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International Chemistry Olympiad: Survey on the Circumstances of its Participant Countries

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Abstract: A survey was made on the circumstances of countries participating in the International Chemistry Olympiad (IChO), with twenty-four collaborating countries. Statistics are presented for the way of selecting and training student delegates, cost for selection, training, and sending delegates. Typical means of selection are (1) with a relatively small number of participants in the first step to start with an advanced high school level exam and select the final candidates in two or three steps and (2) with more than one thousand participants in the first step, to start with the basic high school level exam and select the candidates in three or four steps with increasing level of exams. The typical way for training is to set up ten to nineteen (maybe fourteen) days of a study camp in a university in June, to assign about twenty hours each for problem-solving exercises, laboratory work, and lectures, and to hold one to three tests, each for three to four hours. Instructors are usually university teachers. Delegates are usually selected during the training. The total cost for selection, training, and sending the delegates is usually less than fifty thousand dollars. In about half of the participating countries, the delegates are given the privilege of entering university. Between 1995 and 1999, almost all of the delegates specialized in chemistry or related fields in the university, followed by medicine and computer-related fields. The positive effect of the special training on the candidates, as well as the difficulties or problems facing the participating countries, such as financial ones, is also surveyed.

Introduction

The International Chemistry Olympiad (IChO) [1] started in 1968 with the participation of three East European countries, and has now become an event of international exchange, with ca. two hundred high school students from more than fifty countries and regions, who are interested and talented in chemistry. According to the regulation of IChO [1], it aims at promotion of international association and at enhancement of students in chemistry, through competition in talent and skills in chemistry, and through several accompanying social events. Japan has been

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hesitating about participation for a long time, because of the quite high level of competition. In fact, the past IChO questions are far beyond the contents of the "course of study", the official guideline for high school teaching and learning, in Japan. Recently, however, the Chemical Society of Japan (CSJ) has been seeking a way to send delegates to IChO, reflecting the desire of the students talented in chemistry for international exchange and competition, which was revealed in some contests in chemistry.

In spite of its over thirty years history, however, there seemed be no systematic survey made on the circumstances of participant countries. This caused the difficulty of lack of appropriate information when the Chemical Society of Japan, or, more accurately, the Subcommittee on International Relationship of the CSJ Council of Chemistry Education, started to consider possible participation in this international event for the students. This situation forced the Subcommittee to make a survey on the circumstances of participant countries in IChO.

At the end of March 2000, we mailed a questionnaire entitled "IChO Survey" [2] to mentors in the countries participating in the 31st International Chemistry Olympiad. Their addresses were picked up from the home page for the 31IChO [3]. In spite of the sudden request, the mentors in as many as twenty-four countries sent back a reply by the end of June.

Here, the summation of the answer to each question was shown and general trends observed in the results are presented, together with some consideration. The figures shown represent the number of countries which marked the check box for each category in the questionnaire, unless otherwise noted.

Results and Discussion

The Distribution of Responding Countries and the Method of Selecting Student Delegates

The first inquiry concerned the history of participation in the IChO, followed by the method of selecting students as delegates.

Q1 In what year did your country begin participating in the IChO?

'60s: 4 '70s: 3 '80s: 7 '90s: 10

The number distribution of replying countries agrees approximately with that of countries participating in IChO for '70s, '80s, and '90s. There seems to be no significant bias in the distribution of the decade of first participation for the replying countries from that for all participating countries [4].

Q2 How were the student delegates to the IChO selected in the latest IChO your country participated in? Were the National exams conducted to select the team?

Yes: 24 No: 0

All countries are holding domestic Chemistry Olympiads or the corresponding selection, where the delegates have been chosen. As far as the countries surveyed, no country decides delegates based on the recommendation of school teachers. Thus, the questions 4.1 to 4.6 in the questionnaire were skipped.

The outline of the selection method (or the National Chemistry Olympiads)

The following inquiries are focused on the examination for selection among the ordinary students, prior to the special training for the selected candidates in 1999.

Q3.1 How many steps of exams or other screening processes were taken to select the student delegates to the IChO? (If the student delegates were selected from the finalists through special training processes such as a study camp, these processes are not to be included here.) How many local sections was the country divided into in the screening processes? (before final selection)

(1 step: 5)*   2 steps: 13(4)*   3 steps: 8(3)*   4 steps: 4(2)*

* Figures in parentheses indicate the numbers of countries affording the final selection during the training period.

