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During the 1960s and 1970s the study of creativity in the public schools reached a high point, mainly through the writings and applications of E. Paul Torrance. Unfortunately, this area was seriously curtailed beginning in the 1980s because of institutional pressures to produce defensible educational outcomes. Thus, one measurement program after another became the featured "cure-all" of the day, starting with high-stakes testing and today's common core. These testing programs have strangled interests in offering the types of creativity programs originally introduced by Torrance. However, an awakening has occurred that is being led by various individuals in the gifted field. I would particularly like to discuss the current work of Joan Franklin Smutny, Director of The Center for Gifted/Midwest Torrance Center for Creativity in Glenview, Illinois.

Joan was Paul Torrance's friend and colleague who was noted for his longitudinal studies of creativity, development of the Torrance Tests of Creative Thinking, and Future Problem Solving. With over 1,800 publications, he influenced educators worldwide to use creativity training in the schools. The reintroduction of his ideas in the public schools will help to restore our nation's emphasis on innovation, creative thinking and a can-do philosophy. As a democracy founded on principles of individual initiative and achievement, it is important to bring back this aspect of our social and educational culture.

Joan has been instrumental in helping children to express their creativity through writing, poetry, art, music and invention. She directs The International Torrance Legacy Creativity Awards which began in 2009, and is pleased to share a new journal entitled, *Torrance Journal of Applied Creativity*, to be published this November 2015 by The Center for Gifted/Midwest Torrance Center for Creativity. The journal's intent is to identify key concepts of E. Paul Torrance and other pioneers in creativity and to discuss the application these ideas to classroom and home experiences.

Its focus will be on practical applications that can initiate and advance creativity, problem solving, and original approaches to teaching and learning. The first issue will commemorate the 100th anniversary of Paul Torrance's birth. It will be published once a year beginning this November 2015. The written version will be $10. If you are interested in writing for the journal, please call Joan Smutny at 847-256-1220, 847-436-1525, or 847-736-4690 or email her at joanfsm@aol.com.

Articles in this Issue:

1. Sally Reis and Joseph Renzulli present a detailed discussion of differentiated instruction. These scholars at the University of Connecticut have devoted their careers to designing the best differentiated programs for gifted students. With their Five Dimensions of Differentiation, this is a definitive article for teachers and administrators. Please see information at the end of the quarterly about the annual ***Confratute*** at the University of Connecticut, July 12-17, 2015.
2. Stephen Schroth and Jason Helfer present a comprehensive analysis of environmental studies for gifted students that are designed to improve their creativity and critical thinking skills. This article will serve as an useful resource with its emphasis on sustainability, green curriculum, and an informative list of online resources.
3. Harry Roman is a writer of technical publications in the STEM, mathematics and engineering fields, and he also helps teachers and students to solve engineering and science problems. His article shows how using a single sheet of paper can help gifted students to understand such concepts as analysis and planning, teamwork, force, strength, weight and gravity.
4. Michael E. Walters concludes this issue with his discussion of one of the geniuses of medical science, Ben Carson, MD.

Maurice D. Fisher, Ph.D. Publisher

Compass White Paper on Differentiation

Sally M. Reis and Joseph S. Renzulli

University of Connecticut

"True differentiation requires that we look at all the characteristics of the learner in addition to achievement level." – Dr. Joseph Renzulli

"Differentiation is a journey that all teachers must take. With multiple levels of achievement, interests, readiness, learning and product styles represented in each classroom, effective and meaningful differentiation may be the most important attribute of the 21st century teacher who wants to help each student make continuous progress in learning." – Dr. Sally Reis

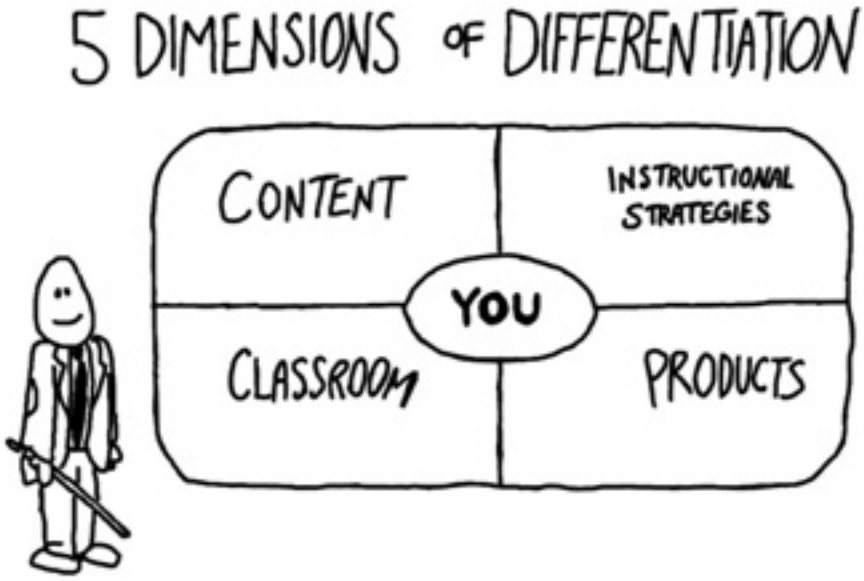
The diversity of skills, talents, and interests of students that we serve in our schools requires a remarkable range of teachers' skills, time, and resources. This brief article focuses on differentiation and the ways that teachers can adapt and differentiate the regular curriculum to meet the academic needs of all of their students. Challenges and solutions about how differentiation can be implemented will be discussed, as will a variety of strategies that can be used to differentiate, challenge, and engage all students. Defined simply, differentiation is matching a required curriculum with the learning styles, expression styles, interests and abilities of students. It's predicated on the simple belief that engaged, motivated students score higher, are easier to manage, and enjoy learning more. Both research and current practice illustrates the importance of differentiated instruction for meeting every child's needs as well as raising achievement – and some of that research is summarized in this article.

Defining Differentiation

In order to accommodate the needs of students across many different levels of academic achievement, teachers across the country have implemented within-classroom strategies referred to as differentiated instruction. Differentiation is an attempt to address the variation of learners in the classroom through multiple approaches that modify instruction and curriculum to match the individual needs of students (Renzulli, 1977; Tomlinson, 2000). Students vary in their abilities, interests, and prior knowledge. Differentiation serves to address this variation by matching the content, instruction, and assessment to students' needs and interests. Tomlinson (1995) emphasized that when teachers differentiate curriculum, they stop acting as dispensers of knowledge and serve as organizers of learning opportunities. Differentiation of instruction and curriculum suggests that students can be provided with materials and work of varied levels of difficulty, different levels of assistance, various types of grouping, as well as different environments in the classroom. In other words, differentiation is the opposite of a "one size fits all curriculum".

Five Dimensions of Differentiation

The three components that are most often associated with successful differentiation are: curriculum or content -- what is being taught; instruction or process — how it is being taught; and student product — tangible results produced based on students' interests and abilities, but more recently, Joseph Renzulli expanded these components in the "Five Dimensions of Differentiation," explained as five ways to integrate differentiation into teaching practices.



1) **Content**: Students have different academic abilities, and interests – and teachers can differentiate the content/curriculum delivered to their students. Some students need content that matches their interests, or is more or less challenging and appropriate for their reading level – and not every student should receive the same content in any given lesson.

2) **Instructional Strategies**: Students also arrive with different learning styles – some learn best through group work and some by working alone, some learn best by doing projects, while others learn by discussion. Teachers can differentiate by using different instructional strategies that match the preferences of individuals or groups in your classroom.

3) **The Classroom:** Teachers can differentiate the learning environment itself, and how they manage it. Students can have the opportunity to work in groups with other students like themselves, or work in groups in which every student has a chance to demonstrate their different style – or, you can introduce new guest speakers or technology – or bring your class into new environs like the computer lab, library, or a field trip.

4) **Products**: Students express what they've learned in different ways – some students' preferred expression style is written – while others do better with technology, social action, or visually. Teachers can differentiate products by giving students options, when practical, to choose their own modes of expression to demonstrate what they have learned.

