THE NEEDS OF HIGH SCHOOL GIFTED CURRICULUM

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ABSTRACT

The development of high quality curriculum is a shared vision between educators, administrators, and developers, and, as a result, large publishers, school districts, and individual teachers develop disparate curriculums. To make things more complicated, the curricular needs of gifted learners differ from those in general education settings - a point that is especially true in high school science classes. Science curriculum is particularly poised to meet the unique needs of gifted learners. The sciences can provide many opportunities including greater depth and complexity and/or accelerated materials.

Keywords: *curriculum, school, gifted, science*

HIGH SCHOOL GIFTED SCIENCE CURRICULUM

The development of high quality curriculum is the goal of any educational institution. The measure of the quality of these curricula is standardized assessment. National legislation, such as No Child Left Behind (NCLB, 2002) and the Every Child Succeeds Act (ESSA, 2015), has added high stakes testing as a measure of success. Generally four subject areas are the primary focus of standardized testing: English Language Arts (ELA), mathematics, science, and social studies. However, many times the central focus is on ELA and mathematics. As a result, science and social studies are often neglected areas in the classroom. Despite controversy over the effectiveness and appropriateness of these assessments the results are regularly used to both develop new curriculum and modify existing curriculum.

Corporate developed curriculum dominates the educational landscape. The educational wing of publishing companies develops many of the nationally distributed curricula. These curricula are developed for a given grade and skill level. These curricula include activities for students to complete in class. Lessons are provided with a script that the teacher can read to students and pre-developed activities, which are usually divided into "below level", "on level", and "above level". While there is a three-tiered level of differentiation it is very narrow with little adaptability. There are smaller companies that develop their own programs to be ancillary to the primary curriculum, and many of these ancillary curricula focus on science instruction. Some of these programs are designed to use everyday household items for science activities while others have material that can be purchased directly from the publisher. Entire school districts, individual schools, or even individual teachers can buy programs. Because these curricula are for sale, companies have to consider sales based factors such as marketability, profit, and appeal to adults. Those concerns do not always align with student needs.

Other curricula are created and distributed by non-profit organizations. There are both national non-profits programs, such as Project GLAD and Eureka Math, and regional non-profits that operate within a single city or state. Examples in New Mexico are the programs Cooking with Kids and Kids Cook. These are two nutrition and food awareness programs that have developed to fit a need in the local community. Curriculum designed by non-profits is often developed in response to an area of need. These programs design curriculum that aligns with national and state standards and fills the curricular gap. Their implementation is limited by funding and is often adopted at specific school sites.

If a district does not wish to purchase a new curriculum they can create their own. This is often a long and difficult process that requires expertise in curriculum design. School districts are in a good position because of the accessibility to teachers who are already experts in the implementation of the material. To develop the curriculum, these teachers have to either be removed from the classroom and be temporarily replaced or work outside the normal school day. Either way it can be a long and expensive process for a district. Curriculum can be created or supplemented on a school-based level as well. The same issues apply as for a district created curriculum but, because of the smaller size, there is more burden on an individual school. With the current trend of diminishing budgets schools have difficulty justifying staff members who are not working directly with students on a regular basis.

The gap in what is needed for a specific population and what is available often leads teachers to create their own curriculum. This is especially true for science fields where available curricula often lack depth. Barry Bull (1990) argues that teachers do not have true autonomy in the classroom but rather are controlled by the expectations put on the classroom from political, administrative, and societal sources. These sources factor into the creation or adaptation of curricula. Curriculum may or may not fit the needs of the students in a particular location or population. Experience with the subject matter is important for the construction of quality curriculum. It is more difficult and less effective to rely on teachers that are new to a school or subject area. When teachers are familiar with a subject area, they are able to implement curriculum with greater efficiency; these teachers are also better suited to adapt curriculum to the needs of specialty learners.

There are many factors that need to be evaluated in the creation of curriculum within the classroom. The teacher needs to be able to evaluate student base knowledge before they are able to develop the trajectory of what students need to know next. Base knowledge is compared against standards to make sure that local expectations of learning align with federal expectations. Curriculum developers need to procure or create the materials needed to implement the new curriculum, which may include other curriculum components such as textbooks, workbooks, and manipulatives. Especially important for science lessons is the availability of science equipment. Science equipment is often expensive and not all schools have dedicated science labs. Grants and other forms of outside funding can address these needs.