Most countries select their candidates for special training in two or three steps of exams.

The numbers of attendants to the last exam in some countries suggest that the last one would be done in the training term. This would be caused by the ambiguity in the expression in the question, for which some improvement will be required for more accurate research in the future.

The reply sheet was so designed as to give the numbers of steps for local and national exams separately. Since the ambiguity of the question seemed to cause confusion, we gave up on counting each of them separately.

The second question proved to have been ambiguous, so the replies are not included.

Q3.2 What types of publicity campaigns were carried on to recruit student participants in the selection?

(1) Through school teachers	13
(2) Through education system out of school	2
(3) Newspapers and TV	0
(4) Other	1 (Posters)
(1) and (2)	4
(1) (2) and (3)	1
(1) and (4)	2 (Web site)
(1) (2) (3) and (4)	1 (Web site)

In total, nineteen countries mention campaigns through school teachers. Seven countries use facilities other than schools, while few counties use the media such as newspapers, TV, or WWW.

Q3.3 What was the approximate number of the students who participated in each step? In what grade were the students?

Only the first step is shown. The distribution of the total number of participants is shown in **Figure 1**.

No. of Students	No. of Responding Countries			
1st step	Total	Twelfth	Eleventh	Tenth and under
0	0	2	2	9
~100	1	0	5	3
100~500	10	7	6	2
500~1,000	4	4	2	0
1,000~5,000	6	3	1	2
5,000~10,000	2	1	0	0
10,000~	1	0	1	1
No Answer	0	7	7	7

In most countries, the majority of the participants are twelfth graders. In four countries the numbers of eleventh or lower graders are similar to those for the twelfth graders, while only eleventh or lower graders are participating in the selection in two countries. There is a country taking four steps of selection prior to special training, with *ca.* 200,000 participants in the first step. The country uses in *ca.* 20,000 local places for the first step, which is supposed to correspond to almost all the high schools in the country.

In connection with **Q3.1**, all the countries taking only one step in the selection have the total participants of 300 or less. On the other hand, all the countries with participants of over 1000, with only one exception, carry out the selection in three steps or more.

The percentage of students participating in the first step could be elucidated, if the approximate number of high school students in one grade in each country had been included in the questionnaire. Instead, the ratio of the participants to the national population was calculated. National populations, in the years ranging from 1992 to 1995, are taken from the statistics available on the Web (searched at Yahoo! Japan [5]).

Table 3.3.2 Distribution of the number of participants in the first step exam per one million national population (see also Figure 2).

Participants/million	~10	~30	~50	~100	~300	~500	500~
Number of Countries	2	7	5	4	2	0	3

The mode in the number of countries is at ten to thirty participants per million. For Japan, this corresponds to one to three thousands students. It should be noted that the majority of the countries with more than fifty participants are those with less than ten millions of population.

Q3.4 What types of exams did the students take? Please give the approximate time for each.

Average	Written exam	Experimental exam
1st step	2.8 hours/23	4 hours/1
2nd step	3.5 hours/23	3.5 hours/15
3rd step	4.4 hours/12	3.6 hours/11
4th step	6.0 hours/5	4.0 hours/4

The time for the written exam ranges from three to four hours in the first and second steps, while longer than four hours in the third step and after. One country imposes an experimental exam from the first step. On the other hand, three countries impose no experimental exam throughout the overall two or more steps of selection.

Q3.5 Level of the problems in each selection step? (please check one or two only)

The level of each step should differ depending on the number of total steps, so that the replies are collected for the countries with an equal number of total steps.

Two steps (twelve countries)

	High school (Basic)	High school (Advanced)	Intermediate	IChO
1st step	5	4	2	1
2nd step	0	3	5	4

Three steps (seven countries)

	High school (Basic)	High school (Advanced)	Intermediate	IChO
1st step	1	5	1	0
2nd step	0	2	5	0
3rd step	0	0	4	3

Four steps (five countries)

	High school (Basic)	High school (Advanced)	Intermediate	IChO
1st step	3	2	0	0
2nd step	0	5	0	0
3rd step	0	2	3	0
4th step	0	0	3	2

In the first step, most countries impose problems of high school level. In the last step, irrespective of total steps, the number of countries imposing intermediate level problems and the number of those imposing IChO level ones are similar. Only one country imposes IChO level problems prior to the last step.