5) **The Teacher**: Obviously, it's hard to imagine that teachers can differentiate every lesson every day – so differentiation is about the decisions and choices that teachers make about how to differentiate the curriculum for a diverse group of students. Differentiation requires that teachers consider their students' learning styles, interests, abilities, and expression styles – and that they accept the freedom, flexibility, and creativity to implement this process in the classroom.

Renzulli's (1977; 1988; Renzulli & Reis, 1997) five dimensions of **content, process, products, classroom organization and management, and the teacher's own commitment to differentiate** into a learner as well as a teacher provide a method to differentiate instruction. As noted in Figure 1, the differentiation of *content* involves adding more depth to the curriculum by focusing on structures of knowledge, basic principles, functional concepts, and methods of inquiry in particular disciplines. Within the **content** area, representative topics are explored and webbed, with open-ended questions that probe into a particular field of knowledge (Renzulli, 1997).

The differentiation of **process** incorporates the use of various instructional strategies and materials to enhance and motivate various students learning styles. The differentiation of **products** enhances students' communication skills by encouraging them to express themselves in a variety of ways. To differentiate **classroom management,** teachers can change the physical environment and grouping patterns they use in class and vary the allocation of time and resources for both groups and individuals. Classroom differentiation strategies can also be greatly enhanced by using the Internet in a variety of creative ways. The Internet can expand the **learning environment** far beyond the walls of the classroom and offers particular promise for engaging and differentiating content for children. Last, teachers can differentiate **themselves** by modeling the roles of athletic or drama coaches, stage or production managers, promotional agents, and academic advisers. All these roles differ qualitatively from the role of teacher-as-instructor. Teachers can also "inject" themselves into the material through a process called artistic modification (Renzulli, 1988). This process guides teachers in the sharing of direct, indirect, and vicarious experiences related to personal interests, travel experiences, collections, hobbies, and teachers' "extra-curricular" involvements that can enhance content.

Five Dimensions of Differentiation Described in a Classroom

The following description illustrates what a differentiated classroom would be like if each of Renzulli's five dimensions were implemented. Content would be adjusted and changed to meet the needs of advanced students. In reading, for example, advanced self-selected reading materials would be used to challenge talented readers, and less than challenging but high interest content would be used to engage struggling readers (Reis, McCoach, Little, Muller & Kaniskan, 2011). Instructional strategies or **processes** used to teach and stimulate student problem solving and critical thinking would include but not be limited to problem-based learning, simulations, independent study (both guided and unguided), and higher-level thinking questions. Higher-level thinking questions should incorporate critical thinking skills to enable students to conduct research, brainstorm, identify problems and develop an action plan and motivate students to pursue independent investigations of real world problems, what Renzulli calls Type III studies (Renzulli, 1977).

These types of **products** associated with a differentiated approach reflect both the learners' expression and the applied skills of a field of study. These products can be achieved through exposure to learning opportunities developed within the classroom or through the out of school environment such as agencies, museums, TV, radio, community organizations, and mentorships or apprenticeships. When differentiation is occurring in a **classroom environment**, teachers use a combination of interest and learning centers across the classroom, organize study areas, computer stations, and work areas for products as well as artistic, literary, and scientific work. Some students will need to use additional out of school learning areas (e.g., library, gym, auditorium, and lab) if the topic being investigated requires additional resources or environments that allow for freedom of movement. In the last dimension of differentiation, the **teacher** extends him/herself by becoming part of the learning exploration through direct personal experiences, an opinion or belief that sparks a curiosity or confrontation with knowledge, or by modeling the love of learning. Using Renzulli's five dimensions of differentiation, educators can adapt and implement differentiation in a consistent and progressive manner to meet the needs of all learners.

Differentiation by Competency, Grouping, and Using Compacting

A recent emphasis on differentiated instruction calls for the use of assessment data to support modification of curriculum and instruction to respond to differences in students' readiness, interests, and learning profile (Renzulli, 1988; Tomlinson, 2001). Differentiated instruction emphasizes that learning is most effective when teachers are able to assess students' current levels of functioning and learning preferences, and then use this information to help students progress to more advanced levels of functioning and more advanced learning. This is exactly what the Compass/Odyssey and activities are developed to do. Odyssey curriculum enables teachers to use data-based decision making to pre-assess student learning and use assessment, instruction, and data management to differentiate content.

Differentiated instruction combines flexible grouping of students with adjustments to the learning tasks; in some instances, whole group instruction is the most appropriate delivery model, while in other instances, students work in small groups or individually to

complete tasks that are targeted to their own levels of readiness, interests, and learning preferences. Kulik and Kulik studied the use of some form of grouping — the practice of organizing classrooms in graded schools to combine children who are similar in ability to ascertain whether they were positive or negative effects in their meta-analysis of 31 separate studies of grouping children at the elementary school level (1984). The studies primarily focused on grouping students within a school into different classes based on differing average ability levels. After analyzing 28 separate studies that examined effects of grouping by achievement test performance, the authors found that grouping over heterogeneous grouping worked. Another study by Tieso (2005) found that significant student achievement gains resulted when teachers used flexible within-class ability grouping. To differentiate for students in homogeneous groups, teachers should use formal and informal assessment data to determine the most appropriate learning objectives and instructional strategies to better ensure that students will gain the most learning from being placed into these instructional groups. In addition to differentiating instruction for students in tiered groups, professional development for teachers, flexibility, and a combination of different grouping structures may also attribute to student achievement. In a three-year longitudinal study, Gentry and Owen (1999) found that flexible cluster grouping had positive effects on all ability levels of students in a small rural, Midwest elementary school when accompanied by professional development.

Another proven strategy for differentiation is curriculum compacting. Curriculum compacting, a service described by Joseph Renzulli and Sally Reis, is another process that can be used to eliminate or modify work that may already be mastered, and thus enable students to prove that they already know content. This strategy is one of the most widely used approaches to encourage curriculum differentiation (Renzulli & Reis, 1992). Curriculum Compacting is an instructional technique that is specifically designed to make appropriate curricular adjustments for students in any curricular area and at any grade level. Essentially, the procedure involves (1) defining the goals and outcomes of a particular unit or segment of instruction, (2) determining and documenting which students have already mastered most or all of a specified set of learning outcomes, and (3) providing replacement strategies for material already mastered through the use of instructional options that enable a more challenging and productive use of the student's time. Curriculum Compacting might best be thought of as *organized common sense,* because it simply recommends the natural pattern that teachers ordinarily would follow if they were individualizing instruction for each student. In research on compacting, approximately 40 to 50% of traditional classroom material was compacted for targeted students in one or more content areas. When teachers eliminated as much as 50% of regular curricular activities and materials for targeted students, no differences were observed in posttest achievement scores between treatment and control groups in math concepts, math computation, social studies, and spelling. In science, the students who had between 40 to 50% of their curriculum eliminated actually scored significantly higher on science achievement posttests than their peers in the control group. And students in group one whose curriculum was specifically compacted in mathematics scored significantly higher than their peers in the control group on the math concepts posttest (Reis, Westberg, Kulikowich, & Purcell, 1998).

Differentiation with Enrichment

Enrichment opportunities enable children to move beyond grade level lessons and extend the regular curriculum with individualized opportunities. Examples of enrichment include exposure to new topics and ideas, training in creative and critical thinking skills, problem solving, first-hand investigative opportunities, the development of an independent study in areas of choice with individual research, and the use of advanced research methods. There are a variety of factors to consider when using enrichment to differentiate instruction and content. For example, what types of enrichment opportunities can and will be made available? Will the regular curriculum be extended with enrichment or will it be compacted and replaced with teacher-selected advanced content? Will students have the opportunity to pursue their personal interests using independent study? Enrichment can take many forms and these questions about content and how curriculum can be enriched are at the core of the decisions that guide enrichment selections.