Once classroom created curriculum is prepared it needs to be reviewed. Both large and small curricula should go through the same stringent process to determine the level of effectiveness towards objectives. Assessment and student data are collected and compared against the curriculum. Strengths and weaknesses are identified and adjusted to strengthen the program. Classroom curriculum needs to be put through a rigorous level of review involving impartial outside examination. The review will also help determine the next steps for improving the execution of the curriculum. This can include new materials, equipment, and professional development. The evaluation of curriculum should involve triangulation with outside sources that are familiar with curriculum development.

Curriculum must have a level of accountability. When curriculum is developed in the classroom there must be an appropriate assessment to measure student success with the material. Assessments should be implemented regularly to show specific content knowledge as well as overall growth or regression. Data from assessments must be evaluated quickly in order to make adjustments to meet students' immediate areas of need. If students are showing a deficiency in any area, the curriculum can be adapted. The assessments, therefore, will be used to make adjustments to the curriculum. The assessment will also identify which students will need additional tier 1b, tier 2, or tier 3 support. Tier 1b and tier 2 supports are classroom interventions implemented to help "at risk students." If these interventions are unsuccessful students will be referred to special education where, upon qualifying, they will receive tier 3 support. Tier 3 support is targeted instruction and curricula in a special education classroom. A potential downside is that the creation of teacher-developed curriculum is time and labor intensive and requires an individual or group of individuals who are experienced in designing curriculum.

Curriculum Within the Classroom

For many teachers curriculum development is a single semester class taken during a teaching program and rarely revisited, especially in the initial years of teaching. Most experience for teachers comes from first hand interactions with curriculum and periodic professional development. Professional development is often targeted to implementation and assessment of an established curriculum and rarely directly addresses elements of curriculum development.

If teachers do not want to create their own, science curricula are available for purchase from various organizations. However, much of the large-scale science curriculum is designed for superficial rote learning and thus lacks depth and complexity. Depth and complexity are essential for the development of higher order thinking and science based skills (Çalikoglu, & Kahveci, 2015). Programs are designed for ease of use by teachers and for student academic success. Student academic success is measured by large-scale state and national tests. Curriculum developed by publishers is designed to directly address the skill sets measured on such tests. Student success can additionally be measured by assessments created by the same company who created the curriculum.

The curriculum and student assessments should be closely aligned. A strong assessment will be used to adjust and update the curriculum. Student results should be tracked and compared over multiple years in order to improve upon the curriculum. An expert in curriculum needs to be able to measure the validity and reliability of the assessment to determine if it is truly measuring the success of the curriculum. It becomes a little bit of a chicken-and-the-egg scenario as to which should be developed first. Best practices would recommend that once a curriculum and assessment are well developed they should not be quickly replaced. Many district implement mandatory textbook adoptions around a set schedule regardless of how the curriculum is impacting students. With the current focus on high stakes testing, core and special education curricula take the primary focus. Gifted curricula are often overlooked entirely in this process.

Outside foundations and companies supply targeted science curriculum to fit the needs of particular districts. An example is the nonprofit Santa Fe Science Initiative, which provides professional development for teachers as well as premade science kits for use in classrooms. Similarly Albuquerque Public Schools uses house made science kits combined with the nationally purchased Amplify program. Science kits are designed around a theme such as weather, states of matter, or the water cycle and contain a series of activities as well as student and teacher materials. Amplify is a basal program with a set progression developed around a series of experiments. These programs contain both teacher and student materials. Within these materials there is a minimal amount of differentiation. Amplify was purchased on a large scale and was therefore expensive to implement. To save on costs at adoption, the district chose not to purchase consumables, the raw material, for the experiments. They instead moved the expectation to the schools and individual teachers.

Once a curriculum has been either purchased or developed schools have to consider fidelity of implementation. Teachers implementing the curriculum must be well trained initially and then receive follow up trainings to maintain the structure of the program. Once teachers are trained, the school has to consider turnover of staff. New staff members require initial training. If this is not a point of focus for a school, teachers end up with varied levels of training and implementation. When this occurs the curriculum fails to have consistent implementation and loses effectiveness.

Gifted Education

Nationally, gifted learners are most often included in the Individuals with Disabilities Education Act (2004). This prevents educational discrimination based upon students' needs. In the state of New Mexico, the identification of gifted students occurs through an Individualized Educational Plan (IEP) and becomes a legally binding contract. Students with an IEP are required to receive the educational exceptions to meet their needs, and if they are not met the district leaves itself open to legal action. This is one of many reasons why gifted learners need to receive high quality curriculum designed to meet their needs. Gifted learners are classified as tier 3 learners receiving additional interventions to meet their needs.