Through the replies to **Q3.1** to **Q3.5**, the countries may be divided into two groups based on the way of selection. About half of the countries in the first group, with relatively small numbers (less than five hundred) of participants, carry out advanced high school level exams and select the final candidates (or delegates) in two or three steps. About one third of the countries typically in the second group, with more than one thousand participants in the first stage, start with the basic high school level exam and select the candidates in three or four steps with increasing level of exams and decreasing number of participants.

Training of the Student Delegates to the IChO including Finalists

According to the regulations of IChO [1], each country may afford special training for the selected candidates within fifty students for not longer than two weeks. Queries were made on how and what kind of special training was carried out for IChO to the student delegates (or candidates).

Q5.1 How were the student delegates trained?

Study camp: 23 Weekend Lessons: 1

In some countries, study camp was combined with another way of training as follows:

Study camp and correspondence course: 3

Study camp and self-learning: 1
Study camp and lessons during the year: 1

In the country with no study camp, seven Saturdays from March over April have been allocated for the training. One country holds fifteen lecture and experimental classes in a year in addition to the study camp.

What follows are the answers to the further questions on study camps.

Days:	1~4: 6	5~9: 6	10~: 11			
Month:	Mar-Apr: 1	April: 5	Apr-May: 1	May: 5	May-Jun: 1	June: 9
Place:	University: 20	High school: 2	No answer: 1			

The typical way of the training would be described as follows: ten to nineteen (maybe fourteen) days of a study camp held in a university in June, during which final selection is afforded. After that the delegates go for IChO in the beginning of July. This would be the most reasonable approach for the countries in which the academic calendar starts in September and ends in June.

Q5.2 How many students were trained? (No. of Students: No. of Countries)

4: 7 5: 3 6~10: 4 11~19: 5 20~: 5

Training only four to five students indicates that the delegates are determined by the selection exam and that the training is conducted only for them. Ten countries adopt this method. In other countries, the training period corresponds to the final selection step.

Q5.3 What types of training did the students receive? Please give the approximate time for each.

Hours	0	~5	~10	~15	~20	~40	41~
Problem-solving exercises	3	2	5	2	6	3	2
Laboratory work	0	2	3	1	11	4	2
Lectures	3	3	2	2	8	4	2
Tests	9	3	7	3	0	0	1
Other:	22	0	1*	0	0	0	0

*Visit to Pharmaceutical Company. See also **Figure 3**.

In some replies it seems that the problem-solving exercises and tests (exams) are not clearly distinguished. The typical curriculum for training would be as follows: assign about twenty hours each for problem-solving exercises, laboratory work, and lectures and afford one to three tests, each for three to four hours.

The net training time in total for each country was compiled in **Table 5.3.2**.

Table 5.3.2 Distribution of total training time in each country

Time/h	~9	~29	~49	~69	~89	~109	110~
No. of Countries	1	0	9	3	7	1	3

Se also **Figure 4**.

In comparison with the answer to **Q5.1**, every country having the training period within a week has the total time of forty-nine hours or less. Countries taking seventy to ninety hours for training have training periods ranging from ten to fourteen days.

Q5.4 What and how many people taught and trained the students?

	No. of Countries (No. of People)
High school teachers:	2 (4 and 12 trainers each)
University teachers:	13 (~5: 6, 6~10: 4, 11~: 2, No answer: 1)
HS and Univ. teachers:	4 (HS/UT 1/2, 2/5, 2/6, 7/5 each)
HS teachers and Former participants:	1 (3 and ?*)
Univ. teachers and students:	2 (3 and 1, No answer)
Univ. teachers and Industrial chemists:	1 (5 and ?*)
HS and Univ. teachers and Ind. chemists:	1 (3, 1, 1)

* The corresponding figure is not shown.

There are nineteen countries in which university teachers are mainly in charge of the training. High school teachers are mainly in charge of the training in four countries.

Q5.5 If the student delegates were chosen from the finalists, how were the student delegates selected?

Mostly based on study camp or final step test achievement (seventeen countries), some considering the mark in high school or that in the regional Olympiad.

Q5.5.2 Was any honor conferred on those who were not selected for the student delegates?

