; subsequently, teachers are asked to record behaviors of students that they believe are good exemplars of individual scale items. They can discuss their responses and come to a consensus on one or two behaviors that best represent the scale item and can subsequently use these benchmarks to guide them in rating students on these characteristics.

Discussion

Creating research-based scales to identify the characteristics of gifted and high-ability students in specific content areas has been the subject of limited previous research, and most checklists used for these purposes, if they are available, are anecdotal. Finding research-based methods to identify specific characteristics of talented students in reading, science, mathematics, and technology can lead to many exciting outcomes. The validity studies reported in this article indicated an adequate fit for the hypothesized factor structure in the validation sample. To further investigate the validity of the new rating scales, we also examined the relationship between students' grades in each of the domains and the ratings they received from their teachers using the new scale for that domain. The new scales have strong reliability estimates, as the lowest reliability estimate was over .94.

Current research suggests that although there are many ways to challenge students who are talented in reading, little is being done (Reis et al., 2004). In recent research, characteristics

of talented readers have been defined as: reading early and above level, enjoying the reading process, exhibiting advanced processing in reading, and having advanced language skills (Reis et al., 2004). Using the new SRBCSS reading scale might enable teachers to identify a broader pool of academically advanced students for differentiated instruction using acceleration and enrichment with methods such as differentiated instruction, compacting, grouping, or other forms of acceleration. The same strategies could be used in mathematics, science, and technology to enable students to benefit from differentiated and advanced opportunities in each of these areas.

The mathematics scale helps identify students who are creative and critical problem solvers, which represent characteristics of successful mathematicians. Using the mathematics scale would enable students with aptitude, interest, and motivation to be identified and then be given opportunities to challenge and extend their higher level reasoning abilities. Instruction can take the form of differentiated lessons in heterogeneous classrooms, homogeneous advanced mathematics classes, or after-school programs for mathematically talented students. The key is providing challenging materials that encourage students to develop the characteristics akin to mathematics. In this regard, new materials such as Project M[3]: Mentoring Mathematical Minds curriculum units are being developed for talented students and field tested with promising research results in mathematics achievement (Gavin, Casa, & Adelson, 2006).

The science scale was designed to measure students' interest and approaches to solving problems in science and their ease in understanding scientific concepts. Advanced science work could provide opportunities for creativity, flexibility, and critical thinking in science, and this scale may be used to help identify students who might receive advanced and differentiated services in science. Developing science and engineering talent is currently a national priority.

The technology scale could be used to identify students who might benefit from the time, resources, and opportunities to create advanced technology products. They might also be encouraged to creatively integrate technology in advanced ways to gather and analyze data about questions in areas of interest (Siegle, 2007). As stated earlier, the technology scale represents a preliminary attempt to define and measure the proposed construct of technological giftedness. Future research on this proposed construct is needed.

This study has summarized work on the development of a set of teacher rating scales focusing on specific content area aptitudes. We hope that the use of these scales will stimulate both expanded identification initiatives for high-ability students in these content areas, as well as more attention to their curricular and instructional needs.

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