The Triad Model, along with its larger-scale translation into the SEM (Renzulli, 1977; Renzulli & Reis, 1985, 1997), is one of the most popular approaches in enrichment education pedagogy (Van Tassel-Baska & Brown, 2007), and it has been used with students in

urban, suburban, and rural schools across the country with positive outcomes for the last three decades (Reis & Renzulli, 2003; Renzulli & Reis, 1994). The SEM has been used widely in both gifted and regular education programs, with this broad applicability of the SEM's three central goals: developing talents in all children, providing a broad range of advanced level enrichment experiences for all students, and providing follow-up advanced learning opportunities for children based on interests. The SEM emphasizes engagement and the use of enjoyable and challenging learning experiences constructed around students' interests, learning styles, and product styles. Renzulli's Enrichment Triad Model and the subsequent Schoolwide Enrichment Model suggest the need for a comprehensive approach to elementary enrichment to differentiate instruction. The Enrichment Triad Model, an organizational and service delivery model, has three components: Type I enrichment (general exploratory experiences), Type II enrichment (group training activities), and Type III individual and small-group investigations of real problems. Their work includes elements such as enrichment planning teams, needs assessments, staff development, materials selection, and program evaluation.

In summary, classroom teachers can provide differentiated levels of enrichment to many students using various types of enrichment. Enrichment usually includes some or all of the following components: exposure to new topics and areas of interest, training in thinking and research skills, opportunities for self-selected investigative activities of problems that students select or are assigned by their teachers. Enrichment usually includes emphasis on authentic content and process, enabling students to serve as firsthand inquirers, and exploring the structure and interconnectedness of knowledge. Enrichment teams, as advocated by Renzulli and Reis in the Schoolwide Enrichment Model, can help plan enrichment experiences for the entire school. Enrichment programs should evolve into an integral part of the differentiated system and should be regularly reviewed to determine both content effectiveness and appropriateness of delivery. All students benefit from a planned, articulated and coordinated enrichment program that will provide differentiated challenges as well as engagement and enjoyment of learning.

Differentiation Using Renzulli Learning

The main goal of the Renzulli Learning System is to provide students with experiences that help them enjoy the *process* of learning through their personal engagement. Renzulli Learning is an exciting and new, interactive on-line educational profile and matching database geared to enrichment resources, creative productivity, and high-end learning that matches student interests, learning styles, and expression styles with a vast array of educational activities and resources designed to enrich students' learning processes. Using Renzulli Learning, students can explore, discover, learn and create by using the most current technology resources independently and in a safe environment.

Field (2009) studied the use of Renzulli Learning, an innovative on-line enrichment program based on the Enrichment Triad Model, for students in both an urban and suburban school. In this 16-week experimental study, both gifted and non-gifted students who participated in this enrichment program and used Renzulli Learning for 2-3 hours each week demonstrated significantly higher growth in reading comprehension than control group students who did not participate in the program. Students also demonstrated significantly higher growth in oral reading fluency and in social studies achievement than those students who did not participate (Field, 2009).

Teachers can use Renzulli learning to differentiate instruction using four steps. The first step consists of a computer-based diagnostic assessment that creates a profile of each student's academic strengths, interests, learning styles, and preferred modes of expression. The on-line assessment, which takes about thirty minutes, results in a personalized profile that highlights individual student strengths and sets the stage for step two of the RLS. The profile serves as a compass for the second step, which is a differentiation search engine that examines thousands of resources that relate specifically to each student's profile. Student profiles can also be used to form groups of students who share common interests. A project management tool guides students and teachers to use specifically selected resources for assigned curricular activities, independent or small group investigative projects, and a wide variety of challenging enrichment experiences. Another management tool enables teachers to form instructional groups and enrichment clusters based on interests and learning style preferences. Teachers have instant access to student profiles, all sites visited on the web, and the amount of time spent in each activity. Parents may also access their own child's profile and web

activities. In order to promote parent involvement, we suggest that students actually work on some of their favorite activities with their parents.

Next, the differentiation search engine matches student strengths and interests to an enrichment database of 40,000 enrichment activities, materials, resources, and opportunities for further study that are grouped into the following categories: virtual field trips, real field trips, creativity training, critical thinking, projects and independent study, contests and competitions, websites, fiction and non-fiction books, summer programs, on-line activities, research skills, and high interest videos and DVDs. These resources are not merely intended to inform students about new information or to occupy time surfing around the web. Rather, they are used as vehicles to help students find and focus a problem or creative exploration of personal interest to pursue in greater depth. Many of the resources provide the methods of inquiry, advanced level thinking and creative problem solving skills, and investigative approaches. Students are guided toward the *application of knowledge* to the development of original research studies, creative projects, and action-oriented undertakings that put knowledge to work in personally meaningful areas of interest, and provide students with suggestions for outlets and audiences for their creative products. The resources available in step two also provide students with opportunities to pursue advanced level training in their strength areas and areas of personal interest.

The third part of Renzulli Learning for students is a project organization and management plan called The Wizard Project Maker. Using this project planner, teachers can help students target their web-based explorations to undertake original research, investigative projects, and the development of a wide variety of creative undertakings. The sophisticated software used in this tool automatically locates potentially relevant web-based resources that can be used in connection with the student's investigative activity. This management device is designed to fulfill the requirements of a Type III Enrichment experience, which is the highest level of enrichment described in our discussion of the Enrichment Triad Model. Specifically, the Project Maker provides students with the metacognitive skills to define a project and set a goal; identify and evaluate both the resources to which they have access and the resources they need (e.g. time, Internet sites, teacher or mentor assistance); prioritize and refine goals; balance the resources needed to meet multiple goals; learn from past actions, projecting future outcomes; and monitor progress, making necessary adjustments as a project unfolds. The Wizard Project Maker helps students make the best use of web resources, helps to focus their interests as they pursue advanced level work, and establishes a creative and viable responsibility for teachers in their role as "the guide on the side." By helping students pursue advanced levels of challenge and engagement through the use of the Wizard Project Maker, we hope students will begin to regard their teachers as mentors rather than just as disseminators of knowledge.

The final step in the Renzulli Learning System is an automatic compilation and storage of all student activity from steps one, two, and three into an on-going student record called the Total Talent Portfolio. A management tool allows students to evaluate each site visited and resource used, students can complete a self-assessment of what they derived from the resource, and if they choose they can store favorite activities and resources in their portfolio. This feature allows easy-return-access to on-going work. The portfolio can be reviewed at any time by teachers and parents through the use of an access code, which allows teachers to give feedback and guidance to individual students and provides parents with information about students' work and opportunities for parental involvement. The Total Talent Portfolio will travel with students throughout their years at the Academy to serve as a reminder of previous activities and creative accomplishments that they might want to include in college applications, and it is an ongoing record that can help students, teachers, guidance counselors, and parents make decisions about future educational and vocational plans.

Teacher resources in Renzulli Learning enable teachers to differentiate assignments, and send tiered and compacted assignments to students by placing them in their electronic talent portfolio. Teachers can also use Renzulli learning to group students based on their interests, learning, and expression or product styles.

How Many Teachers Actually Differentiate?

While most teachers, if asked, would indicate that they are committed to meeting students' individual needs, many teachers do not have background information to put this commitment into practice. Research demonstrates, for example, that many academically talented students receive little differentiation of curriculum and instruction and spend a great deal of time in school doing work that they have already mastered (Archambault, Westberg, Brown, Hallmark, Emmons, & Zhang, 1993; Reis, Westberg, Kulikovich, Caillard, Herbert, & Plucker, 1993; Westberg, Archambault, Dobyns, & Salvin, 1993). Many educators would like to adapt or modify or differentiate the regular curriculum for their above-average students. Accomplishing this, however, is no small task. Too little time, too many curricular objectives and poor organizational structures — all can take their toll on even the most dedicated professionals. The emphasis on differentiated instruction using assessment data to support modification of curriculum and instruction should respond to differences in students' readiness, interests, and learning profiles (Renzulli, 1988; Tomlinson, 2001). Differentiated instruction emphasizes that learning is most effective when teachers are able to assess students' current levels of functioning and learning preferences, and then use this information to help students progress to more advanced levels of functioning and more advanced learning. Differentiated instruction combines flexible grouping of students with adjustments to the learning tasks; in some instances, whole group instruction is the most appropriate delivery model, while in other instances, students work in small groups or individually to complete tasks that are targeted to their own levels of readiness, interests, and learning preferences.