Yes: 8

Including the honorary or authorization certificates, prizes (book, *etc.*), or qualification for entrance into university as wished.

Q5.6 Is it considered that the students learned something special other than knowledge and skill required for the IChO?

Yes:9
No: 14
No Answer: 1

We expected that the additional influence on the trained students might be recognized in more countries. A larger number of positive replies might be induced, if several terms, such as those shown below, were used on the reply sheet for selection.
Inquiry was made on the content to the countries which answered "yes".

Knowledge of chemistry required in university studies:	2
Interest and enthusiasm for chemistry:	2
Team work:	2
Meeting other talentful youngsters:	2
Meeting university professors and/or good industrial chemists:	1
Domestic and world history, English, psychological training:	1
Practical working skills in laboratories:	1

In addition to the knowledge and skills for the future, socialization with teammates and team work fostered through study camps are exemplified as the positive effect. It is interesting that some countries train in the culture and skills necessary for international association, such as history and language (English?).

Cost and Difficulties in Organizing

Queries were made on the financial bases supporting the prolonged participation for selection, training, and IChO stages.

Q6 How much were the expenses?

	No. of Countries		
US$:	Selection	Training	IChO
~500	2	1	0
~1,000	3	3	0
~2,000	5	9	0
~5,000	3	5	8
~10,000	0	2	12
~50,000	6	3	3
50,000~	3	0	0
No answer	1	1	1

See also **Figure 5**.

The replies about the selection cost may be categorized in two groups on the basis of the cost required. The first is the countries spending less than $5,000, with a mode at about $2,000. Another group is those spending more than $10,000. The cost shows no significant correlation with the number of participants in the country (shown in the reply to **Q3.3**). Of course, price conditions are different from one country to another, but there would be some other cause for this discrepancy. For instance, the cost would vary greatly whether or not a traffic fee was paid to the participants in the (final) national selection, although details of the selection cost were not shown in the reply.

Similar trends are observed in the cost for training, but not all of the countries spending large amounts for selection also spend much for training. For instance, only two countries spend more than $10,000 for selection among the five countries spending more than $5,000 for training. With the replies to **Q5.1** and **Q5.2** taken together, the training cost per student per day may be calculated as shown in **Table 6.2**.

Table 6.2 Distribution of cost for training per student per day

Cost/US$	~10	~20	~50	~70	~100	~200	200~
No. of Countries	3	3	6	0	3	6	1

See also **Figure 6**.

The distribution also shows the presence of two groups: one below fifty dollars and the other with a mode at $100~200. The countries involved in each group suggest that difference in price condition is not a major factor reflecting the distribution. This cost seems to reflect the policy of the country: some depend on the voluntary effort of instructors using cheap facilities for training, while others seem to depend on internal subsidy for the cost as far as possible.

The cost for sending delegates to IChO mainly ranges from $5,000 to $10,000, mainly reflecting the aero-traffic cost. All the countries spending less than $5,000 for sending are European, reflecting the cost before 1999 when IChOs were held inside Europe.

The cost was summed up for each country and the distribution of the overall cost is shown in **Table 6.3**.

Table 6.3 Distribution of the total annual cost for participating in IChO

Total Cost/10^3 US$	~5	~10	~20	~30	~50	~100	101~
No. of Countries	1	6	6	3	4	0	3

See also **Figure 7**.

The cost for selection, which represents the major part of the total cost and which varies widely in different countries, is reflected in the distribution of the total cost.

In summary,

(1) The cost for selection makes up the major part of the total annual cost for participating in IChO.

(2) The cost for training depends not on the number of candidates and dates, but on the facility used and the treatment of the cost for the instructors. The cost per candidate per day does not exceed $200.

(3) The cost for sending delegates depends on the location of the host country, but does not exceed $20,000.

(4) Each country seems to divide the available funds for each cost, considering its own circumstance, in order to enable continuous participation.

Finally, the sponsorship for the participation is shown in **Table 6.4**.

Table 6.4 Sponsorship for participation in IChO (Multiple selection)

	No. of Countries		
	Selection	Training	IChO
Academic	9	8	7
Government	17	18	19
Foundation	5	3	7
Private	7	9	6

See also **Figure 8**.

