INDIVIDUAL BEHAVIORS AS MOTIVATION, TASK COMMITMENT, AND LEADERSHIP EXHIBITED BY SCIENCE GIFTED STUDENTS AT SCIENCE GIFTED EDUCATION CENTER AND ITS IMPLICATIONS FOR DIFFERENTIATED INSTRUCTION

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Abstract

The research aimed to explore characteristics of individual behaviors as motivation, task commitment, and leadership exhibited by science gifted students at enrichment program in science gifted education center. Results showed that motivation was highest at introduction stage, but decreased as lessons progressed. Task commitment and leadership tended to increase from planning and conducting stages. Leadership was highest at discussion stage. Each student exhibited different sequences of behavioral characteristics along lesson stages. It was called for planning individually differentiated instructional strategies.
Keywords: *individual behavioral characteristics, science gifted students, student leadership, task commitment*.

Introduction

It is not easy to predict how future society will change. The global society is closely connected in complicated ways and is actively interacted with open-communication due to infinitely developing internet network and unlimitedly accessible information. Complex societies generate more unexpected phenomena and various problems, and people use knowledge to solve problems and create new values. Jack Andraka, when he was15-year-old as a high school student, had mastered hundreds of research papers and had conducted thousands of experiments to invent an early diagnostic kit for pancreatic cancer. In the future society, we will need more creative talents who can demonstrate competence, accept change, pioneer the future, grow infinitely, and propose new alternatives beyond the fixed framework.

Looking at past history, there were experts of each field in the process of changing and developing the times. As a result, society has developed and culture has been formed. For this reason, many countries are focusing on cultivating top-notch specialists and high-

quality human resources. In order to lead advanced science and technology, countries are strengthening science gifted education with the aim of fostering high-quality human resources capable of producing creative knowledge in science and technology. In other words, science gifted education makes more efforts to educate students to demonstrate outstanding expertise of science and technology in future.

In science gifted education, we are interested in exploring the characteristics of scientists who have achieved excellent outcomes, and are more interested in teaching students to demonstrate the scientists' characteristics. It is reported that those who had made excellent productivity did not achieve only by high intellectual abilities of innate giftedness, but rather that they were provided with appropriate opportunities and conditions to perform and practice enough (Tennenbaum, 2003). Their distinguishing feature was the commitment and sacrifice that they were willing to make it pursuit of their creative productivity (Subotnik, Olszewski-Kubilius, & Worrell, 2011). From this perspective, exceptional expertise can be interpreted as a result of combining individual characteristics of motivation, task commitment, and leadership. It can be effective teaching strategies for science gifted students to experience such behavioral characteristics during science learning.

In previous research, motivation, willingness to succeed, concentration, and leadership were discussed as predictors of excellent scientific creativity (Trost & Sieglen, 1992, recited from Heller, 2007). Such predictors include motivation and abilities to solve problems, to desire to influence initiatives and leadership for the success, to search for more knowledge, and to perform concentration ability and persistence. Science gifted students enjoy the process of discussing with their peers of similar abilities and interests, and they are motivated through exchanges with mentor professionals (Whybra, 2000). Gifted students were found to have higher motivation and greater enthusiasm in the course of mutual support and mutual evaluation and recognition by their peers in the learning process (Fredricks, Alfeld, & Eccles, 2010). Therefore, it is necessary to find out how and when students exhibit behavioral characteristics of motivation, task commitment, and leadership.

This research aimed to explore individual behaviors exhibited by science gifted students during the enrichment program of biology at a science gifted education center in Korea. For this purpose, research questions are formulated as follows: First, how frequently distinct behavioral characteristics such as motivation, task commitment, and leadership are observed at different stages of science lessons. Second, how these behavioral characteristics are individually sequenced at various stages of science lessons. It is expected that the research results are useful for developing individually differentiated teaching strategies to strengthen such behavioral characteristics.

