

Using an Interdisciplinary Approach with Problem-Based Learning for Gifted Learners

Nathan Cotton

Abstract: Gifted learners and their needs are often inadvertently overlooked. Planning for the needs of all students requires deliberate thought including specific goals. Additionally, tested and reliable instructional methods and techniques should be sought out and implemented within our classrooms to meet the needs of students and problem-based learning, PBL, is one such method. PBL is based on ill-structured, open-ended problems; problems that do not have a correct answer. Gifted learners need the type of learning environment that PBL can create in order to utilize their creativeness, improve their critical thinking, and problem-solving abilities. This manuscript includes an overview of how an interdisciplinary approach with PBL can provide a path to increase opportunities for gifted learners to maximize their potential.

Introduction

I had a unique, year-long experience with a class in the recent past. Two of the most gifted students that I have known during my 23-year teaching career were in the same high school Honors Chemistry class. This class offered both challenges and moments of success concerning the class dynamics but also left me with questions about differentiating for gifted learners. The two students fit the textbook definitions of two types of gifted learners; Dylan (a pseudonym) was an autonomous learner and Sidney (a pseudonym) was a successful learner. Dylan was not driven by grades but by the challenge of learning itself, whereas Sidney would typically only do what was required to earn an A.

During one class period we were studying the classifications of chemical reactions and as an example of combustion reactions we used common hydrocarbons that students come in contact with daily as reactants, such as natural gas (used in heating homes) and octane (found in gasoline). By this time of the year, I was familiar with my student's behavior and mannerisms enough to know that Dylan and Sidney already knew the answers while most of the students in the class were still predicting the products. Sidney very rarely contributed to extending conversations on science subject matter but Dylan consistently wanted to extend topics and this occasion was no different; Dylan connected the production of carbon dioxide in these very common reactions to the concept of global warming and climate change before I had the chance to bring it up.

Dylan asked, "So what are we doing about this?"

I responded to him and the class, "What can we do? Don't we want to maintain our modern conveniences?"

While Dylan's and some of his classmates' responses were centered on popular science and technology-based solutions, Sidney finally spoke up and said, "It's simple, tax the people who produce or use the most carbon dioxide and credit those that don't." At that moment, our discussion turned from one of just science-

centered solutions to a holistic, interdisciplinary discussion. Gifted learners thrive in the type of educational environment that provides them with open-ended questions and freedom of choice. I propose that an interdisciplinary approach with problem-based learning can provide the required parameters to promote growth for gifted learners.

Gifted Learners

According to the Ohio Revised Code (Ohio Department of Education [ODE], 2019), a gifted learner is a student who “performs or shows potential for performing at remarkably high levels of accomplishment when compared to others of their age, experience, or environment.” ODE requires public school districts in Ohio to identify gifted students in categories that include superior cognitive ability, specific academic abilities, creative thinking and ability, and visual and performing arts ability. Students can be identified as gifted in one or more disciplines. Approved, uniform testing measures are used for identification; however, once students are identified by their district, the district is not required to provide any additional services, although the choice not to provide services or to provide only limited services negatively affects the district’s report card. The ODE recently updated the requirements for school districts to earn credit on their district report card for providing gifted education. This scenario leads to a non-uniform application of gifted education practices across the state and magnifies the challenges facing individual teachers trying to maximize learners’ opportunities.

Gifted learners have different needs in regards to their education than either regular or special needs learners. They generally have a greater capacity for learning and creativity than either of those other groups. At the same time, it is important to note that not all gifted learners have the same ability levels or strengths. In my experience teaching in southeastern Ohio, there are roughly an equal number of students identified as gifted learners as learners with special needs. Each of the school districts that I have taught seemed to have held the belief that gifted learners will be successful without intervention; therefore, resources were not generally allocated for the benefit of those students.

It is a challenge when planning curriculum for gifted learners, deciding on course offerings, and determining the distribution of staff and other resources. These challenges do not appear to have easy solutions. Yet differentiation for these students is necessary, and how we go about designing and implementing plans to do so can determine how successful we are.