The paperwork required to complete an IEP is a laborious venture, taking months to fully complete. Teachers must have at minimum ten weeks of intervention data, vision and health screenings, and parent signatures for documented meetings. If the process is not properly completed, paperwork will go unfinished and students will never receive the support they need. Special education, gifted, and twice-exceptional determinations are identified through the IEP process. Twice-exceptional students show evidence of high academic performance and also have a disability that impedes their ability to learn. Twice-exceptional students remain under-represented in gifted programs, and some researchers attribute such under-representation to the negative beliefs and low expectations about twice-exceptional students held by teachers (Missett, Azano, Callahan, & Landrum, 2016).

Different programs are available for learners depending on where they are in their educational careers. In the early primary grades, pullout programs are the most commonly used mechanism for providing gifted content. Students are assigned a level of need and corresponding hours per week or month dependent on their needs. They are then removed to a homogeneous ability classroom for work with a certified instructor. Gifted education classes often incorporate students of different ages. These models of gifted instruction utilize an enrichment model where students go into greater depth of investigation on the material than their peers. The biggest challenge for these models is to modify existing traditional approaches that attend to the intellectual functioning, cognitive resources, and learning characteristics of gifted learners (Riba, Fonseca-Pedrero, Santarén, & Urraca-Martínez, 2015).

In rural areas where there are not enough students to establish full programs, gifted students receive differentiated instruction within the classroom most often from their general education teacher. Instruction must always meet the requirements of the IEP. In some cases students will be grade skipped where they advance to the next grade before their peers or skip a grade entirely. While grade skipping is shown to be an effective form of acceleration it does not maintain popular support (Colangelo, Assouline, & Gross, 2004). Both of these methods rely on standard curriculum with some varied degree of differentiation.

Advanced programs are also commonly used when a student population is large enough to support it. Students are grouped in single or multiage classrooms and given some level of accelerated curriculum. Advanced programs are still required to teach national standards and students are accountable to state tests. These programs require a large enough population of students to warrant a separate teacher and a dedicated space. It also requires a supportive staff that understands the importance and needs of gifted education, but it can often be difficult to move past teacher or administrative preconceived notions.

There are unique contextual factors that are likely to affect the implementation of curriculum interventions. The instruction will take one of the differing grouping arrangements with varying amounts of time devoted to providing direct services to gifted learners (Moon, Park, 2016). The exposure and dosage that students receive varies widely. Class size, student population, and student age will affect the degree of gifted instruction that students will receive as well as the pacing of a curriculum.

Acceleration becomes more common in high school where students are given the opportunity to take Advanced Placement (AP) classes or participate in classes with local universities. Students have the opportunity to work with more difficult material while being given the option to earn college credit. Pull out and dedicated advanced programs are used less frequently in high school settings. Some private schools have chosen to beginning opting out of AP classes to implement their own curriculum with a greater focus on content and less test preparation and memorization of facts (Ramirez, 2008). The burden falls on these organizations to partner with colleges and universities so that students can receive secondary credit for their work while still in high school.

Because of the difficulty in identification of gifted learners in early childhood there are few programs available until students enter at least kindergarten but more often 1st or 2nd grade. The identification of early learners often follows students who are, articulate, confident, read early and well, and are born during September to December. Students are often overlooked for gifted identification if they are quiet, have poor fine and gross motor skills, have English as a second language, or have summer birthdays (Sutherland, 2005). It is not that the students do not show cognitive propensity rather the areas in which the students are tested generally need to have some level of academic training.

The Importance of Gifted Curriculum

The curriculum of gifted programs lays the groundwork for the success of the students. Seven of the 10 variables that Cox, Daniel, and Boston (1985) delineated as being representative of exemplary gifted programs were curriculum based. They go further to state that there is difficulty with inconsistency specifically in science curriculum. Inconsistent curriculum limits the support and eventual success for students while consistency allows students to comprehend expectations and focus on growth.

Science curriculum catches natural curiosity. Early interest in science is rarely matched by the curriculum. This is a pattern that continues into higher-level science classes and underscores the importance of hands-on activities. The standard has been the teacher-centered model where a single instructor transfers material to listening students regardless of their level of engagement (Bradford, Mowder, & Bohte, 2016). If students are subjected to long periods of inactivity they are more likely disengage with the material. Science, more so than other curriculum, offers the opportunities to exercise new knowledge. Students are encouraged to practice new knowledge in science labs or are sent outside the classroom.

Gifted qualities are well described by Vygotsky (1978) who thought that educational assessment should be less about what an individual can currently achieve unaided rather than what is currently just 'out of reach' without help. Students who are able to achieve at exceptional levels in school science, or are able to meet demands beyond those experienced in the classroom, are seldom working within their Zones of Proximal Development and will not develop further. Not only are these learners not being developed but they are in danger of becoming bored (Tabler, 2007).