Research Methodology

Participants

Research participants were ten students of middle schools in the Busan metropolitan city in Korea who enrolled in enrichment program of biology at science gifted education center affiliated with a university in March 2018 and who were permitted to continue a scientist mentoring program in the following year of 2019 based on multiple faceted

evaluations. At the beginning of program, the participants filled out a survey of personal preference in science teaching strategies and future profession (Table 1). Students prefer science teaching strategies that allow them to solve lesson topics through experiments, discuss about results, and give class presentation, and share ideas. On the other hand, students do not prefer teaching strategies that science teacher explains, and students listen only without understanding and reasoning and that take too much time to conduct experiments and projects.

Table 1. Demographic information of research participants and their preference in science teaching.

Id	Gender	Grade	Future job to hope	Most preferred science teaching strategies	Least preferred science teaching strategies
S1	Female	7th	Biologist	use experiments and videos	lecture theories and difficult contents
S2	Male	7th	Biotechnologist	explain science concepts	present contents without understanding
S3	Female	8th	Medical doctor	use videos, allowing student presentation	learn only with textbooks and worksheets
S4	Female	8th	Medical robotologist	solve lesson topic through experiments	teacher continues explanation only
S5	Male	7th	Nanobiotechnologist	discuss and share ideas	teacher does all in classroom
S6	Female	7th	Biotechnologist	use a lot of experiments	learn theories only
S7	Female	8th	Biotechnologist	play games about lesson topics	take too much time for experiments
S8	Male	7th	Biologist	no preference	take too much efforts for doing projects
S9	Female	7th	Profiler	no preference	no preference
S10	Male	7th	Microbiologist	share hypothesis and discussion	learn theories without experiments

Data Collection

Participants' individual behavioral characteristics exhibited during the enrichment program of biology were observed and recorded by four preservice biology teachers for 39 classroom hours of 13 lesson topics from April to July 2018. Four observers were instructed to record objectively, concretely, and in details about distinct behaviors exhibited by each student during lessons. The 13 lessons were mostly progressed by four stages: introduction, experiment planning, conducting, and discussing results. Records of observation were divided into four stages at the time of observing

and recording. During data collection, observers focused on observing and recording individual behavioral characteristics as much as possible. However, there is a limitation in that distinct behavioral characteristics of all students are not uniformly observed.

Data Analysis

A framework to analyze data was developed from categorization of raw data. The characteristics of behaviors observed were classified into similar categories into motivation, task commitment, and leadership as Table 2. Raw data were analyzed by utilizing the framework. Inter-rater reliability was established by comparing, discussing and reaching agreement among three raters.

Table 2. A framework of behavioral characteristics for data analysis.

Categories	Subcategories of behavioral characteristics and examples
Motivation	(M1: intrinsic motivation: exhibited as individual level) to question by themselves for further curiosity; to listen and take notes carefully; to ask questions frequently; and others
	(M2: achievement motivation: exhibited during interacting with teacher and students) to participate in experiments; to answer teacher's questions for given tasks; to volunteer classroom presentation; and others
Task commitment	(TC1: persistence: exhibited as making efforts over time) to explain new and more ideas with scientific reasoning to perform experiments thoroughly; to seek for new data not given; present ideas visually and creatively; and others
	(TC2: proficiency: exhibited skills in manipulating experimental tools) to make accurate and detail observation; to manipulate tools in proficient and sophisticated ways; and others
	(TC3: passion/flow: displayed intensively absorbed behaviors) to share happiness and excitement about work with peers; to immerse activities not being aware of peers; and others
Leadership	(L1: leading group performance) to persuade peers and dominate with own ideas; to lead discussion; (negative) to insist own conclusions; and others
	(L2: supporting others' participation) to allocate roles to group members; to encourage and support peers; to explain ideas to group members' better understanding; to remind peers about each role and duty; and others
	(L3: focusing social problems) to propose solutions for societal problems; to emphasize societal duties; and others

Research Results

It was found that there were frequency differences in observed behavioral characteristics among 13 lessons along four lesson stages (Table 3). There were 349 observations with ranges between 46 (lesson: photosynthesis with MBL) and 11 (lesson: immunology and living organisms) and distributed at four lesson stages: 16.9% for introduction of topic, 27.5% for planning experiments, 26.7% for conducting experiments, and 28.9% for discussing results. Differences in frequency observed from 13 lessons were likely to occur due to various teaching strategies from experimental activity oriented to heavy explanation of lesson topics.