Tomlinson and Allan (2000) detailed the roots of differentiated instruction as well as research relating to the importance of challenge in promoting engagement, growth, and authentic feelings of success for students (e.g., Byrnes, 1996; Csikszentmihalyi, Rathunde, & Whalen, 1993; Renzulli, 1977). Nevertheless, teachers still struggle to implement differentiated instruction, and among the challenges they face in implementing differentiation are concerns about planning for and managing differentiation, as well as fear of state assessments and little administrative support (Hertberg-Davis & Brighton, 2006; Katz et al., 2009; Moon et al., 2003; Reis et al.,1993; VanTassel-Baska & Stambaugh, 2005).

With tools like Compass Learning Renzulli Learning, teachers have a much easier and more focused task of implementing differentiated instruction in the classroom.

Glossary of Differentiation

Compacting – Determining goals of curriculum, assessing student mastery, and providing enrichment opportunities.

Differentiation – Matching the given content area with a student's interests, abilities, and learning styles through various instructional strategies.

Enrichment – Activities related to student's curriculum or interest area that involve higher level thinking skills and guided problem solving.

Personalized Instruction – Customizing the curriculum to student's achievement level, learning style, social-emotional concerns, interests, abilities, potential, creativity, and task commitment.

Instructional Style – Method of delivery used by teachers to stimulate learning within and beyond the classroom.

Modification – Changing the existing curriculum either by expanding the depth or breath of the content area.

References:

Purcell, J. H. & Eckert, R. D. (2006). (Eds.), *Designing services and programs for high-ability learners* (pp.32-48). Thousand Oaks, CA: Corwin Press.

Reis, S. M. & McCoach, D.B.; Little, C. M.; Muller, L. M. & Kaniskan, R. B (2011). The effects of differentiated instruction and enrichment pedagogy on reading achievement in five elementary schools*. American Educational Research Journal. 48* (2). 462-501.

Renzulli, J.S. (1977). The enrichment triad model. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S. (2007). (Ed.). *Systems and models for developing programs for the gifted and talented.* Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S., & Reis, S. M. (1997). *The schoolwide enrichment model: A comprehensive plan for educational excellence*. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S. (1988). The multiple menu model for developing differentiated curriculum for the gifted and talented. *Gifted Child Quarterly, 32,* 298-309.

Renzulli, J. S. (1997, July). *Five dimensions of differentiation.* Keynote presentation at the 20th Annual Confratute Conference, Storrs, CT.

Tomlinson, C. A. (1995). *How to differentiate instruction in mixed-ability classrooms.* Alexandria, VA: Association for Supervision and Curriculum Development.

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Environmental Studies: Building Gifted Children's Creative and Critical Thinking Skills

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Gifted children often thrive when presented with a certain degree of ambiguity in the matters they study (Renzulli & Reis, 2003; Smutny & von Fremd, 2009; Tomlinson, Kaplan, Renzulli, Purcell, Leppien, Burns, Strickland, & Imbeau, 2009; Treffinger, Young, Nassab, & Wittig, 2004; Ward, 1980). Awareness of the importance of sustainability has made "going green" a phenomenon among many Americans, with businesses, organizations, and individuals attempting to reduce their carbon footprint and to engage in more environmentally friendly behaviors (Schroth, Helfer, LaRosa, & Lanfair, 2011; Spellman & Stoudt, 2013). Many gifted children enrolled in grades K through 12 are especially concerned with issues that affect their world due to overexcitabilities that are manifested in a heighted ability to respond to emotional, intellectual, imaginational, psychomotor, or sensual stimuli (Dombrowski, 1972; Dombrowski & Piechowski, 1977). Gifted children are especially able to deal with ambiguity, uncertainty, and open-ended problems (Feldhusen & Treffinger, 1980; Renzulli & Reis, 2014; Tomlinson et al., 2009; Treffinger et al., 2004). In response to the many environmental threats to Earth, interest in alternative energy such as wind and solar farms, hybrid cars, and recycling have increased markedly across society (Spellman & Stoudt, 2013). All too often, however, gifted children enrolled in grades K-12 do not

get the opportunity to grapple with problems related to sustainability and environmental issues in a meaningful way (Davis, 2010; Spellman & Stoudt, 2013).

Engaging in problems related to sustainability and environmental problems provides gifted children marvelous opportunities to use creative- and critical-thinking (Davis, 2010; Feldhusen & Treffinger, 1980; Gray, Colucci-Gray, & Camino, 2009). Gifted children thrive when presented with problems that have a certain degree of ambiguity and require potential solutions that may be wide ranging and open-ended (Renzulli & Reis, 2014; Treffinger, Young, Nassab, & Wittig, 2004). Providing gifted children with the knowledge and the tools to effect change in current practices may offer some solutions that will prevent more harm from occurring (Davis, 2010; Gray, Colucci-Gray, & Camino, 2009; Spellman & Stoudt, 2013). A variety of topics can be covered and integrated into the existing curriculum for gifted learners across all grade levels, and stand-alone units can be constructed that focus specifically on sustainability (Davis, 2010; Colucci-Gray, & Camino, 2009).

Sustainability in K-12 Education

Sustainability is concerned with, among other things, providing humans with the tools and the setting for life to continue (Davis, 2010; Spellman & Stoudt, 2013). Sustainability education consequently focuses upon two distinct but related goals: allowing life to continue in a manner that supports human and animal health *and* assuring that future generations will be nourished and physically sustained by the Earth (Davis, 2010; Gray, Colucci-Gray, & Camino, 2009). In many ways, sustainability can be seen as a way of measuring the quality of life. Factors that impede sustainability, such as air pollution, soil erosion, water contamination, and drought also decrease many individual's quality of life (Spellman & Stoudt, 2013). In addition to these quality of life concerns, sustainability also represents the ability to meet the needs of the current population without endangering the ability of future generations to support themselves (Fraleigh-Lohrfink, Schneider, Whittington, & Feinberg, 2013; Schroth et al., 2011). Sustainability issues can focus at the local, national, and international level, all of which are interconnected in many ways (Johnson & Kendrick, 2005; Spellman & Stoudt, 2013).

Sustainability and environmental education, as educational concepts, serve to increase students' awareness of the issues surrounding environmental degradation and stressing that these problems are largely created by human activity (Bland, Coxon, Chandler, & VanTassel-Baska, 2010). This goal is supported by a variety of organizations such as the United States Partnership for Education for Sustainable Development (U. S. Partnership, 2009). Those who advocate for sustainability education describe it as a framework for engaging students in all subjects using the real-world context of complex interconnections between the creation of vibrant communities, strong economies, and healthy ecosystems (Kahyaoglu, 2013; Michaels, Shouse, & Schweingruber, 2008). Sustainability education can provide a useful context for instruction in all academic areas, including English/language arts, mathematics, science, social studies, and the arts (National Research Council, 2000; Robinson, Dailey, Hughes, & Cotabish, 2014; Schroth, 2015). When used properly, sustainability topics promote gifted children's development of creative and critical thinking skills, encourage systems thinking, and promote collaboration and communication (Bransford, Brown, & Cocking, 2000; Hausamann, 2012; Taber, 2010).