Irrespective of the stages, the government bears all or part of the cost in about 2/3 to 3/4 of the countries. Scientific institutes partly bear it in about 1/3 of the countries. In about 1/5 to 1/3 of the countries part of the cost is borne by the support from private enterprises and foundations.

Q7. Are there any difficulties or problems in participating (or continuing to participate) in the IChO?

No: 13 Yes: 11

About half the countries feel difficulties or problems against continuous participation. Nine countries claim budget problems. Other difficulties claimed are as follows (the figure in parenthesis is the number of countries mentioned):

Short of office equipment

Insufficient conditions for laboratory experiments
High participation fee (2)
Insufficient number of mentors to cover the translation of IChO problems due to the structure of language
Criticism against the high scientific level and difficulty of the IChO tasks
Lack of school curricula on national basis

It is noteworthy that every country continues to participate in IChO, overcoming the difficulties as shown above year by year.

The student delegates thereafter

The final set of questions are related to the privilege of the selected students and the course after they enter university.

Q8.1 Are the qualified students such as student delegates to the IChO and finalists privileged to be admitted to (top-class) universities or receive scholarships?

No: 12 Yes: 12

All "yes" countries provided a scholarship or grant for entrance to university. In only one country the privilege is limited to scholarship. The faculties allowing for privileged entrance range as follows:

Almost all:	7 (3 with scholarship or remission of tuition fee)
Natural science and related:	2
Imposing chemistry in entrance examination:	1
Department of chemistry:	1

Two of the countries replying "No" commented that this level of students can usually enter any university they wish.

The privilege is not related to the number of participants in the selection. In many countries with no privilege, forty to eighty students per million population participate in the selection (**Q3.3**).

Q8.2 How many student delegates participated in the last five IChO?

Almost all answers are "four times years of participation".

Q8.3 Were the courses of the former student delegates having graduated from high schools followed?

Yes: 9 No: 11 No Answer : 4

Q8.4 If surveys were conducted into the former student delegates to the IChO now in the universities, what are the majors of the students participated in the last five IChO? If the exact numbers are not available, please only check the majors at least one student have specialized in.

Twenty-three countries gave an answer, among which ten specified the numbers and four indicated their trends. In three of these fourteen countries the majority of students did not specialize chemistry in the university, among which two did medicine.

Field	No. of Countries	Field	No. of Countries
Chemistry:	23 (Major*: 11 Minor: 3)		
Applied chemistry:	5	Chemical engineering:	14
Biochemistry:	5	Agricultural chemistry:	1
Pharmacology:	5	Physics:	6
Biology :	2	Other natural sciences:	3
Mathematics:	2	Statistics:	0
Computer science:	10	Biotechnology:	1
Other engineering:	8 (Electronic: 1 Computer: 1 Telecommunication: 1)		
Medicine:	19 (Major*: 2)		
Business:	1	Economy:	1

* Majority of the student delegates took the course in the university.

Departments of applied chemistry or of agricultural chemistry, although common in some Asian countries, may not exist in most other countries. Almost all of the students specialized in chemistry or related subject, including chemical engineering, biochemistry and pharmacology. Medicine is at the top of the other specialties, followed by computer science.

Conclusion

Trends in the circumstances of countries participating in IChO are described, based on the replies to our questionnaire from twenty-four countries. Statistics are shown for the way of selection, training, cost of participation, and the specialty of the delegates afterwards. Privileges for the delegates and finalists and difficulty or problems against participation are briefly introduced. Care should be taken, however, since the materials presented here reflect the replies from only twenty four countries, just about half of the total participants.

The authors express their hearty gratitude to every mentor of each country who politely collaborated to this survey.

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The Japanese version of this report is available from the Council for Chemistry Education, Chemical Society of Japan.

