

# CHEMISTRY OLYMPIAD AND STUDY CAMP FOR SENIOR HIGH SCHOOL STUDENTS IN TAIWAN

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## Abstract

A study on the evaluation of the learning ability and gifted toward chemistry of the senior high school students has been carried out. The instruments for the evaluation have been established on the basis of (1) the sense of "gifted in chemistry", (2) the cognitive development in the "game of chemistry", (3) the process skills of the science, and (4) the experience of the International Chemistry Olympiad (IChO). The instruments were used in the Chemistry Study Camp and domestic Chemistry Olympiad which were sponsored by the Ministry of Education for screening the candidates in the gifted science of chemistry. The details of the activities of both programs are to be reported in this paper.

The results show the consistency of the evaluation by these instruments with that of the standard IQ tests. Study Camp is helpful for cultivating the excellence in chemistry. Subjective domination on the evaluation is still hard to be avoided in these instruments. The recommendation of the championship of the candidates through these instruments to the participation of IChO is one of goal of this study.

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## I. Introduction

Gifted students constitute one of the important resources of a country. One way of helping these gifted students to develop their innate ability is to discover them and educate them in special programs as early as possible. The Administrative Yuan is highly concerned about the education and guidance of gifted students and has repeatedly urged the Ministry of Education to do suitable research in this regard. In November 18, 1982, the MOE announced the "Guidelines for Educational Guidance for Gifted Students in Natural Sciences." Since then, gifted students of this category have been chosen each year to participate in a one-week science training camp, sponsored by and held at the Center for Science Education, National Taiwan Normal University. The program aims at observing and understanding the aptitudes and potentialities of these students so that the right candidates may be selected for proper education guidance. The Training Camp in Chemistry was implemented in 1982, 1983, and 1984. The main purpose of this study is to explore various aspects of the activities of the Training Camp program and try to find out whether or not the program is scientific and educational in orientation and whether or not the selection of candidates is in essence a fair process. This study is supported by a research grant from the MOE.

## Evaluation Instruments

A pilot study on the evaluation of the learning ability in chemistry of the secondary school students gifted in natural science and mathematics has been carried in 1984.

The instruments for the evaluation have been established on the basis of the following considerations:

- (1) the sense of "gifted in chemistry"
- (2) the cognitive development in the "game of chemistry"
- (3) the "process skills of the science"
- (4) the domestic experience of the adaptation of gifted student in the gifted science and mathematics project in the previous three years, and
- (5) the experience of International Chemistry Olympiad (IChO)

Accordingly, eight items of the instruments have been developed for the senior high school students:

- (1) the achievement test of the science process skills based on the chinese version of TIPS I and TIPS II.
- (2) test in experimental ability (t-dependent)
- (3) practical progressive experimental test (logic thinking-dependent)
- (4) research on an elected special topic
- (5) seminar and scientific article written
- (6) the achievement test in chemistry
- (7) the interview (oral) on quick-witted chemistry questions, and
- (8) written responses on the study camp

The instruments were used in the study camp for screening and training of the candidates in the gifted chemistry project sponsored by the Ministry of Education in the year of 1986.

The program for study camp is shown in Table 1.

The results based on the score 100 for the aboved-mention seven instruments except item (8) are tabulated in Table 2. Results in first instrument by using the chinese version of TIP I and TIP II is a prototype for comparison with the domestic and international level of the science process skills are listed in Table 3. Eight out of ten candidates of senior high school students major in chemistry in that year passed the screening of the study camp. Interestingly, the results show the consistency of the evaluation by these instruments with that of the standard IQ and aptitude tests shown in Table 4. Only one student recommended from the championship of the science fair, who failed in IQ test, passed the these instruments.

The jury consists of the chairman of the department of chemistry (NTNU), chemistry professors from National Taiwan University and National Ching-Hwa University. The jury marks the examination paper as well as lecturers in the training study camp.

Table 1. Schedule of the Chemistry Study Camp

Period	Date Content	March 29 (Saturday)	March 30 (Sunday)	March 31 (Monday)
	1	Opening	Tests in Experimental Ability	Research on a series of elected special Topic  (I)
	2	Ceremony		
	3	Scholar	Scholar	
	4	Speech (I)	Speech (III)	
	5	Audio-viedo Chemistry TIPS I test	Practical Progressive Experiments  (3 sections)	Research on a series of elected special Topic  (II)
	6			
	7	Scholar		
	8	Speech (II)		

Date Content		April 1 (Tuesday)	April 2 (Wednesday)	April 3 (Thursday)
	1	Research on a series of elected special Topic  (III)	Research Paper Written (continue)	Chemistry  Congress (III)  TIPS II tset Closing Remarks
	2			
	3			
	4			
	5	Chemistry Achievement test	Chemistry  Congress (I)	
	6			
	7	Scientific article writ- ten training	Chemistry  Congress (II)	
	8			