Sustainability is a key component of environmental education, although a formal environmental studies program is not necessary to introduce such topics to students (Heilbronner, 2013; Kim, VanTassel-Baska, Bracken, Feng, & Stambaugh, 2014; Newman & Hubner, 2012). Indeed, there are few jurisdictions that mandate the study of environmental issues and little formal curriculum that examines sustainability. Only 18 states have adopted formal environmental education learner objectives and outcomes, or are in the process of adopting them (Schroth et al., 2011; Spellman & Stoudt, 2013). Of these, 12 have mandated some form of environmental education, while others have required certain aspects of sustainability in the curriculum but have not provided funding to assess or enforce this (Schroth et al., 2011; Spellman & Stoudt, 2013). Those states that have mandated the study of sustainability have done so by incorporating them into the existing science curriculum rather than making them a separate area of study. Even without a state mandate, school districts and classroom teachers have the option of creating a curriculum for teaching sustainability (Pride, 2014; Roberts, 2013; Schroth, Helfer, Beck, & Swanson, 2011). Many districts that have done so have outlined their intention to assist students in thinking about what constitutes sustainability and how we can engage in behaviors that decrease environmental

threats (Seo, Lee, & Kim, 2011; Smith, 2011; Spellman & Stoudt, 2013). These schools have frequently assembled resources that assist teachers in exploring these topics in the classroom (Roberts, 2013; Robinson et al., 2014; VanTassel-Baska, 2008).

Benefits of a Green Curriculum

Broadening the scale on which students learn about the environment assists teachers and parents who are determining topics to examine with a green curriculum (Drapeau, 2014; Feldhusen & Treffinger, 1980; Johnson & Kendrick, 2005). Almost all aspects of a K-12 curriculum can incorporate aspects of sustainability (Renzulli & Reis, 2004; Tomlinson, Kaplan, Renzulli, Purcell, Leppien, Burns, Strickland, & Imbeau, 2009; Treffinger, Young, Nassab, & Wittig, 2004). Sustainable curriculum can be buttressed with resources such as the Common Core State Standards (CCSS) or learning guidelines from the North American Association for Environmental Education (NAAEE). These resources can assist teachers and curriculum coordinators in determining which topics to approach at which grade levels (Schroth et al., 2011; Tomlinson et al., 2009; Treffinger et al., 2004). Additionally, the standards serve as a practical guide and a helpful tool that permits educators to create assessments of gifted children's knowledge of sustainability. Many of the standards correlate with English/language arts, mathematics, science, social studies, art, and music instruction so that teachers can introduce sustainability topics across the curriculum. Those standards devoted entirely to sustainability tend to outline learning objectives for students by the time they have completed the 4^{th}, 8^{th}, and 12^{th} grades, permitting a certain degree of flexibility in the topics that can be taught and the order in which these are introduced (U. S. Partnership, 2009).

Themes introduced to elementary school students can be vital to creating a foundation for further learning about sustainability in the upper grades (Spellman & Stoudt, 2013; U. S. Partnership, 2009). As children grow older, their continued experiences with natural science both inside and outside the classroom lead to a better understanding of habitats and various life forms interact (Michaels, Shouse, & Schweingruber, 2008). This essential knowledge is built upon with the continued appreciation of nature. The philosophy undergirding this direction in the curriculum is that children will want to protect nature if they learn about its diversity, rarity, fragility, and importance to human life. Hands-on activities in sustainability are popular at all grade levels as they help gifted children take an ownership in their learning (Perkins, 1992; Michaels, Shouse, & Schweingruber, 2008). Growing plants in various conditions, for example, and charting their relative success and progress permits gifted children to be interactive and to design and control the variables such as light and moisture that will affect the project (Michaels, Shouse, & Schweingruber, 2008; Taber, 2010). In this experiment and others, the focus is on the connection between man-made conditions and the outcome of plants' growth — an imperative aspect of children's understanding of sustainability. Using foundations such as these, children in the upper grades can expand on this and engage in more advanced experiments to further their awareness of sustainability issues.

Implementing a Green Curriculum

Sustainability topics for K-12 classrooms can be categorized under four main objectives. The first involves questioning and analysis, which strengthens gifted children's ability to ask questions, formulate hypotheses, speculate, inquire, and develop answers (Smutny & von Fremd, 2009; Spellman & Stoudt, 2013; Tomlinson, 2003). This will look different at different ages, of course—gifted children in the primary grades might focus on defining a common problem, such as refuge on the floors, and determine possible solutions to solve this situation. After this, the class will determine which of the potential solutions they wish to pursue, and track how their solution changes the problem, if at all. Children who have completed the fourth grade are expected to have mastered the skills of asking questions, formulating hypotheses, speculating, inquiring, and developing answers and to be able to apply them in a variety of settings. This objective involves children's ability to devise ways in which they can investigate problems and come to conclusions about how to design simple experiments to reflect their mastery of this concept (Taber, 2007; U. S. Partnership, 2009). By middle school, gifted children can be expected to use experiments or simulations to explore sustainability topics and to communicate their findings from the initial hypothesis to the final results and to defend their logic. Middle school students might, for example, calculate their daily electricity use, examine different nonrenewable and renewable energy sources, simulate oil extraction, analyze global energy statistics, and use multiple perspectives to evaluate different energy sources. By high school, gifted learners use their skills in questioning and analysis to inquire about current issues in sustainability on a local, national, and global level and suggest possible inquiries and solutions. Gifted high school learners might examine how migration patterns to exurban areas affect commuting

patterns, energy use, suburban sprawl, and consider how additional development might change the local environment. Gifted high school students will focus on investigating all sides of the issues and learning to communicate their findings to groups that would be interested (Roberts, 2013; Smith, 2011; Trna, 2014). Table 1 contains a group of resources that can be used to develop green curriculum.

Table 1: Online Resources to Assist in Sustainability Investigations

Web Site	URL	Content
CLEAN: Climate Literacy & Energy Awareness Network	http://cleanet.org/index.html	A variety of resources that explore the central themes related to climate and energy science
Facing the Future: Global Sustainability	https://www.facingthefuture.org/Home/tabid/54/Default.aspx	Free curriculum and lesson plans that assist in implementing green curriculum
Energy Education & Workplace Development	http://www1.eere.energy.gov/education/lessonplans/	United States Department of Energy site that provides information, lessons, and tools for learning about green energy
Versal	https://versal.com/	Provides the tools to create online learning environment for students that permit individualized explorations
Toward a Sustainable Agriculture	http://www.cias.wisc.edu/curriculum/index.htm	No-cost high school curriculum that explores the economic, environmental, and social impact of agriculture
Students for the Environment	http://www.epa.gov/students/index.html	United States Environmental Protection Agency site providing games, homework assistance, videos, science fair projects, and other tools
Go Green Initiative	https://gogreeninitiative.org/wp/	Grass roots initiative of parents, teachers, and children seeking to create a culture of conservation
Pulse of the Planet	http://www.pulseplanet.com/	Online radio series provides two-minute sound portraits of, blending interviews with extraordinary natural sounds
Green Map System	http://www.greenmap.org/greenhouse/about	Provides tools for mapmaking that permit children to create maps that show the cultural and environmental state of their communities