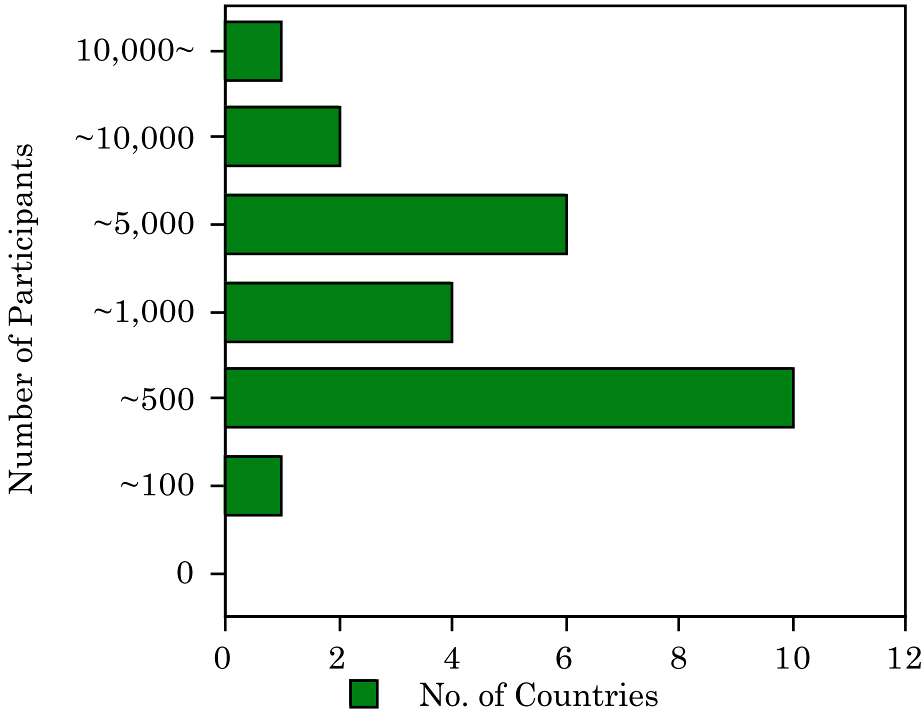

Figure 1 Distribution of Total Number of Participants

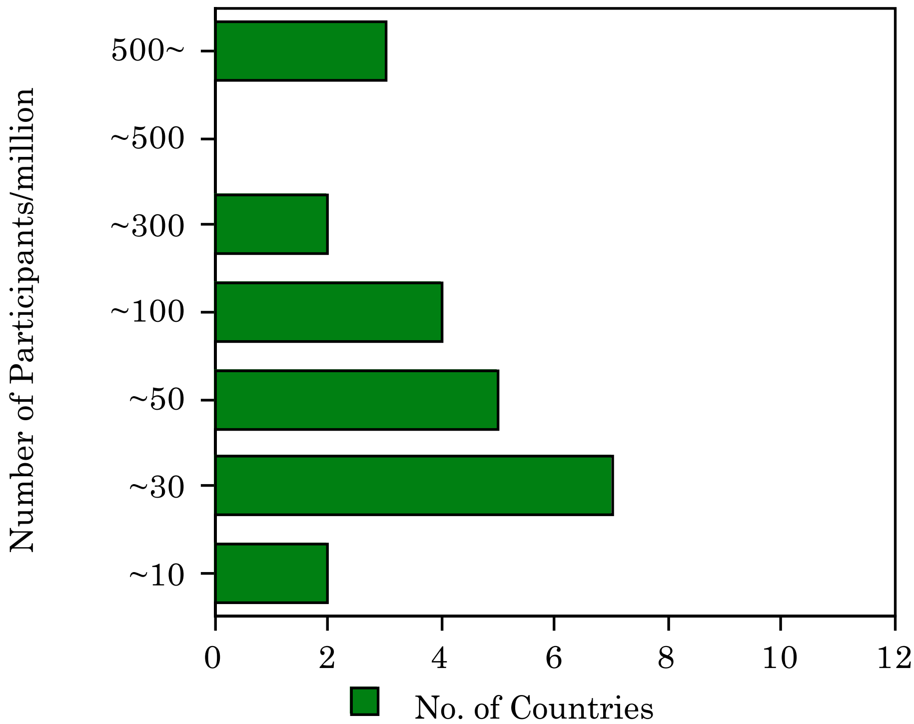

Figure 2 Distribution of Total Number of Participants per Population.

