Fen, Matematik, Girişimcilik ve Teknoloji Eğitimi Dergisi

Cilt 2, Sayı 1, Ocak 2019

Journal of Science, Mathematics, Entrepreneurship and Technology Education
Vol. 2, Issue 1, January 2019

The Effect of Science Lesson Modules on Gifted Students: The CGA Case

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ABSTRACT

It is a common problem that gifted students need to be challenged. We collaborated with teachers of gifted students to create science lesson modules intended for these academically talented pupils. The research aimed to evaluate the implementation of these modules as a part of standard classroom instruction of CGA. Are our modules beneficial for teacher and students, what are the weak points of our modules, how do we increase their effects are the main concerns about the research. Interviews were conducted with teachers and observations about the classroom teaching made. Student pre and posttests implemented as part of standard classroom instruction and provided information about students' science achievement through modules. As a result, science lesson modules showed a significant difference on teaching. In addition to that we concluded that there are weak points of modules and need to enhance.

Keywords: Science teaching, gifted and talented, classroom instruction, science activities, science modules.

INTRODUCTION

In the United States, gifted programming varies among states and districts. Many differences exist among school districts in their middle school education programs for the gifted. Also, middle school gifted programming is varied in structure, curriculum, and implementation. There is limited research available on middle school education programs for the gifted. Then, to know about the CGA case is important and if there is a need for the science instruction and a solid structure. Also, we know that academically many gifted students cannot have challenging activities appropriate for them in their classes or schools (Reis, 2009; Bachinski, 2009). But it is a fact that gifted students should continue their education lives with differentiated education programs and models (Renzulli, 1999; Cooper, Baum and Neu; 2005), and there is a need for special lesson designs for gifted children (Miller, 2011; Koshy and Robinson, 2006; NGSS, 2013; Tomlinson, 1995). And also we know that the immediate goal for the talent development of gifted and talented students is to provide educational programs that are a better match to students' learning paces and levels of achievement (Olzsevski-Kubilius, 2010). The long-term goal of gifted education is to enable more gifted individuals to become creative producers in adulthood and achieve at the highest levels within their fields (Subotnik et al., 2011). To achieve these goals, researchers suggested implementation models resulted from their researches. Willis (2007) suggests the use of proper, challenging learning activities in which information are analyzed, synthesized and evaluated for improvement of creative problem solving and mental interactions in the field of science. Newman and Hubner (2012), and Taber (2010) draw attention that science education should be differentiated and challenging for gifted students. Assouline, Colangelo, Heo and Dockery (2013) highlight the necessity of challenge of differentiated teaching in an appropriate level. Success of differentiated and enriched programs are examined by researchers from different disciplines and revealed the success and necessity of these programs (Reis, McCoach, Little, Muller and Kaniskan, 2011; McCoach, Gubbins, Foreman, Rubenstein and Rambo-Hernandez, 2014; Shaunessy-Dedrick, Evans, Ferron & Lindo, 2015). So, there is a need for scientific lesson plans for scientifically gifted children when we talk about the national outcomes. Researchers working on this subject also agree about the necessity of this special lesson plans for gifted students.

We saw an opportunity to solve this problem to create lesson modules for science classes. We developed modules on three main subjects: motion, DNA and plastics. Also, the theoretical framework of the modules is based on inquiry. In every steps of the activities during the modules, the inquiry-based instruction shows itself. In science classes inquiry-based instruction suggested by researchers strongly (Abd-El-Khalick, Boujaoude, Duschl, Lederman, Mamlok-Naaman, Hofstein, Niaz, Treagust & Tuan, 2004). The inductive nature of the inquiry-based instruction (Schulz, 2012) made a way for scientific processes. Thus, the modules we developed focused on that nature of the inquiry and the activities were formed by this basis.

This study aimed to evaluate the implementation of science lesson modules as a part of standard classroom instruction of CGA. We aimed to use the data gathered from this study for the preliminary evaluation of the modules and then saw the negative and the positive sides. Accordingly, we aimed to interview CGA science teachers to know about the currently and acted curriculum. We collaborated with CGA teachers to create new lesson plans and try to implement these lesson plans in CGA science classes. Research questions are;

- What are the negative and positive sides of the modules developed according to the teacher after the implementation?
- What is pre and post students' science achievement when the developed modules are implemented in CGA?