The second essential foundation concerns knowledge regarding environmental processes and systems. This permits gifted children to demonstrate an understanding of natural systems, habitats, and various changes that occur in the physical environment (Neihart & Teo, 2013; Renzulli & Reis, 2014; Tomlinson, 2001; Treffinger et al., 2004; Ward, 1980). Through this objective, gifted learners study the interconnectedness of the many facets of the Earth and come to understand the delicacy and balance of the Earth's systems — this knowledge is necessary for gifted children to understand what is at stake and to take an interest in sustainability (Michaels, Shouse, & Schweingruber, 2008; Spellman & Stoudt, 2013; Tomlinson, 1999). These objectives are often extant within the current science curriculum, meaning that the foundation for sustainability education is already present and can be adjusted to be developed further (Schroth et al., 2011; Tomlinson et al., 2009). In the early grades, gifted children can focus on broad concepts, such as energy in nature, the water cycle, and elements of ecosystems (Corash & Jones, 2012; U. S. Partnership, 2009). An increased understanding of how the Earth works can lead gifted children to the examination of resources, how humans use them in their daily lives, and their relative availability (Fraleigh-Lohrfink et al., 2012; Spellman & Stoudt, 2013). In connection with this, students can examine the results of using these resources, including related jobs, environmental impact, and how to decrease dependence on nonrenewable resources (Johnson & Kendrick, 2005; Robinson et al., 2014). The results of this investigation can be presented in a variety of ways, either through more traditional methods such as posters or essays, or using electronic resources and tools, such as podcasts, iMovie, or a blog. Gifted learners in middle school can learn more about exchanges in natural processes, such as succession and evolution, and take a closer look at biodiversity and how it ranges around the world (Spellman & Stoudt, 2013; U. S. Partnership, 2009). Additionally, gifted middle school students can examine the human impact on biodiversity, how humans change their environment, and how these factors vary over different cultures (Spellman & Stoudt, 2013; U. S. Partnership, 2009). Students also learn which natural resources can be found in their area and how other resources such as gasoline and electricity reach their community (Spellman & Stoudt, 2013; U. S. Partnership, 2009). Taking this information, and organizing it into a cogent and compelling narrative assists gifted learners in helping them to grasp the underlying concepts underlying this information (Bransford, Brown, & Cocking, 2000; Ford, 2010; Perkins, 1992). By the time students reach high school, they are prepared to mesh these ideas and create hypotheses of how populations, and more specifically, their generation, will respond to environmental changes (Smyth et al., 2000; Treffinger et al., 2004). This can be tailored to the students and their community, and can be detailed to expand into social studies and literature (Jones & Hébert, 2012; Taber, 2000). For example, students can explore how environmental quality affects economic policies, how the risks of pollutants are shared with the populations at risk, how technology has changed the way humans harvest and use resources, and how natural resource trade impacts international relations. High school students can also benefit from exploring careers in resource management and other related fields (Tomlinson, 1999; Tomlinson et al., 2003; Treffinger et al., 2004).

The third essential foundation, investigation of sustainable practices, elaborates on these concepts. This set of objectives guides gifted children so that they are able to identify environmental issues, the groups of people that are affected, and how society responds to these problems. These sorts of activities are ideal for helping gifted children make sense of the world around them and to build the skills necessary to investigate real-world problems (Feldhusen & Treffinger, 1980; Renzulli & Reis, 2014; Tomlinson et al., 2009). In the early grades, students show an understanding of the relationship between humans and the environment by identifying proposals for sustainability and which groups of people are involved in making changes (Spellman & Stoudt, 2013; U. S. Partnership, 2009). Gifted elementary school students might, for example, investigate whether sufficient parkland exists within their community and, based upon their determination, identify those groups that might be able to change this for the better. Middle school students explore how human beliefs and values play a role in sustainability, with the goal of exploring both sides of the issue and improving their ability to determine the credibility of sources (Spellman & Stoudt, 2013; U. S. Partnership, 2009). Students also revisit questioning and analysis, and use these skills in ways that will support these investigations, but that will also transfer to other subjects (Renzulli & Reis, 2014; Tomlinson et al., 2009; Treffinger et al., 2004). By high school, gifted learners have advanced to understanding the human activities that contribute to or support a sustainable environment and how societal values have changed or developed in response.

Fourth and last, the decision and action skills foundation outlines how gifted children can put their knowledge to use by identifying individual actions that impact sustainability, evaluating the reasons why people feel strongly about these issues, and communicating information in a variety of formats (Bland et al., 2010; Perkins, 1992; Roberts, 2013). Younger students can make posters to raise

awareness of sustainability issues and learn how they can influence an environmental issue individually or as part of a group (Gökdere, 2011; Kim et al., 2014; VanTassel-Baska, 2008). Topics covered for this might include a recycling program, an initiative to ban disposable plastic water bottles, or a similar theme. By the end of middle school, students will have a basic knowledge of the politics involved in sustainability, including the budgeting that is allotted for sustainability and the governmental organizations that are responsible for managing environmental issues (Spellman & Stoudt, 2013; Taber, 2010). The middle grades thus present an ideal time for gifted children to attend meetings of the city council, subcommittees of the state legislature focused upon parks or sustainability, or other such governmental entities. By high school, students can express their personal views on sustainability and create an action plan regarding the steps they will take to be sustainable adults (Johnson & Kendrick, 2005; National Research Council, 2000; Smith, 2011). They will learn about the political and legal courses of action that are used to determine the outcome of an environmental issue and choose to take a stand by contacting government officials regarding sustainability.

Conclusion

When working to develop a curriculum that explores environmental issues, a key point across age groups is the identification of individual actions that impact sustainability and evaluation of the reasons why people feel strongly about these issues (National Research Council, 2000; Smutny & von Fremd, 2009). There is an abundance of information pertaining to sustainable living. By introducing it in steps each year and building upon gifted learners' prior knowledge and experiences, educators can help to shape a generation of young minds that think about and work on issues related to sustainability (Michaels, Shouse, & Schweingruber, 2008; Spellman & Stoudt, 2013). Making sustainability a focus of all academic subjects and interweaving it with other curricular topics helps teachers and students to recognize the centrality of its value to our world (Feldhusen & Treffinger, 1980; Tomlinson et al., 2009; Ward, 1980).

References

Bland, L. C., Coxon, S., Chandler, K., & VanTassel-Baska, J. (2010). Science in the city: Meeting the needs of urban gifted students with Project Clarion. *Gifted Child Today, 33*(4), 48-57.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn: Brain, mind, experience and school. Washington, DC: National Academy Press.

Corash, D. N., & Jones, M. (2012). Keeping young gifted students engaged through science. *Understanding Our Gifted, 25*(1), 9-15.

Davis, J. M. (2010). *Young children and the environment: Early education for sustainability*. New York: Cambridge University Press.

Dombrowski, K. (1972). *Psychoneurosis is not an illness*. London: Gryf Publications.

Dombrowski, K., & Piechowski, M. M. (1977). *Theory of levels of emotional development* (Vols. 1 & 2). Oceanside, NY: Dabor Science Publications.

Drapeau, P. (2014). *Sparking student creativity: Practical ways to promote innovative thinking and problem solving*. Alexandria, VA: ASCD.

Feldhusen, J. F., & Treffinger, D. J. (1980). *Creative thinking and problem solving in gifted education*. Dubuque, IA: Kendall/Hunt Publishing Co.

Ford, D. Y. (2010). Underrepresentation of culturally different students in gifted education: Reflections about current problems and recommendations for the future. *Gifted Child Today, 33*(3), 31-35.

Fraleigh-Lohrfink, K. J., Schneider, M. V., Whittington, D., & Feinberg, A. P. (2013). Increase in science research commitment in a didactic and laboratory-based program targeted to gifted minority high-school students. *Roeper Review, 35*(1), 18-26. DOI: 10.1080/02783193.2013.740599.

Gökdere, M. (2011). Knowledge levels of science and classroom teachers about giftedness concept. *Problems of Education in the 21st Century, 28*, 19-32.

Gray, D., Colucci-Gray, L., & Camino, E. (Eds.). (2009). *Science, society, & sustainability: Education and empowerment for an uncertain world*. New York: Routledge.

Hausamann, D. (2012). Extracurricular science labs for STEM talent support. *Roeper Review, 34*, 170-182. DOI:10.1080/02783193.2012.686424.

Heilbronner, N. N. (2013). Raising future scientists: Identifying and developing a child's science talent, a guide for parents and teachers. *Gifted Child Today, 36*(2), 114-123. DOI: 10.1177/1076217512474979.

Johnson, S. K., & Kendrick, J. (Eds.). (2005). *Science education for gifted learners*. Waco, TX: Prufrock Press.

Jones, J. K., & Hébert, T. P. (2012). Engaging diverse gifted learners in U. S. history classrooms. *Gifted Child Today, 35*(4), 252-261. DOI: 10.1177/1076217512455476.

Kahyaoglu, M. (2013). A comparison between gifted students' and non-gifted students' learning styles and motivation styles toward science learning. *Educational Research and Reviews, 8*(12), 890-896.