Gifted students are at a higher risk of dropping out of school than general education students (Norman, 2011). Many experience structural burn out and boredom by high school as gifted learners have become disenfranchised by the current education system. They become frustrated and often disconnect from the material. Much of the core curriculum has been unchallenging and uninteresting, lacking depth and complexity. Students who are turned off from science in high school are less likely to continue into a science-based area of study in college. Boredom and lack of engagement also increase undesirable behaviors in the classroom.

The percentage of students who drop out of school varies widely across different groups of students. The National Center for Education Statistics (1999) collects data on dropout rates, and their national data show that dropouts on average are more likely to be of low socioeconomic status and are more likely to be male than female. 58% of dropouts are male while only 42% are female. Dropout rates are higher among Black and Hispanic youth and lower among Asians in comparison to the rate among White students. Although, numerically, more than half of dropouts are White due to the larger overall number of students who are White. Perhaps the most frequently cited source for the dropout rate among gifted students is the Marland Report (1972), which specifies that 17.6% of dropouts are gifted (in this case, defined as an IQ of 120 or higher). This is often debated due to the lack of consensus on the definition of giftedness.

In science units created at Williams and Mary, problem based learning provides an important catalyst for student learning. Students who worked with the units for a minimum of twenty-five hours showed significant growth gains in the outcomes associated with integrated science processes. They also demonstrated enhanced student and teacher motivation in science learning (VanTassel-Baska, Ries, Poland, & Avery, 1998). Problem based learning is a natural pairing for science curriculum. It also provides students with increased complexity and depth.

In the last twenties years there has been a rise in the number of schools that focus on Science, Technology, Engineering, and Mathematics—commonly referred to as STEM. Science is often defined as the exploration of the natural world and the explanation of the objects and events encountered (Yager, 2015). Technology seeks to answer the problems of the man-made world through engineering and mathematics. Students in STEM programs are presented with hands on, real world applications in the STEM fields. These programs provide a natural environment for gifted learners to pursue their areas of interest. Core learning is added to the learners experience instead of being the focus. STEM programs have an increased focus in visual-spatial reasoning, an area many gifted learners excel in (Anderson, 2014). Importantly, this increased visual-spatial ability is rarely measured in standardized assessments.

With the establishment of STEM schools researchers have looked into who is receiving STEM education. There is an emphasis in education on the representation of students and faculty of different races and ethnicities. There is also a focus in higher education on underrepresentation of racial and ethnic minorities and women in STEM fields (National Science Foundation, 2011). Women have traditionally been turned off from STEM fields and more likely to pursue careers in English, Nursing, Social Work, and Teaching. A disproportionate number of students in secondary STEM fields are male.

The ability of technology and its usage have greatly changed the speed and spread of curriculum. Many programs are being developed through crowd sourcing. A small team of curriculum designers, often comprised of professional curriculum designers or passionate teachers, creates a program structure. Other teachers are then trained in a particular model and upload their own curriculum to a central database. Any teacher is then able to access, edit, and further develop and curriculum. Some of the programs are free to use while others require contract agreements. There are several advantages and disadvantages of this model. Specific needs can be directly addressed in the form of curriculum development such as the needs of gifted high school science. Quality can vary greatly, however, as curriculum is continually altered by different people.

The Need for Depth and Complexity

Gifted students who receive greater levels of depth and complexity in their instruction also show a positive correlation to their attitudes towards sciences (Çalikoglu, Kahveci, 2015). Students who are challenged and motivated become more excited and engaged in their curriculum. This is true in all subject areas but especially so with the hands on nature of science curriculum. Science curriculum provides students opportunities to exercise knowledge and pursue their areas of interest using scientific methods and experimentation. The curriculum needs to be flexible to accommodate the specific interests of gifted learners. Many large curricula follow set progressions that are based off state standards, which limit the opportunities for students.

National standards are just as applicable to gifted learners as any other students. Gifted education must move through individualized sets of state standards, reorganizing, compressing, and adding as needed, to develop and maintain a coherent framework for gifted student learning (VanTassel-Baska, 2003). Because of the varied nature of giftedness and the ever-evolving definition, standards need to be accommodating and continually adapted to the needs of the individual learner.