Differentiation

All students, regardless of their ability, have the right to instruction that is appropriate for their needs (McGrail, 1998) and differentiation is one method to meet diverse student needs. Each individual student has their own strengths and weaknesses in regards to their learning process and differentiating curriculum can benefit all students. The students found on either end of the ability spectrum have the greatest need for differentiation, and can benefit the most from it. That said, differentiation to serve the needs of special needs learners has been common practice in

education for many years, but only recently have the needs of gifted learners started getting some attention.

Differentiation or curricula modification can be accomplished through assignment modification, lesson modification, and scheduling modification (McGrail, 1998). Most high school science classes are heterogeneous groupings of mixed-ability-level students. At the same time, due to scheduling modification linked to tracking, gifted learners are often found in higher-level courses with other motivated and above average learners which may also include students that have missed being identified (Fiero, 2012). This presents opportunities to use techniques such as problem-based learning (PBL) to differentiate through lesson modification. PBL can offer each student in the class an equal opportunity to challenge themselves while also providing the necessary environment for gifted learners to thrive.

Problem-Based Learning

Problem-based learning is a technique used for differentiation that has been adapted in a range of educational settings, from colleges to medical schools to K-12 schools, as a way to support students' development of problem-solving skills. PBL is designed around ill-structured problems, the kind of questions that most adults face in real life (Gallagher, Rosenthal & Stepien, 1992). Most problems that students face in school are well-structured problems; questions and problems that have correct answers. An ill-structured problem has no correct answer, allowing for multiple possible solutions. Consequently, students must develop a knowledge base of relevant information in order to reach a solution (Coleman, 1995). Steps taught in PBL include fact-finding, problem finding, brainstorming, solution finding, implementation, and evaluation. Entire courses can be based on PBL but most often, the problem-based approach is used to present a focus topic within a traditional course (Gallagher, Rosenthal & Stepien, 1992). Since high school science education curriculum is content heavy, I do not believe that it would be feasible to teach entire courses using PBL. Nevertheless, science classes do offer unique opportunities to apply the content to common environmental issues facing society today in a student-centered, problem-based format.

Gifted students and PBL

While all students in a mixed ability level class could benefit from PBL, Gallagher, Rosenthal and Stepien (1992) have argued it can offer more benefits for gifted learners by increasing opportunities for them to use active learning strategies, to engage in higher order thinking and self-directed learning, and to work with advanced content. Learning how to engage in PBL can improve a student's ability to research, manage data, and present and share information, which are all important goals for gifted education (Renzulli, 1994).

Many science teachers may already be familiar with PBL, but I argue that an interdisciplinary approach using PBL can allow gifted high school learners opportunities to merge their discipline-specific knowledge base, their own interests, and their creativity, all while allowing them to work toward possible solutions for the complicated environmental issues that today's society faces. These socio-scientific

issues do not presently have solutions and thus we should not expect our students to solve the actual problems, but rather that attempting to do so would create opportunities for them to work and to learn productively alongside their peers.

Interdisciplinary approach with PBL

According to Margot and Kettler (2019), student-centered instructional strategies used in STEM (science, technology, engineering and mathematics) courses such as PjBL (project-based learning) and PBL have been gaining popularity, shifting away from the traditional lecture based, and teacher-centered strategies. These newer strategies have been found to promote improved critical thinking, students' attitudes toward science, and learning enhanced science content knowledge (Burriss & Garton, 2007). Tamim and Grant (as cited in Keiler, 2018) state that PjBL is a product driven strategy that can be intimidating to teachers. However, PBL may be less intimidating for teachers and students, because while students involved in PBL explore real-world problems in groups, a finished product is not the goal (Coleman, 1995). This difference between PjBL and PBL can make PBL more appealing and less intimidating for classroom teachers looking to transition to a student-centered approach (an approach also favored by gifted learners; McGrail, 1998). Designing units or activities to include disciplines such as the social sciences and/or English Language Arts (ELA) may further provide a route to increase the students' interest in education and better prepare our gifted learners for their future.