Kim, K. H., VanTassel-Baska, J., Bracken, B. A., Feng, A., & Stambaugh, T. (2014). Assessing science reasoning and conceptual understanding in the primary grades using standardized and performance-based assessments. *Journal of Advanced Academics, 25*(1), 47-66. DOI: 10.1177/1932202X14520946.

Michaels, S. A., Shouse, A. W., & Schweingruber, H. A. (2008). *Ready, set, science! Putting research to work in K-8 science classrooms*. Washington, DC: National Academies Press.

National Research Council. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: National Academies Press.

Neihart, M., & Teo, C. T. (2013). Addressing the needs of the gifted in Singapore. *Journal for the Education of the Gifted, 36*(3), 290-306. DOI: 10.1177/0162353213494821.

Newman, J. L., & Hubner, J. P. (2012). Designing challenging science experiences for high-ability learners through partnerships with university professors. *Gifted Child Today, 35*(2), 103-116. DOI: 10.1177/1076217511436093.

Perkins, D. (1992). Smart schools: Better thinking and learning for every child. New York: The Free Press.

Pride, L. D. (2014). Using learner stories to capture "gifted" and "hard-worker" mindsets within a NYC specialized high school for the sciences. *Theory into Practice, 53*, 41-47. DOI: 10.1080/00405841.2014.862121.

Renzulli, J. S., & Reis, S. M. (2014). *The school-wide enrichment model: A how-to guide for talent development* (3rd ed.). Waco, TX: Prufrock Press.

Roberts, J. L. (2013). The Gatton Academy: A case study of a state residential high school with focus on mathematics and science. *Gifted Child Today, 36*(3), 193-200. DOI: 10.1177/1076217513486649.

Robinson, A., Dailey, D., Hughes, G., & Cotabish, A. (2014). The effects of a science-focused STEM intervention on gifted elementary students' science knowledge and skills. *Journal of Advanced Academics, 25*(3), 189-213. DOI: 10.1177/1932202X14533799.

Schroth, S. T. (2007). Gifted English language learners: Developing talent while supporting English-language acquisition. *Gifted Education Press Quarterly, 20*(2), 5-9.

Schroth, S. T. (2015). STEMming the tide: Using the common core standards to enhance gifted children's exposure to and education in the arts. *Gifted Education Press Quarterly, 29*(1), 2-6.

Schroth, S. T., Helfer, J. A., Beck, D. L., & Swanson, B. L. (2011). *Planning differentiated instruction and assessing results: Teaching to assure each learner's success*. Dubuque, IA: Kendall/Hunt Publishing Co.

Schroth, S. T., Helfer, J. A., LaRosa, D. M., Lanfair, J. K., & Mahone, C. D. (2011). Integrating sustainability education concepts into K-12 curriculum. In J. Newman (Ed.), *Green education: An A-to-Z guide*. Thousand Oaks, CA: SAGE Publications.

Schroth, S. T., Helfer, J. A., Varela, A., & Scott, Jr., L. L. (2013). Parenting Gifted Children: Making Choices and Decisions that Cultivate Optimal Development. *Illinois Association for Gifted Children Journal, 13*, 7-14.

Seo, H., Lee, E. A., & Kim, K. H. (2005). Korean science teachers' understanding of creativity in gifted education. *The Journal of Secondary Gifted Education, 16*(2/3), 98-105.

Smith, K. J. (2011). *Challenging units for gifted learners: Teaching the way gifted learners think—science*. Waco, TX: Prufrock Press.

Smutny, J. F., & von Fremd, S. E. (2010). *Differentiating for the young child: Teaching strategies across the content areas, PreK-3* (2nd ed.). (2010).

Smutny, J. F., & von Fremd, S. E. (2009). *Igniting creativity in gifted learners, K-6: Strategies for every teacher*. Thousand Oaks, CA: Corwin Press.

Smyth, M. M., Collins, A. F., Morris, P. E., & Levy, P. (2000). Cognition in action (2nd ed.). Hove, East Sussex: Psychology Press, Ltd.

Sousa, D. A., & Tomlinson, C. A. (2011). *Differentiation and the brain: How neuro-science supports the learner-friendly classroom*. Bloomington, IN: Solution Tree Press.

Spellman, F. R., & Stoudt, M. (2013). *Environmental science: Principles and practices*. Lanham, MD: Scarecrow Press.

Subotnik, R., Olszewski-Kubilius, P., & Worrell, F. C. (2011). Rethinking giftedness and gifted education: A proposed direction forward based on psychological science. *Psychological Science in the Public Interest, 12*(1), 3-54. DOI: 10.1177/1529100611418056.

Taber, K. S. (Ed.). (2007). *Science education for gifted learners*. New York: Routledge.

Taber, K. S. (2010). Challenging gifted learners: general principles for science educators and exemplification in the context of teaching chemistry. *Science Education International, 21*(1), 5-30.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2003). *Fulfilling the promise of the differentiated classroom: Strategies and tools for responsive learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A., Kaplan, S. N., Renzulli, J. S., Purcell, J. H., Leppien, J. H., Burns, D. E., Strickland, C. A., & Imbeau, M. B. (2009). *The parallel curriculum: A design to develop learner potential and challenge advanced learners* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Tomlinson, C. A., & Moon, T. R. (2013). *Assessment and student success in a differentiated classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.

Treffinger, D. J., Isaksen, S., & Stead-Doval, B. (2006). *Creative problem solving: An introduction* (4th ed.). Waco, TX: Prufrock Press.

Treffinger, D. J., Young, G. C., Nassab, C. A., & Wittig, C. V. (2004). Enhancing and expanding gifted programs: The levels of service approach. Waco, TX: Prufrock Press.

Trna, J. (2014). IBSE and gifted students. *Science Education International, 25*(1), 19-28.

United States Partnership for Education for Sustainable Development (U. S. Partnership). (2009). *National education for sustainability K-12 student learning standards* (3rd ed.). New York: Author.

VanTassel-Baska, J. (2008). Curriculum development for gifted learners in science at the primary level. *Revista Española de Pedagogia, 66*(240), 283-296.

Ward, V. S. (1980). Differential education for the gifted: A perspective through a retrospective (Volume 2). Ventura, CA: Ventura County Superintendent of Schools Office & National/State Leadership Training Institute on the Gifted and Talented.

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The Single Sheet of Paper Challenge

Harry T. Roman
Inventor, Author, Teacher, Retired Engineer

I cannot remember how many times in the last twenty years I have used this wonderfully creative activity – having given it to both students and teachers. Every time I have been surprised by how teams of student see and solve this problem.

This team activity is best served with 4-5 members per team. Make sure to divide your students into equally balanced teams with both head and hand- learners on each team, so they can learn from each other. It's a simple design challenge…

> "Each team may do whatever they want to a single sheet of Xerox ® paper, just so long as it supports their history book 1 inch off the table."

Have some scissors, a little tape and some things like rulers, pencils and such available. It will be OK for them to use a little tape, but not excessive amounts of it. The key is to get the paper to do the work (no taping of the book supporting structure to the table!).

The Fun Begins

All teams usually begin by trying to manipulate the paper so as to increase its strength. There is not a great deal of deductive reasoning at this point; as most teams are anxious to crumple, fold, twist, and bend paper to get the challenge underway. The teams

are running on instinct at this point and flying by the seat of their pants. In almost all cases, students ignore the "1 inch" criteria … but for now that is OK.

Generally, students end up crumpling the paper and trying to see if that will let them support the book. Walk around with a ruler doling out the bad news about that pesky "1 inch" request. It's as if most students are so much more concerned with simply supporting the book, rather than meeting the "1 inch" constraint.

Students also often fold the paper into a long strip and usually tape it into a cylindrical form and then attempt to balance the book on this shell of paper. Again, our trusty ruler reveals a continued lack of respect for the "1 inch" criteria. Some students at this stage will try and add more books to their paper foundation and see how many books they can support. The urge to compete is great….but keep pushing them to meet that "1 inch" criteria.