There are several advantages that are associated with increased depth and complexity in curriculum. Findings reveal that increased depth and complexity positively affect gifted and non-gifted students' understanding across the disciplines. Gifted students' understanding was greater than non-gifted students' understanding, and gifted and non-gifted students perceive prompts of depth and complexity to be helpful, interesting, and challenging (Dodds, 2010). Both depth and complexity are essential for the creation of meaningful curriculum for gifted learners however many basal programs lack these aspects in their curriculum. In addition, current standardized assessments do not take depth of knowledge into consideration.

Gifted curriculum must have a focus beyond basic skills (Northwest Regional Educational Laboratory, 1999). Gifted curriculum should have hands on, real world experience. One way to engage students in more complex curriculum is to create internships and partnerships with the community. There are many opportunities to partner with highly skilled individuals, small and large businesses, and government organizations. This interaction need to occur on a small scale where connections are made from districts, schools, or even individual teachers. This is an example of where individual teachers and or programs are able to meet a specific need. If those opportunities are not available in the immediate area, then technology can be used to connect students with experts in the field. Video conferencing, remote desktops, and 3d printing allow students to connect with the scientific field like never before. The Smithsonian Museum is currently working on 3d scanning their archives. The scans are made public where students are able to handle a virtual 3d version and print a replica at any scale (Stromberg, 2013).

While, as a discipline, the sciences follow basic methodology, there exists a wide range of material and practices. In small schools or districts a single teacher can be asked to teach multiple disciplines. In a large program those same disciples can be broken into separate departments that may or may not interact on curriculum needs. The materials and resources needed to teach chemistry are not the same needed for biology, physics, geology, or astronomy. This extends to the physical layout of a science classroom itself. While most classrooms are adaptable to different subject areas they do not always meet the specialized needs of the sciences. Science laboratories are often equipped with exhaust hoods, gas lines, and storage for the various teaching tools. The more specific needs of science classrooms can limit the number of students who can fit comfortably into the space.

Class size initially boomed in the early 20th century when children aged 5 to 19 were brought into the school system; however, class size has largely stabilized in the subsequent decades. There have been minor fluctuations associated with increased childbirth and economically stable periods but class size has remained similar to other developed nations (Chingos, 2013). Research suggests that even large sized classes benefit from non-traditional, student-centered approaches to instructions (Gordon, Barnes, & Martin, 2009). With budgetary shortfalls many districts have hired fewer teachers leading to the number of students in a class to creep up. This problem is compiled with nationwide teacher shortages leaving districts scrambling to either eliminate positions or fill vacancies.

The number of students in a class may influence how teachers implement curriculum, instructional pedagogy, and the use of technology (National Center for Education Statistics, 2000). Science curriculum is especially sensitive to the number of students in the class. A greater number of materials and supplies are needed for classes with a greater number of students. Larger classes also reduce the opportunities for students to engage in hands on activities, including experiments. Because of the highly specialized nature of high school science classrooms the number of students in a class can quickly become prohibitive to instructional pedagogy.

What does Gifted High School Science Curriculum Need?

In developing science curriculum for gifted learners, several factors should be included: learning concepts, higher order thinking, inquiry and problem-based learning, the use of technology, and learning the scientific process (VanTassel-Baska, Ries, Poland, & Avery, 1998). Gifted learners move through material at an accelerated pace and should not be slowed to focus on basic skills. This is an opportunity where curriculum acceleration should be considered. The integration of technology has allowed students to access resources that were previously unavailable. Technology has also allowed students to interact with members of the scientific community directly. Time and time again we have seen the need for higher level and critical thinking problems when teaching to gifted learners.

In order to have meaningful reform in science classes, teachers, parents, districts, and administrators need to consider the future structure of their programs. Modular materials should be selected rather than basal materials for classroom use (VanTassel-Baska, Ries, Poland, & Avery, 1998). Teachers should receive content-based training in professional developments. Schools need to be in charge of their own curricular monitoring. Adjustments need to be based on specific needs of the population. All teachers should be trained in the needs of special education, gifted, and twice exceptional students.

Science curriculum is stuck on teaching basic skills. It lacks complexity and depth and thus fails to offer gifted students accelerated materials. Teachers or departments often supplement high school science curriculum from their own base of knowledge. The quality of the curriculum is therefore dependent on the quality and engagement of the teachers. Teachers and administrators alike need to recognize that gifted learners must be challenged in their area of greatest interest and potential expertise (VanTassel-Baska, 2003). It is evident that large-scale curriculum does not meet the needs of gifted learners and especially so in the sciences. There must be comprehensive shifts to the development and implementation of science curriculum to meet the specific needs of gifted learners. The development and maintenance of high quality curriculum is a shared responsibility on everyone in education.

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