METHODOLOGY

In this research, first, the Columbus Gifted Academy (CGA) case was discussed and then the modules were implemented to the science lesson by teachers. The modules include the challenging activities and problems. These modules were developed by the researcher in collaboration with the science teachers. Students had an opportunity to access challenging and interesting activities on their level. It is anticipated that science lessons in CGA are more challenging and interesting for students and could develop their scientific reasoning. But every child has unique interests in science and the activities and modules have limitations if we think about the range of content. They may be interested in the problem and the solution.

a) Research Design

The research design was a mixed type. Both qualitative and experimental design were used. In qualitative design the interviews were conducted with teachers and management of CGA to understand how the science lesson was structured and curriculum was designed. And after that the modules developed by researcher in collaboration with the science teachers were used as science lesson plans by the CGA science teacher. As a part of normal classroom science instruction pre and post-test were implemented to understand academic success. And also interviews with science teacher about the modules were conducted.

b) Sample

Science teachers and school management were the study group of qualitative design. As a part of standard classroom practice, teachers collected student pre and posttest achievement data when the modules were implemented in their curriculum. In total 11 students participated in the experimental design.

c) Measurement / Instrumentation

Semi-structured interviews with teachers were conducted. Teachers provided de-identified pre/posttest paired student achievement data. For the qualitative design, the triangulation was implemented for validity and reliability. The three data sources are teacher interviews, student achievement data and classroom observation. Research design was strengthened by these multiple factors that contribute the study's credibility (Denzin, 1970; Polit & Hungler, 1995). Interview questions were reviewed by both of the researchers and expert and this increased the validity of study. The observation and interview data were collected by researchers, as a part of standard classroom practice.

d) Detailed study procedures

At first the interviews were conducted with the teacher. After that the science teachers gave the pre-test to the students about modules. Then the teacher continued his/her lesson with the modules. After these lessons a post-test was completed by students for each module. After the post teacher interview, the data collection process was ended. The teacher assigned codenames to students, student names were not written on pre and post-test sheets. And the teacher is the only person who knows the personal information about students. Also there are not any questions in the interview that asked about the subjects' confidential information.

e) Internal Validity

We can learn the science instruction and curriculum in CGA only from science teachers and about how the CGA works and applied district rules could be learned from management. So there is no other plausible source of information to provide an explanation for this problem. And the researcher engaged multiple methods like interview, observation and pre-posttests which led to more valid, reliable and diverse construction of realities.

f) Data Analysis

In this content analysis research the data collected by qualitative methods were analyzed. Literature recommends different strategies for observation analysis and interview analysis (Marvasti, 2014; Roulston, 2014). An inductive analysis strategy was used for data collected with the observations which specific field observations gradually led the researcher to generalize ‘plausible relationships proposed among concepts and sets of concepts’ and ascertain the categories, themes and patterns of the data (Strauss and Corbin, 1994). The analysis of interview data consists of three phases; (1) data reduction, (2) data display, and (3) conclusion drawing/verification (Miles & Huberman, 1994). It is called flow model and in this view data analysis is a continuous and iterative enterprise (Miles & Huberman, 1994: p, 10). Both strategies are consistent with the content analysis method.

In this way the data analysis was structured and formalized and we tried to find answers to the first three research questions. Analyzing the pre and post-test via quantitative analysis answered to the fourth question.

FINDINGS

After developing the process of science lesson modules for gifted students, the teacher used these modules in classroom. Before implementation each module’s pretests were conducted and after implementation posttests were conducted as well. Also, a teacher interview was conducted about the modules and to determine general student responses during implementation. The data obtained from these implementations are presented in this section.

In Table 1, pre and posttest scores of gifted science modules were compared. To show the result of this comparison Paired-Sample *t*-test was conducted.

Table 1. Paired-Sample *T*-Test Results to Compare Pre and Post-Test Scores of Learning Modules

	Pre-Test		Post-Test					
Outcome	*M*	*SD*	*M*	*SD*	*n*	*Sig.*	*t*	*df*
Motion	10.21	6.06	24.10	5.25	11	.000*	10.15	10
DNA	6.26	6.29	14.63	7.13	11	.000*	6.05	10
Plastics	7.55	6.56	26.11	9.50	11	.000*	8.63	11

*****p = .000

A paired-samples *t*-test was conducted to see motion, DNA and plastics modules’ effect on student learning comparing pre and posttest scores. There was a significant difference in the scores on the motion module post-test (*M* =24.10, *SD* = 5.25) which were higher than scores on the motion module pre-test (*M* =10.21, *SD* =6.06), t = 10.15, p = .000. These results suggest that the motion module really does have an effect on the understanding the motion and acceleration concept.

