

## A Case Study on the Underachievement of Three College Physics Students

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**Abstract:** *This case study intends to provide an explanatory account on the underachievement of three gifted students studying physics in a Taiwanese university. The students' physics achievement was diagnosed with Sato's student-problem analysis chart. In order to (1) understand the association between their academic performance, self-concepts, and support systems, and (2) elicit the pattern of their learning behaviors, these students were asked to finish a questionnaire and a follow-up interview. They expressed that their self-worthiness was not damaged by their underachievement and that they still believed in their own potentials. We found that these students started encountering academic problems during their senior high school years. The learning characteristics that could attribute to their underachievement were: (1) a lack of motivation and not applying self-actualization on subject matters, (2) focusing on memorizing and mastering skills and sticking with wrong learning strategies, (3) a lack of genuine interests in the subject. This study also found that although these students had clear future goals and generally positive self-concepts and self-knowledge, their career development suffered from a lack of execution. The authors also drew several concluding suggestions based on the results.*

**Keywords:** underachievement, giftedness, case-study

### 1. Introduction

Gifted students seem to have a better opportunity to be successful, and they are usually regarded as “God’s favored children.” In either western or oriental studies, as early as in 1955, Gowan pointed out the importance of the studies on underachievement of gifted students. He suggested that the underachievement of gifted children is the largest social waste in culture (Tsai, 2001). Seeley (1993) estimated that in the United States, 15% to 40% of gifted students may face the crises of underachievement or low achievement. Lupart and Pyryt (1996) predicted that at least 21% of the gifted students in elementary school and junior high school in Canada experienced underachievement. The report of Commonwealth Magazine in Taiwan also indicated that a gifted physics student recommended for admission to National Taiwan University suffered from failure in college learning (Kao, 2003). The above show that the underachievement of gifted students is a global issue and may occur to any stage of the learning of gifted students.

Whitmore (1980) indicated that after going to senior high school, some gifted students will suffer from underachievement under the high pressure of academic performance and peer competition. In terms of the learning content of physics, Du (2006) suggested that compared with the physics courses in junior high school, the depth and width of knowledge, learning methods or mathematical application of physics course in senior high school are significantly different. Therefore, the phenomenon of gifted students’ underachievement in senior high school and college is quite common.

Based on the research background and motivations mentioned above, this study intends to investigate the learning performance of underachieving gifted students. Firstly, this study selected junior students taking the course of “modern physics” as the participants in the in-depth investigation, in an attempt to analyze the learning process of an important

concept “one-dimensional infinite square well system” of 3 underachieving gifted students. Secondly, this study used the “questionnaire on self-concept and external support system for underachieving gifted student” to understand underachieving students’ self-concept and external support system. Thirdly, this study conducted in-depth interviews to understand underachieving students’ thoughts and reflections on their own learning performance.

## 2. Methods

This case study used document analysis and in-depth interviews to collect and analyze data. The researcher obtained the information about 3 junior students in Department of Physics who are gifted students but fail to perform well in their major of physics.

### 2.1 Research Participants

The basic information of participants is as follows:

Table 1 Basic Information of Research Participants

Code	Gender	Grade	Ranking of academic performance of modern physic	of performance	Educational background of parents	Average daily hours spent on study review
A	Male	Senior	56/97		College, junior college	1-2 hours or less
B	Male	Senior	52/97		Graduate school, junior high school	1-2 hours or less
C	Male	Fifth year	46/97		Senior school/vocational high school	1-2 hours or less

Participant A: a lazy, easy-going and chubby gourmet

The most special thing about participant A was that he would ask the teacher loudly in class, “Will I get any score by studying the content?” and “Will I get any score by memorizing the content?” The PR value of his Basic Competence Test for Junior High School Students was as high as 93. However, it was hard to imagine that he almost failed every required course every year. When taking the make-up course of thermal statistical physics in the first semester of the senior year, he listened to the advice from the teacher to change his learning strategies and obtained good academic performance. However, such a good academic performance soon vanished in the second semester of the senior year.