Issues that are interdisciplinary by nature, such as global warming and climate change cross multiple science disciplines and have complex explanations that are well supported by scientific experimentation and data that identifies the causes and the included effects on the environment. Even though scientists have presented their findings and gone as far as proposing possible solutions and necessary timelines, a solution to the issues goes beyond science requiring students to engage with content from mathematics, social studies, and ELA.

Science

In order to set the stage for students when developing a PBL activity for an environmental science course, the students need to first be able to rely on content from past science courses in order to work through understanding the underlying science behind issues in question, such as with acid rain. During chemistry courses students learn how acid rain is formed and how the increase in acidity effects the water and soil pH, and the solubility of metals found in rock. Life sciences are needed to explain how plant and animal life are affected by the lower pH and the increased concentration of metals in the water. Students would attack the issue by first researching what has been discovered, already changed, and the associated data. Science courses would be responsible for the portion of the issue that explains the mechanisms and possible solutions. Even though Dylan was ready to hear what science is doing to solve the issues, he and his classmates would soon learn that decisions and policies cannot be enacted based on science alone; we must also consider how other factors such as the political, social, and financial aspects are involved in decision making.

Social Studies

In Ohio schools, social studies departments offer both U.S. government and economics. As taught in our school, U.S. government introduces students to the process involved in making policy and laws, and how organizations such as the EPA operate within the government. Students also learn what information is required by the politicians when making decisions and the effect that lobbyists and special interest groups have on the decision-making process. Economics courses address how policy changes can affect the decisions made by other levels of government, individuals' personal finances and spending, and companies, and how these changes impact the nation's economy as a whole. This is all pertinent to understand and respond to Sidney's comment related to taxation.

When Sidney suggested that we tax those that use the most, how would an individual or company respond and what would the effects be on the nation's economy? Would individuals cut back on personal usage, would they be able to absorb the increased cost of purchased goods because industry would pass their expenses on to the consumers? Would the increased taxation push smaller industry out of business and decrease the workforce? Science and technology have possible solutions and using an interdisciplinary approach, learners would research and evaluate how possible solutions and decisions drive and influence the process of policymaking.

English Language Arts

Presentation and public speaking, skills generally associated with ELA, are necessary for learners to share and communicate their ideas and findings with their peers effectively. Open, effective dialogue is essential in the decision-making process; it extends opportunities to promote cooperation, collaboration, argumentation, and learning from others.

Students often do not connect the importance of communication with the learning process and the overall functioning of society. Many gifted learners fall into this category where their strengths are increased cognitive abilities; they may still lack an ability to communicate effectively. Presenting and sharing information is one of the goals of gifted education (Renzulli, 1994) and incorporating the components into an interdisciplinary PBL activity can help meet that goal.

Conclusion

Students are often uninterested in the topics embedded within our standards, often asking the question, "When am I ever going to use this?" The application of PBL using interdisciplinary methods could provide an excellent example of when they will use the topics and also an opportunity to actually put their knowledge into practice. Learning is much more effective when the students take the concepts they have been introduced to and put them into practice.

Science and social studies courses are the primary areas of focus for researching, gathering and interpreting data and language arts courses play a vital role by providing the instruction and direction for presenting and sharing the information. We are charged as teachers to maximize our learners' opportunities and we can do

so while improving their ability to research, manage data, present and share information. PBL provides an appropriate avenue to reach these goals.

Each of our students have their own strengths, weaknesses and personal interests, which often determines their motivation to learn. While our students probably cannot become experts in every field, they can at least contribute to the process and understanding the problem-solving process, leading them to be readier to take on the responsibility of solving important societal problems as adults.

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About the Author

Nathan Cotton earned his Bachelor of Education in Comprehensive Science and Master of Education and Science in Chemistry from the University of Toledo. He has been a longtime classroom teacher of chemistry and physics, and is currently teaching chemistry at Circleville High School.