There was also a significant difference in the scores on the DNA module post-test (*M* =14.63, *SD* =7.13) which were higher than scores on the DNA module pre-test (*M* =6.26, *SD* =6.29), t =6.05, p = .000. These results suggest that the DNA module really does have an effect on the understanding the DNA and heredity concept.

There was also a significant difference in the scores on the plastics module post-test (*M* =26.11, *SD* =7.13) which were higher than scores on the plastics module pre-test (*M* =7.55, *SD* =6.56), t =8.63, p = .000. These results suggest that the plastics module really does have an effect on the understanding the plastics and environment concept.

Specifically, our results suggest that using gifted oriented lesson modules in gifted science classroom could create a difference in classroom learning activities.

The interview conducted with the teacher supported these results. The 6th grade science teacher concluded that the modules supported the students' learning through inquiry-based activities. And students also liked the activities and were challenged through implementation. But the teacher added that some of the activities were too challenging for this level and students had to figure out what were they dealing with this new kind of implementation. She said that through the implementation students get used to it and overall it was a successful lesson plan. You can find some important sections of the interview with the science teacher given below.

> "I like that they were very inquiry based. And that they had to figure out a lot on their own and design their own, check their own variables."

> "They really enjoyed doing the different experiments that we attached to it. Whether it was the fruit with the DNA or designing their own acceleration experiment."

> "One of the things that I'm trying to do more of this year, and the modules helped with that, was doing the more of experiment design so you understand the concept, how could you actually design an experiment to test?"

> "They have to be able to apply it and they have to be able to use the scientific process when they are designing and actually testing their experiments. And so it was a good learning opportunity for the kids because they were like, well, what happened? Well we needed this set up or we needed more time for this or we needed more data points."

There are also some negative features of the modules teacher mentioned which need to be developed. Here are some examples from teacher interview about these features;

> "For example, I know in the plastics one, we wanted them to research about plastics, but we didn't give any parameters, so we had to go back and say, "Okay, here's different articles that would fill in the information that they need."

> "They struggled with a little bit more when it comes to the research discussion part. They just weren't as involved which is typical of middle school students."

DISCUSSION

We know that the science education of gifted students should be challenging and differentiated (Taber, 2010; Newman and Hubner, 2012; Reis and Renzulli, 2010). Also teachers have different sources to find classroom activities like websites, research papers and textbooks or sometimes they differentiate the known and used science activities in district schools. The negative side of these activities - there is no scientific evidence that shows they prompt the learning or developing scientific talent. Literature suggests designing experimental researches and to develop classroom activities that meet the gifted students' educational needs (Subotnik et al., 2009; Dai, Hu & Zhou, 2015). We developed these learning modules and activities to meet these needs of gifted students and to show teachers the difference between the activities that are especially created for gifted students from those found on websites or classic textbook. This research showed that the modules or the classroom activities especially designed for gifted students are challenging and prompted learning. The result of the experimental design is promising and leads us in developing new modules concerning the real-life problems like the module-3: Plastics. Because the data showed that students were more successful in this module compared with the other modules' scores. The difference in this module is the problem. We used the real-life problem which directed the students understanding of chemical properties of plastics and the environmental awareness. We know that gifted students enjoy these kinds of problems thanks to their characteristics (Karnes, & Riley, 2005).

The other important result is that the teacher's observation about the levels of students. We thought that modules were for 6th – 8th grade students. But at first they had to figure out how the modules work and it showed they are not ready for these kinds of classroom activities. So next time we are going to design this research for only 7th and 8th grade students and look for the difference between levels. The literature also suggests the level of the students is an important factor for challenging and differentiation (Betts, 2004; VanTassel-Baska, 2005; Olenchak, 2001).

After this study, we saw that the positive aspects of these modules are the inquiry based problems that students needed to puzzle out for themselves. Using real life problems and subjects made the modules more interesting for students. And most importantly, the achievement of the students on the subjects of the module increased significantly in post test analysis.

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