Participant B: a hip-hop dancer insisting on being himself

Participant B got a perfect score in English in the Basic Competence Test for Junior High School Students. However, his score in the Department Required Test was merely more than 10 points. He spent all his time on his favorite leisure activity – hip hop. The dynamic information on his Facebook was almost “dance showcase” and “I have an inspiration for rehearsal in the midnight and I cannot help dancing.” He was frequently absent from the class, and he also failed the admission examination for graduate schools where Educational Program for Secondary School Teachers is available. He had prepared for delayed graduation.

Participant C: a passionate and persistent student association president

Participant C was certainly an underachieving gifted student. Although he looked smart, he took the makeup courses of many required courses. As the student association president and department badminton team captain, he had

a strong sense of responsibility for his duties. As long as the teacher requested him to do anything, he would devote himself to the mission. He failed the admission examination for all graduate schools in the senior year. In his fifth year in school, he swore that he would only study in top graduate schools. He is now enrolled in a top Graduate School of Physics in a certain National University in the southern Taiwan.

## 2.2 Research Tools

2.2.1 Researcher - This study used the researcher as a research tool. Therefore, the reliability and validity of this study were significantly correlated with the research methodology, skills, sensitivity, and honesty of the researcher (Wu, Li trans, 1999).

2.2.2 student-problem score table, S-P chart - The method provided item caution index and student caution index, and was able to concurrently analyze the test items and correct answer pattern of individual students to effectively diagnose the learning difficulties experienced by 3 students.

2.2.3 Questionnaire on Self-concept and External Support System for Underachieving Gifted Students – This questionnaire was revised from the “Questionnaire on the Self-concept and External Support System for Senior High School Students Failing to Overcome Underachievement” developed by Yang (2004). The content of the 48 items were completely identical, and only the descriptions for different learning stages of respondents were slightly modified. Items 1 to 22 investigated respondents’ self-concept, including self-understanding, learning attitude, and interpersonal relationship. Items 23 to 38 investigated respondents’ “family support system,” including parents’ parenting attitude, communication method, family atmosphere, expectation attitude, and support for children’ continuing study during their underachievement. Items 39 to 48 investigated “school support system,” including the aspect of teachers and the aspect of peer group.

2.2.4 Interview outlines for learning behavior performance of underachieving gifted students.

## 2.3 Data Analysis

2.3.1 To perform statistical analyses on student-problem score, S-P chart (Sato, 1980) – This study used S-P chart to perform analyses on the performance of 3 participants in this study, as well as that of other students concurrently taking the course of modern physics, in order to find out the correct answer rate, stability, and learning pattern of 3 participants.

2.3.2 Data coding and analysis – In order to find out the context associated with the theme. After reading the three transcripts for many times, the researcher intended to establish categories based on the content and then gradually established the theme and main theme, in order to reach conclusions in the end (Huang, 1998).

## 3. Results and Discussion

### 3.1 Problem solving performance and pattern of 3 underachieving gifted students in the learning of

#### *“one-dimensional infinite square well system”*

Table 2 shows the common two-way classification of students’ correct answer rate and caution index (Yu, 1996). The results of cross interaction are divided into 6 categories: good learning and high stability; stable learning and studying harder is required; lack of learning ability, insufficient learning and studying harder is required; mistakes are caused by carelessness; occasional carelessness, insufficient preparation, and studying harder is required; extremely unstable learning, arbitrary studying habit, and insufficient preparation for test content. The students taking the same course with 3 participants exhibited a total of 6 performances. The correct answer rate of participant A in problems where memorization was required was better. Therefore, participant A belonged to category 2. Both participant B and participant C belonged to category 1. The problem solving performance of 3 participants are shown in Table 3. The

level of difficulty started to gradually increase from C3, where both memorization and understanding were required. Almost none of them provided the correct answers.