Table 3. Behavioral characteristics observed at 13 lesson topics along four lesson stages.

Lesson topics	Lesson stages									
	Introduce topics		Plan experiment		Conduct exp.		Discuss results		Total	
1. Photosynthesis experiments with MBL	4	(8.7)	21	(45.7)	10	(21.7)	11	(23.9)	46	(13.2)
2. Science inquiries and experiments	4	(19.0)	7	(33.3)	6	(28.6)	4	(19.0)	21	(6.0)
3. Research like Darwin and Finch	3	(12.5)	15	(62.5)	2	(8.3)	4	(16.7)	24	(6.9)
4. Structure and function of brain	3	(9.4)	13	(40.6)	2	(6.3)	14	(43.8)	32	(9.2)
5. Implant Brain	0	(0.0)	13	(32.5)	5	(12.5)	22	(55.0)	40	(11.5)
6. Chromosome and DNA in plant cells	1	(5.0)	7	(35.0)	8	(40.0)	4	(20.0)	20	(5.7)
7. Protozoa observation and its ecosystem	5	(19.2)	3	(11.5)	14	(53.8)	4	(15.4)	26	(7.4)
8. Immunology and living organisms	10	(90.9)	0	(0.0)	1	(9.1)	0	(0.0)	11	(3.2)
9. Diverse senses in human	11	(45.8)	6	(25.0)	0	(0.0)	7	(29.2)	24	(6.9)
10. Osmosis and protoplasm	2	(5.6)	7	(19.4)	15	(41.7)	12	(33.3)	36	(10.3)
11. The world of mysterious optical illusion	5	(25.0)	2	(10.0)	11	(55.0)	2	(10.0)	20	(5.7)
12. Stem cells and therapeutics	8	(47.1)	2	(11.8)	6	(35.3)	1	(5.9)	17	(4.9)
13. Investigating epidemics and science writing	3	(9.4)	0	(0.0)	13	(40.6)	16	(50.0)	32	(9.2)
Total	59	(16.9)	96	(27.5)	93	(26.7)	101	(28.9)	349	(100.0)

Relative percentages of motivation, task commitment, and leadership based on frequencies of behavioral characteristics were shown in Figure 1. At the lesson stage of introduction, motivation (78.5%) was mainly exhibited and task commitment (19.6%) also appeared while leadership (1.8%) was rarely observed. During the planning stage, task commitment (48.9%) was higher than other categories, while motivation (35.6%) was decreased and leadership (15.6%) was increased. During the conducting stage, task commitment (54.7%) was higher than other categories, while motivation (19.8%) was again decreased and leadership (25.5%) was further increased. At discussion stage, leadership (45.2%) was highest and task commitment (43.2%) was also high. In general, motivation was the highest at introduction stage, but decreased as the lessons progressed. On the other hand, task commitment and leadership tended to increase from planning and conducting stages. During discussion stage, leadership was the highest.

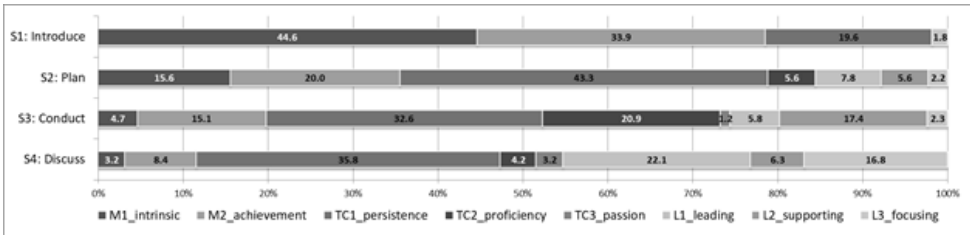

Figure 1. Behavioral characteristics observed at 13 lesson topics along four lesson stages.