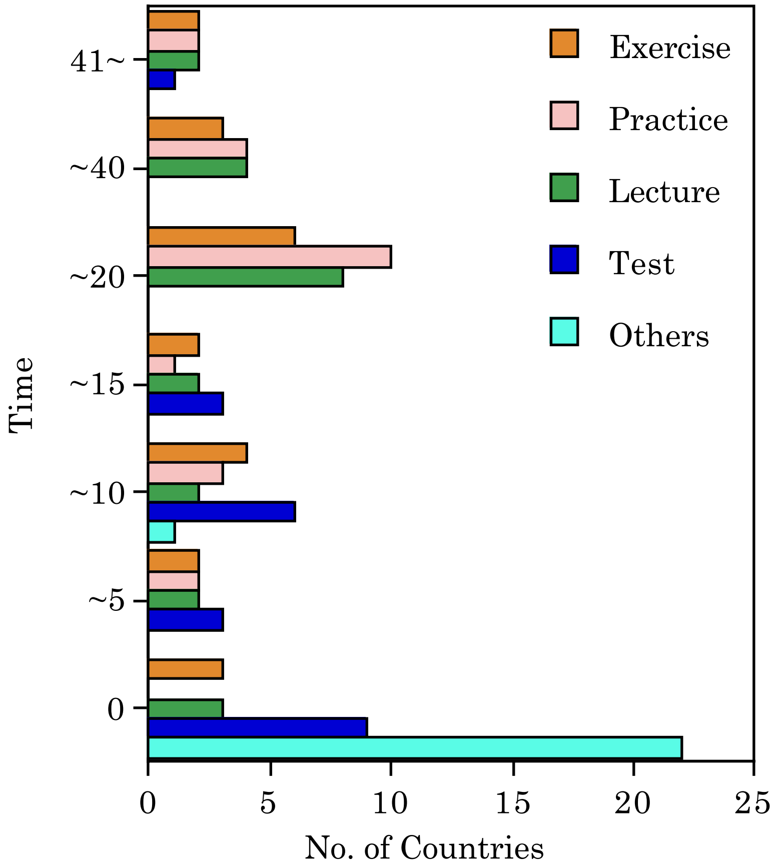

Figure 3 Distribution of Training Time

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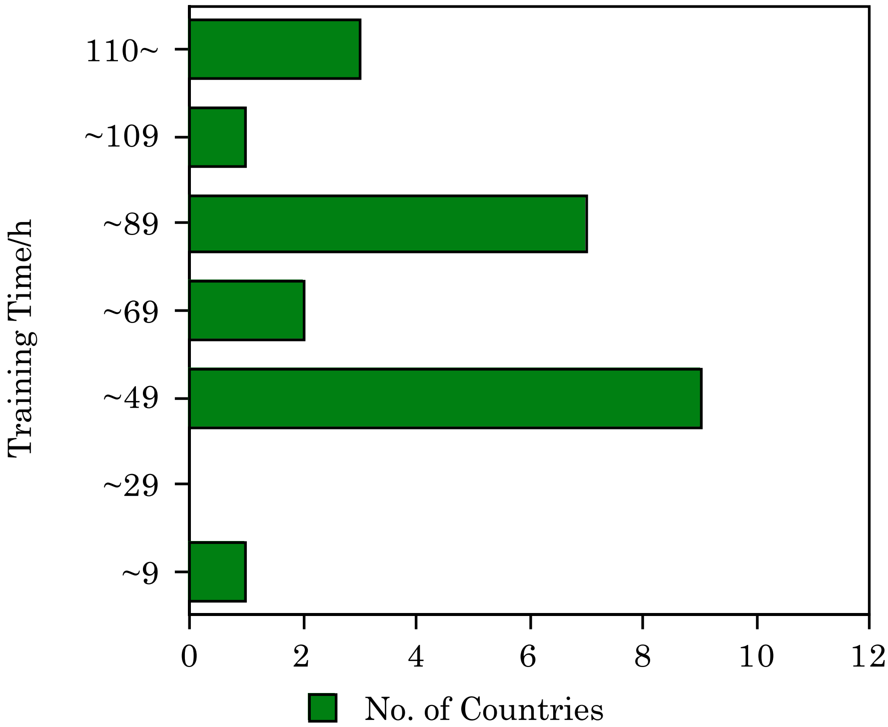