Table 2 Students' Performance Results Assessment Summary Table

category	Students' performance (two-way classification cross interaction of student and caution index)	correct answer rate	student caution index	Number of students	Percentage
1	Lack of learning ability, insufficient learning and studying harder is required	0-.50	0-.50	35	44.3
2	Stable learning and studying harder is required	.50-.75	0-.50	31	39.2
3	Good learning and high stability	.75-1.00	0-.50	3	3.8
4	Extremely unstable learning, arbitrary studying habit, and insufficient preparation for test content	0-.50	.50-1	4	5.1
5	Occasional carelessness, insufficient preparation, and studying harder is required	.50-.75	.50-1	3	3.8
6	Mistakes are caused by carelessness	.75-1.00	.50-1	3	3.8
Total			.50-1	79	100

Table 3 Problem-solving Performance of 3 Students

Infinite Square Well Problem Solving Concept	Participant A	Participant B	Participant C
A1 Writing down correctly a particle's Schrodinger eqs. in various areas	○	○	○
B1 Correctly converting Schrodinger eqs. in various areas into second order differential equations.	○	○	×
C1 Writing down correctly the boundary conditions.	○	×	○
C2 Using boundary conditions to calculate the energy levels and coefficients of differential equations.	○	○	○
C3 Knowing the origin of boundary conditions.	×	×	×
D1 Writing down correctly the normalization conditions.	×	×	○
D2 Being able to calculate the probability distribution of various energy states and to calculate the probability value of various energy states in various positions.	○	×	×
E1 Being able to use Heisenberg Uncertainty Principle to explain that when the number of quantum is extremely large, the analysis result of quantum mechanics is consistent with that of classical mechanics and the probability density is even.	×	×	×

E2 Being able to use Heisenberg Uncertainty Principle to explain that when the system size is extremely large, energy levels are continuous and the probability density is even.	×	×	×
Correct answer rate	0.56	0.33	0.44
Student caution index	0.32	0.29	0.14
Students' performance pattern	2	1	1

○ represents that the answer to the item is correct × represents that the answer to the item is incorrect

1 Lack of learning ability, insufficient learning and studying harder is required

2 Stable learning and studying harder is required

### ***3.2 The “Questionnaire on Self-concept and External Support System for Underachieving Gifted Students” showed the respondents’ self-concept and external support system***

#### ***3.2.1 Respondents’ self-identification for the cause of underachievement and self-perception when facing underachievement***

##### **Participant A**

Participant A had the highest level of agreement with Item 6 “I do not often have conflicts with other people,” Item 16 “I do not feel that my self-esteem is hurt when facing underachievement,” Item 18 “Other people will not despise me due to my underachievement,” and Item 20 “I do not feel that I am worthless due to my underachievement.”

##### **Participant B**

Participant B had the highest level of agreement with Item 1 “I think that my intelligence is not inferior to that of my classmates,” Item 3 “I think that my creativity performance is better than that of my classmates,” Item 4 “I think that I have a very high expectation towards myself,” Item 11 “I will not experience a sense of inferiority when I discuss with my classmates about the schoolwork,” Item 13 “I understand the real cause for my underachievement,” Item 19 “I think that I have an active learning attitude,” Item 20 “I do not feel that I am worthless due to my underachievement,” Item 21 “I still believe that my potential is unlimited in terms of my current status,” and Item 22 “I did not care about my ranking in class in the past.”

##### **Participant C**

Participant C had the highest level of agreement with only one item in the aspect of self-concept of the questionnaire: Item 13 “I understand the real cause for my underachievement.”

To sum up, it seemed that the self-concept of three participants was not affected by their underachievement and did not become negative. Two participants even strongly agreed with Item 20 “I do not feel that I am worthless due to my underachievement”, and one participant somewhat agreed with it. Moreover, the three participants strongly agreed or somewhat agreed with Item 21 “I still believe that my potential is unlimited in terms of my current status”.

#### ***3.2.2 Support from Family, Peer Group, and Teacher when Facing Underachievement***

##### **Family Support System:**

Participant A had the highest level of disagreement with Item 23 “My parents will not blame me for my underachievement” and Item 33 “My parents will not compare the performance of my siblings, relatives, or classmates with mine to form pressure for me,” followed by Item 24 “My parents will not worry about my future owing to my underachievement,” Item 25 “My academic performance will not affect my communication with my parents,” Item 26 “The harmonious family atmosphere will not be affected by my academic performance,” and Item 31 “My parents hold an adequate expectation towards my academic performance.” Participant A indicated that his parents hoped that he could graduate from the school smoothly. He even came to the teacher’s office to claim that his parents could not afford his study in the fifth year when he was certain that he failed the required course, suggesting that he did feel the pressure

from family expectation.