A team or two may just by luck hold a book off the table at 1 inch or maybe a bit more. They may also become adept at balancing about 4-8 books on a shell of paper. Here is where they resort to the tape to make the paper immune to crumpling. Eventually they fail at maybe 10-12 books. At this point, call a breather and inject some tips about thinking the problem through…

> "All teams — listen-up: that 1 inch request is important. You need to pay attention to it. Many of you are having trouble balancing the books on your single paper support. Think about how you can make that book more stable. How are things supported in the real-world? What makes a table so strong?

Trying Harder

At this point some lights go on and students realize they can cut the single sheet of paper to make supports for the corners of their book. Some teams also choose a triad design as well, using three supports instead of four.

Away we go again with the urge to pile books up. Alas, the "1 inch" request still gets little serious play. Teams are back to crumpling and folding paper most furiously. Now they might by luck get perhaps 12-18 books off the table, but they are far from the "1 inch" criteria. Frustration starts to set in, as teams bend the rules, trying to force a solution. Lots of tape will be used in a vain effort to make the paper very strong. Or some students will try using more than 1 sheet of paper.

It's now time for a little talk on engineering and a common material all around us. By tearing a piece of cardboard, students see why the cardboard is so strong. The inside is a rolled and glued column-like structure. Discuss how this type of construction provides great strength – emphasizing the columns of paper that run through the sheets of cardboard perform the same function as columns in a building.

> "Engineers have built cardboard structures so strong, they can hold up battle tanks. Surely, this class can design some paper structure that can hold up some books … 1 inch off the table."

Now focus hard on the "1 inch" criteria. This is where engineers start – with the specifications about exactly what is needed. The "1 inch" is what gets the planning process started, because planning comes before building anything. In fact, more than 50% of any project is analysis and planning. The rest is pretty straightforward after that. But here in class, it seems to be all building and no planning.

Soon the teams are experimenting with columns, and eventually they begin constructing columns from 1 inch strips of paper they measure and cut from a single sheet of paper. As they learn how to make the columns nice and tight and seal them with a little tape, the number of books they can support radically increases … while they meet the 1 inch criteria.

Flushed with success, the students now scramble for books; and if they don't get over-anxious and load them up carefully … we're talking something like 25+ books nicely piled up and still exactly "1 inch" off the table. Use the floor at this point for the column test as it is much easier to stack the books that way. Desks can wobble under the weight of the books.

I have seen piles over 40 books in height and one as large as 52. With each history book estimated at 5 pounds, we are talking in excess of 200 pounds supported on paper columns!

Some Final Words

This exercise drives the flowing points home:

1) The key to success is in the details and the specifications given about what the solution must satisfy;
2) Those specification details drive the design challenge, and hence the analysis and planning for a successful project;
3) We all want to "do" the challenge, and get caught up in the excitement. The right thing is to step back and understand the problem;
4) Jumping around, trying one thing and then another, just wastes time and makes for frustration; and,
5) Real creativity starts with understanding exactly what the specifications are and innovating around them.

This is an exercise where hand-learners can often shine, able to see solutions before their book-learner counterparts. Have fun with this activity, and remember … the key is in the details and that 1 inch specification. Have plenty of books on hand!

In one class, we ran out of books and team members resorted to placing students on top of the book piles they had already created…..and the little columns of paper took the weight! Be prepared as this challenge generates all sorts of enthusiasm and competition.

Dr. Ben Carson: Redemption through Giftedness

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"Someone told me that creativity is just learning to do something with a different perspective. So maybe that's what it is – being creative." From ***Gifted Hands*** by Ben Carson. p. 81.

Over forty years ago, Dr. Maurice Fisher and I were privileged to be students of one of the greatest theoreticians of education – Dr. Virgil S. Ward (deceased in 2003). Ward's model of giftedness emphasized the synergy of cognitive, affective and social areas. It also emphasized that giftedness was not just having the right learning skills and test scores but was also related to goals, purposes and realms of meaning. Dr. Ben Carson is an example of a highly successful and gifted individual who in addition to having effective goals, purposes and meaning is also concerned with creating a personal mission to help humanity.

Mentors and support systems have been very important for Carson. His first and major network was his family, i.e., his mother and brother. His mother, Sonya, was a very unique individual – a petite woman who was married and had children in her early teens. Her husband abandoned the family when the children were young. Sonya then became a single parent who constantly worked at several jobs to provide for her sons. Despite her non-literate status, she had a tremendous respect for education. She would come home tired and weary, but the first things she asked her sons were, "What have you learned in school today?" "What books are you reading?" This 5 feet 3 woman would not hesitate to challenge the school administration on the career goals they set for her sons. Rather than being placed in a non-academic program, she insisted that they remain in an academic course of study and stressed that they had the ability to do this. Her most important assets for her sons were that she believed in their potential for success, and they should have self-confidence. Ben Carson's next important mentor was his older brother, Curtis. When he was in middle school, he had problems controlling his temper, and his brother helped him to resolve these problems. Curtis later became a successful mechanical engineer.

Members of the Seventh-Day Adventist Church were also effective mentors. One of principles of this church is maintaining good health and a healthy diet. The role of the missionary doctor was also revealed to Carson as another important principle. In addition, he had many excellent academic mentors from middle school, high school and through his medical training. One of the most unique aspects of his medical practice was that he perceived his patients and their families as being helpful mentors. Desperate parents of neurologically impaired children would come to see Carson when he was Director of the Pediatric Neurosurgery Division at Johns Hopkins University (Professor Emeritus). His ability to give parents hope for their children's survival was amazing where he was truly the court of last resort for them and their parents.

His wife Candy has been an ongoing mentor. She shared his vision of using his giftedness for the benefit of humanity. In this regard, Carson demonstrates that there does not have to be a separation between scientific and cultural interests. For example, he is not only an admirer of classical music but has encouraged his wife and sons to become involved in classical string quartet performances. Also, the Carson Scholars Fund provides college scholarships to thousands of promising students.

Carson had constantly applied his giftedness to making risky decisions in medical practice. For the sake of his patients, he would innovate by designing new brain surgery techniques to save their lives, and was a master technician of on-the-spot applications. He is also a great respecter and practitioner of synergy. Every operation he performed has involved the participation of highly skilled staff members from the Johns Hopkins community – nurses, anesthesiologists, plastic surgeons, medical technicians, blood experts, immunologists, radiologists, computer experts and so forth.

Throughout his life Dr. Ben Carson has constantly given back to his community. When he was at Yale University, he and his wife were recruiters in the Detroit area for attracting gifted minority students to Yale. He constantly emphasizes that making good decisions are as important as obtaining high test scores. His career and life are about creating a nexus between giftedness, creativity, and human redemption.

References

Carson, Ben. (1996). ***Gifted Hands: The Ben Carson Story***. Grand Rapids, MI: Zondervan.

Carson, Ben. (1996). ***Think Big: Unleashing Your Potential for Excellence***. Grand Rapids, MI: Zondervan.

Carson, Ben. (1999). ***The Big Picture: Getting Perspective on What's Really Important in Life***. Grand Rapids, MI: Zondervan.

Carson, Ben. (2007). ***Take the Risk: Learning to Identify, Choose, and Live with Acceptable Risk***. Grand Rapids, MI: Zondervan.

Carson, Ben. (2012). ***America the Beautiful: Rediscovering What Made This Nation Great***. Grand Rapids, MI: Zondervan.

Carson, Ben & Carson, Candy. (2014). ***One Nation: What We Can All Do To Save America's Future***. New York: Sentinel.

Fisher, Maurice D. (Editor). (2003). ***Ten Tributes to Professor Virgil S. Ward***. Gifted Education Press Quarterly. *17* (3), pp. 1-13.

Ward, Virgil S. (1961). ***Educating the Gifted: An Axiomatic Appoach.*** Columbus, OH: Charles E. Merrill.

Ward, Virgil S. (1980). ***Differential Education for the Gifted***. Los Angeles: N/S-LTI-G/T.

Ward, Virgil S. (1983). ***Gifted Education: Exploratory Studies of Theory and Practice***. Manassas, VA: Gifted Education Press.

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