Table 2. The Results of the Study Camp Evaluated by the indicated Instrument

No.		1	2	3	4	5	6	7	8	9	10
Experimental	OS	85.7	79.3	76.7	82.3	85.7	78.7	74.7	81.0	73.7	82.3
Ability test	2/32	5.4	5.0	4.8	5.1	5.4	4.9	4.7	5.1	4.6	5.1
Science Process	OS	93.2	89.0	84.9	90.4	90.4	91.8	91.8	76.7	83.6	87.7
Skill (TIPS I & II)	2/32	5.8	5.6	5.3	5.7	5.7	5.7	5.7	4.8	5.2	5.5
Practical Progressive Experiments	OS	72	63	72	70	68	72	62	48	52	67
	4/32	9.0	7.9	9.0	8.8	8.5	9.0	7.8	6.0	6.5	8.4
Achievement	OS	80.5	62.0	69.5	69.5	74.5	64.5	62.0	66.0	63.0	56.5
Test	2/32	5.0	3.9	4.3	4.3	4.7	4.0	3.9	4.1	3.9	3.5
Elected Special	OS	91.8	88.3	88.7	88.5	88.8	85.1	93.0	85.8	84.0	85.7
Topic Research	12/32	34.4	33.1	33.3	33.2	33.3	31.9	34.9	32.6	31.5	32.1
Scientific	OS	85	88	86	82	90	84	85	90	87	89
Article Written	4/32	10.6	11.0	10.8	10.3	11.3	10.5	10.6	11.3	10.9	11.1
Seminar	OS	82.3	83.3	82.3	83.0	81.3	84.7	81.5	89.3	81.5	91.0
(oral)	6/32	15.4	15.6	15.4	15.6	15.2	15.9	15.3	16.7	15.3	17.1
Total Score		85.6	82.1	82.9	83.0	84.1	81.9	82.9	80.6	77.9	82.8

Table 3. Comparison of the Results of TIPS I & TIPS II Tests

		Domestic Junior High School Student (Tips II)				
		Grade	Test Samples	Average Score	Standard Deviation	Cronbach's $\alpha$
Tips II	Tips I	7th	680	23.20	6.32	0.83
Average (10 candidates)		8th	745	25.44	5.89	0.82
		9th	792	28.11	4.87	0.77
34.5 27		Total	2217	25.71	6.03	0.83

		Foreign Middle School Students (Tips II)				
		Grade	Test Samples	Average Score	Standard Deviation	Cronbach's $\alpha$
		7th	128	15.91	6.15	0.80
		8th	124	19.41	5.29	0.75
		9th	134	19.49	6.64	0.85
		10th-11th	73	25.27	5.07	0.79
		Total	459	19.14	6.93	0.86

		Foreign Middle School Students (Tips I)				
		Grade	Test Samples	Average Score	Standard Deviation	Cronbach's
		7th	250	15.39	6.76	0.84
		8th	-	-	-	-
		9th	255	19.83	6.46	0.84
		11th	204	22.29	8.08	0.91
		Total	709	18.91	7.60	0.89

Table 4. Comparision of the evaluation of Aptitude, I.Q. test &amp; Study Camp

No.	Aptitude Test		I.Q. Test				Final Score in Chemistry
	%	Z'	Verbal	Math.	Space	T score	Study Camp
1	98	131	121	123	99	116	85.6
2	98	131	111	136	127	133	82.1
3	99	133	132	136	126	142	82.9
4	85	115	121	111	118	123	83.0
5	98	131	118	113	94	109	84.1
6	70	108	126	119	110	124	81.9
7	97	129	132	127	96	120	82.9
8	65	106	89	113	85	95	80.6
9	80	113	87	104	112	103	77.9
10	70	108	118	131	98	116	82.8



### Chemistry Study Camp

Goal : To screen the students selected for chemistry major into the University without participation of the joint college entrance examination.

Selection of Students for the Study Camp:

- (1) Recommendation by the senior high school teacher based on the student's performance in chemistry up to 99% of the class, including the winner of the national Chemistry Olympiad and Science Fair in Chemistry.
- (2) Pass the standard I.Q. test (score better than 120).
- (3) Qualified students reviewed by the board assigned by the Ministry of Education to approve the final list for the study camp.
- (4) about 10-30 students gifted in chemistry allowed to sit in the study camp

Programs: Table 1 is a typical program arranged for the camp. Reports from 1982 to 1988 written in chinese are available in the nearby of the poster.

### National Chemistry Olympiad

Goal : To promote the excellence of the "Chemistry Education, and to find out the gifted in science of Chemistry.

Candidates : Three levels competitions were held.