Participant B had the highest level of disagreement with only one item: Item 30 “My parents’ expectation towards my academic performance is consistent.” There was no significant difference in the rest of the items.

The items with which participant C had the highest level of agreement were similar to those of participant A, such as Item 24 “My parents will not worry about my future owing to my underachievement” and Item 26 “The harmonious family atmosphere will not be affected by my academic performance.”

School support system:

The 3 participants all indicated that “I spend too much time playing around with my classmates or on extracurricular activities”. They all disagreed with Item 46 “Most of my friends are those who attach high importance to academic performance.” The fact showed that their friends were not those who enjoy studying in class.

In terms of school teachers and learning environment, the participants all agreed that they perceived the support from the school and teachers. Participant A used to pay attention to his academic performance for a while owing to the instruction from the teacher. Consequently, his response for Item 43 “I will consult with teacher or classmate when encountering academic problems” was 4 points. Participant B’ response was 4 as well. The score of Item 39 “School teacher usually encourages me” was high as well. What was interesting was that the 3 participants all answered that the place where they do their schoolwork most frequently was “school.”

### ***3.3. Thoughts and Reflections of Underachieving Gifted Students on their Own Learning Performance***

#### ***3.3.1 Attribution of Causes for the Underachievement in Senior High School Learning***

Lack of interest in academic study or having a dislike for a certain teacher or certain learning methods:

Participant A

As a matter of fact, my academic performance started to fall behind since the second semester in the second year of high school. To be more specific, my ranking started to fall down since the first examination in my high school lifetime and was never improved...because I intended to become a chef instead of going to college after senior high school .

Participant B

I did not like the chemistry teacher in high school, ... He always asked us to memorize with no reasons, and I hate that.. That is why I didn’t like chemistry and got a bad grade. On the other hand, my poor English is because of my laziness in memorizing vocabularies, and I didn’t dislike my English teacher.

Participant C

I thought that it was necessary to study hard in the freshman year. I kept keeping notes in class and studying the notes before taking the examination. However, when I got the exam paper, I found that I could not answer any question. The reason was that the test questions were the practice questions in the textbook. I did not buy the textbook, and had no idea that the test questions would be the practice questions. I felt that I was pranked, and then gave up studying.

#### ***3.3.2 Attribution of Causes for the Continuous Underachievement of College Learning***

Lack of learning motivation and self-actualization for academic performance:

Participant A

I almost did not study at all in the sophomore year and junior year...I lacked the learning motivation and did not find it important to be in first place. I thought that poor academic performance does not matter at all. I just want to pass.

Participant B

In general, I would concentrate on the content in the first few classes only, and then even never attended the class.

I hate to learn due to being criticized or stressed. I dance happily because no one forces me to dance.

Participant C

I just played around in the freshman and sophomore years. As a matter of fact, I did study many makeup courses in the junior year.

When there were more professional courses to be taken in the same time, it was difficult to get good grades in

every subject. My started to uphold the attitude that studying in college is just to get every subject passed ...A half of my time was spent on student association.

Sticking to the wrong learning strategies:

Participant A

It is strange that I did not feel difficult when studying by myself and discussing with classmates. I even felt easy when solving problems. In addition, when teaching others, I felt comfortable and could present smoothly. I could copy teacher's calculation process very well after reading two times, but could not solve the similar problems in the examinations. I have had successful experience in studying thermal statistical physics with a learning strategy recommended by the teacher before, but failed in this course. I have to say honestly that I didn't follow teacher's advice in this course.

Participant B

I hate keeping studying hard. I found that I am really anticlimactic at times. I did not study well.