Mean frequency of behavioral characteristics for each student appeared as 2.69 (0.99) at each lesson (Table 4). Ten participants showed ranges between 4.00 as highest and 1.54 as lowest frequency of behavioral characteristics at each lesson.

Table 4. Mean frequency of behavioral characteristics at each lesson for each participant.

Std ID	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Av-er-age
Mean Fre-quency *SD*	3.00 1.78	2.46 1.98	2.92 1.66	1.54 1.13	2.23 1.24	3.31 2.06	1.92 1.04	2.23 1.30	3.23 1.54	4.00 2.27	2.69 0.99

Sequences of behavioral characteristics along four stages of science lessons were extracted. Among ten participants, most students showed distinct behavioral characteristics over one or two stages. However, six participants displayed certain specific sequences over three or four stages (Table 5). Student 1, who likes science teaching by doing experiments and watching videos, showed her sequences starting with leadership to explain additional ideas to lead peers (L1) at planning stage, and manipulating microscope skillfully to observe cells accurately (TC2), and observing repeatedly and recording precisely (TC1) at conducting stage, and finally taking photos of observation

by cellular phone camera (TC2), sharing photos with peers to explain her own additional observation (L2), summarizing newly learned biology terms in notebooks by herself (M1), and asking teacher to make sure what she understood (TC1) at discussion stage. Student 2, who prefers science teaching by explaining science concepts, showed his sequences starting with leadership to explain how to establish variables to peers (L2), adding more variables from his own perspectives (TC1), and presenting his ideas to predict experimental results to class voluntarily (M2) at planning stage. At conducting stage, he encouraged peers to fill out worksheet and assist them (L2) and he initiated discussion (L1) and tried to encourage peers to complete worksheet (L2) at discussion stage.

Student 3, who likes class presentation, and student 6, who prefers doing experiments, exhibited similar sequences of motivation to answer teacher's questions (M2) at introduction and planning stages, and following task commitment (TC2, TC1) at conducting stage, and supporting peers (L2) or emphasizing social problems (L3) at discussion stage. Student 8 showed motivation (M2) at planning stage, and task commitment (TC1, TC2) at conducting stage, and finally became to absorb in his own results without being aware of peers (TC3) at discussion stage. Student 10, who likes discussion, started with motivation of curiosity in lesson topic at introduction stage (M1) and task commitment (TC2, TC1) till to immerse experiment without noticing teacher's comment (TC3), and motivation (M2, M1) at conducting stage, and task commitment (TC1) at discussion stage.

Table 5. Sequences of behavioral characteristics along four lesson stages.

Student ID	Lesson topic	Phases and behaviors				# of observed
		Introduce	Plan experiment	Conduct experiment	Discuss results	
S1	Osmosis and protoplasm		L1→	TC2→TC1→	TC2→L2→M1→TC1	7
S2	Photosynthesis w/ MBL		L1→TC1→ M2→	L2→	L1→L2	6
S3	Diverse senses in human	M2→	M2→	TC2→L2		4
S6	Brain structure and function	M2→	M2→	TC1→	L3	4
S8	Osmosis and protoplasm		M2→	TC1→TC2→	TC3	4
S10	Photosynthesis w/ MBL	M1→M1	→	TC2→TC1→TC3→	M2→M1→TC1→TC1	9

Conclusions and Implications

It is interpreted that science gifted students turn their motivation to task commitment by initiating experimental ideas and conducting experiments. Furthermore, leadership was interpreted to be exhibited more in class situations where group activities lead to cooperation, discussion, and agreement with peers. However, each student showed different sequences of motivation, task commitment, and leadership along lesson stages. Some students started with leadership at planning experiment stage and exhibited more at discussing results stage, while some students started with motivation and exhibited task commitment intensively at conducting experiment and discussing results stages. Such different sequences of individual behavioral characteristics along lesson stages called for individually customized and differentiated instructional strategies.

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