- (1) School level : each senior high school selected one to two teams (2 students/team), depending on the population of that school, about 40,000 participated.
- (2) Local level : Five geological areas including Taipei city, Kaoshiong city,

Northern, Central and Southern Taiwan Province, were divided into eight competition stations. Selection method left to discretion of the belong Normal University (National Taiwan Normal University for Northern Taiwan, National Chung-Hwa Normal University for Central Taiwan, and National Kaoshiung Normal University for Southern Taiwan.) Totally about 350 students participated.

Table 5. Schedule of the National Chemistry Olympiad

February 20, 1989 (Monday)	
8:00 - 8:30	Registration
8:30 - 9:00 9:00 - 9:40	Opening Ceremony
9:40 - 11:40	Written Test (I): Theoretical and Inorganic Oriented
13:30 - 14:20 14:30 - 15:20	Experiments (I) 2 fifty-minutes and 1 hundred-minutes rotatory experiments
15:30 - 16:20 16:30 - 17:20	(exploring properties of materials)
February 21, 1989 (Tuesday)	
8:30 - 9:30	Written Test (II): Synthesis and Analysis of an Organic Compound
9:40 - 12:30	Experiment (II) : Synthesis and Analysis of an Organic Compound
14:00 - 16:00	Tested Demonstration and Jury Conference Closing Remarks on the Competition
16:00 - 17:00	Closing Ceremony

- (3) National level: Student selected by local section take national examination. About 40 students participated. Organized by the Science Education Center, and examination questions by Department of Chemistry, NTNU. This project was conceived in 1984 academic year. At the first two olympiads, only manipulating experiments were the contents of the contests. Traditional written test is added to the competition items from 20% of the contents in 1987 to 40% of the contents in this academic year (1988). The schedule for 1988 National Chemistry Olympiads is listed in Table 5. The last two years reports in chinese on these events are also displayed on this poster board. Ideally, the level of International Chemistry Olympiad is going to be gradually into our national level of the Chemistry Olympiads. About five students received awards, prizes which including the right of participating Study Camp, eventually enter into university majoring in Chemistry.

### III. Discussion and Recommendations (Conclusion)

One of the aspects of school education is to cultivate the minds of the students so as to help them accumulate knowledge. However, owing to two different ways of training, we can have two radically different results---'cultivation' or 'concealment' of the gifted. Gifted students in our country are the elites among the student population. They have gone through many processes of selection. But whether every one of these gifted candidates is suitable for the liberal education training in colleges and universities is still an open question. Some

f them, therefore, will necessarily find it difficult to adapt themselves to college life and will have less than ideal or even low achievement. These less-well-adjusted students are still highly intelligent individuals with great potentialities and will be of immense value to society, once properly trained.

The characteristics of gifted students are: wide interest areas, broad range of curiosity, excellent memory, good comprehension capability, quick intelligence, and unique ways of learning. These constitute an urgent need for learning. On top of all these characteristics, gifted students may also have some preconceived notions of how college life may be. And these notions may or may not be correct. All these factors, plus the lack of training to do independent thinking and study in their high school life, will make it extremely difficult for some of them to make proper adjustment to college life. However, there are also some who have the right attitudes toward college life and are willing to adapt themselves to the new environment of higher education. As we have mentioned earlier, gifted students are one of the important resources of a country or society. To give proper guidance to these students, therefore, should be an important task of the educational authority.

It has been a controversial issue as to how to render proper guidance to gifted students. The purpose of all the guidance programs is to discover and cultivate these promising young minds at as early a stage as possible so that they can have the best achievement possible in various branches of science. However, some of these gifted students feel that they have been burdened with undue heavy load both in the form of self-expectation and peer group pressure and thus cannot adapt well in their academic career.

Some of them even resist the very idea of guidance, claiming that it is both restrictive and unnecessary. But the actual fact is that their peers do not treat them as a special type of persons and most, if not all, of their psychological burden, is self-imposed. If they are given proper guidance, they will certainly have a better and more assertive and active kind of attitudes towards life.

From the achievement of gifted students in college, it is not difficult to find out that they have unique ways of doing research and most of them are quite satisfied with their present situation. They will certainly have better achievement if more guidance, geared to their own interest, is given to them in the most proper way.

In the process of selecting candidates, a standardized test is needed, although it is quite time-consuming to develop one. However, once a standardized test is designed, the effectiveness of the test will very soon be lost, because of the coaching programs of the cram schools. The responses given by subjects of this study show that these students are tired of being tested by the use of the same instrument(s) by various institutions. It is suggested that while it is important to establish norms for these tests, their contents should also be revised and changed so as to avoid overuse of the same materials. We have not established any particular norm in this study, but we have set up a model for the training camp for students gifted in Chemistry.

It seems to us that ICO may be the guideline of our future activities. For those students who have chosen to enroll in Chemistry departments in universities without having to go through the Joint College Entrance Examination, it is our hope that the activities in the training camp program may be of help to them. It is also our hope that some of these students will, with the help of the training camp program, somehow be qualified to join the ICO in the foreseeable future.