Participant C

I did concentrate in class, but didn't like to review after class. I believe I can learn quickly and understand well, but I didn't want to do it. I like happiness rather than high grade.

## **Excuses and Wrong Concept of Return on Investment**

Participant A

Now, I think that the objective of learning is to get employed in the future. I have heard that what I have learnt is not useful at all at work. To make money, many people will learn the investment skills about stocks, futures, etc. Some people will take the examination of certified public accountant or actuary, and others will take senior civil servant examination in order to become public officials. I have never heard anyone engaging in occupations concerning physics.

Participant B

In junior high school, I was too young to develop a wide perspective. My teacher said that I have to study hard to have a more promising future. Therefore, I used to study hard in the past. However, I do not think that studying is the most important thing now.

I really do not like the education style in Taiwan. Students do anything (e.g. studying physical education or music) other than studying will be criticized. Only when you become a super star will you be praised as the honor of Taiwan.

Participant C

Getting a high score does not represent that you completely understand a subject. In addition, being able to understand a subject does not represent that you have to get a high score.

### **Strong in Persistence for Career Planning, but Weak in Execution**

Participant A

I would like to prepare for civil servant examination during my alternative service. I would not go to cram school because going to cram school requires specific period of time.

Participant B

I would like to become a junior high school physics teacher. However, I failed in the admission examination of teach training program.

I have not yet found my goal in the future, but I really think any kinds of experiences are more important than learning.

Participant C

I am still the same as before, and will do any thing without change...I just want to be happy.

## **4. Conclusions and Discussion**

4.1 The results of the problem-solving performance and pattern for the learning of "one-dimension infinite square

well” indeed reflected their learning behavior and attitude. The correct answer rate decreased with the complexity of item concepts, suggesting that the participants did not completely understand the concepts and were dependent on memorization.

4.2 The responses to the questionnaire on “self-concept and external support system of underachieving gifted students” showed that, the participants did not develop negative self-concept. In addition, they did not suffer from too much family pressure owing to current academic performance. The reason might be that the participants did not reveal the information to other classmates that they used to be gifted students with excellent academic performance. There was no tokenization effect. It seemed that their personal traits did not include perfectionism and success oriented. Chang’s follow-up study on gifted students with excellent academic performance in senior high school mathematics and natural science found that, the gifted students who have higher self-expectation perceive more pressure from other people around them (2000). The participants in this study did not experience learning pressure. Whether such a phenomenon is associated with the absence of high self-expectation is worthy of investigation.

4.3 Participants started to accumulate the experiences of failure since senior high school. The atmosphere of peer competition was not significant and the reason might be the teaching of teacher or the property of course. Such a fact showed that as participants attached less importance to academic performance, their ranking worsened. However, they did not exhibit any aggressive behavior to change it. They simply relied on their good academic performance in one or two subjects to get enrolled in college. They chose department and school near their home in an attempt to escape from Department Required Test. They usually would not go to cram school or engage in other learning activities in leisure time.

4.4 Hung (1993) investigated the factors affecting the learning of college students in Taiwan and found that among the factors affecting students’ learning at college, the effect of personal factors (stress from examination, learning interest, examination score, self-expectation, concentration, time management, learning motivation, etc.) is more significant than that of school factor, and family factor. Wang, Peng, Chang, Tseng (2006) also suggested that underachieving gifted students may be characterized by the lack of learning motivation, lack of work commitment, bad habit, value conflict or low self-concept, etc. It is advised to find out the cause-and-effect relationship or interactive model first and then prioritize the factors to establish the counseling goal. Although the research results are not consistent with those of two studies mentioned above, they are quite similar. It seems that the factors affecting the learning behavior of gifted students and general college students are common.

4.5 The underachievement of most of the gifted students in junior high school will be extended to their adult career performance or choice, it is important to provide early intervention and prevention strategies (McCoach & Siegle, 2008). Family, school, peers, and teachers should cooperate with one another to help trigger students’ motivation for creating success or develop their accurate learning strategies and skills. It is always important for every educator to assist gifted students in finding themselves and becoming a “spontaneous changer” to reverse underachievement.

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