Figure 4 Distribution of Total Training Time

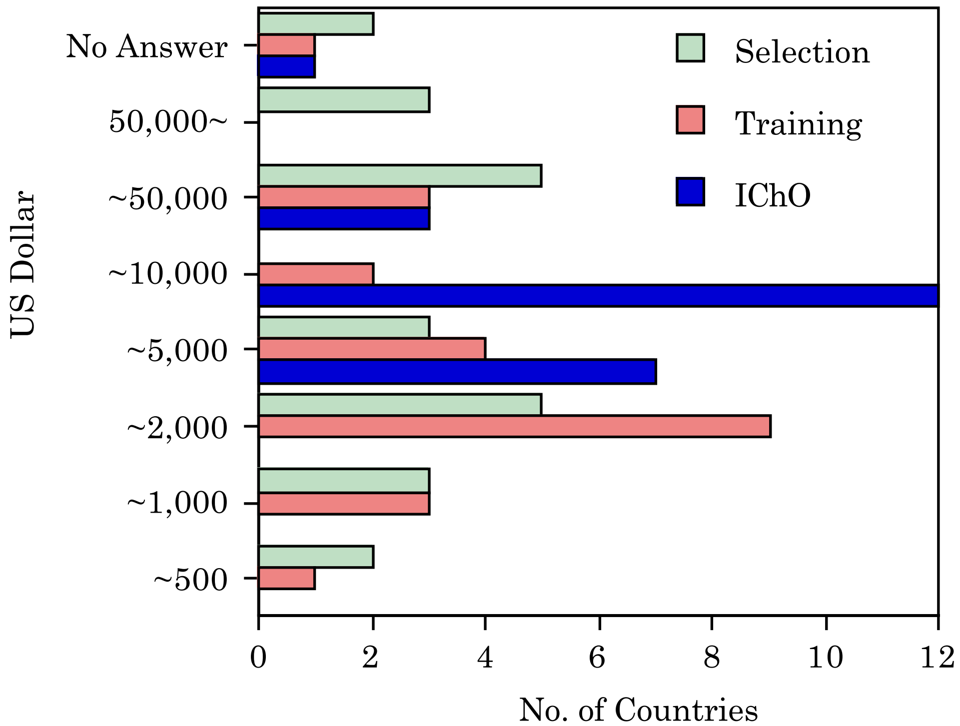

Figure 5 Distribution of Cost for Selection, Training, and Sending Delegates to IChO

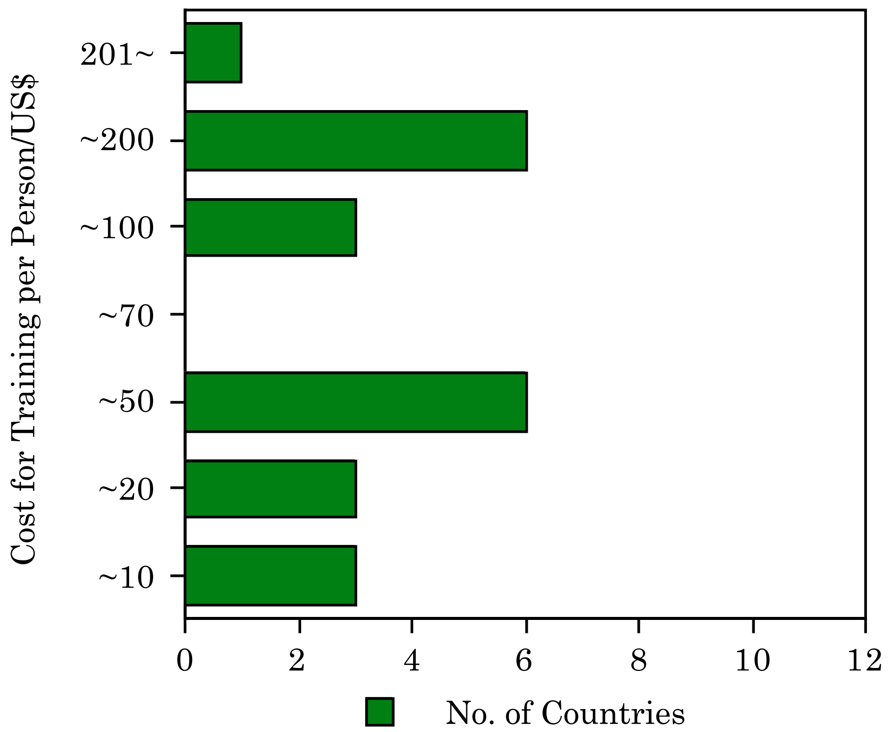

Figure 6 Distribution of Cost for Training per Person

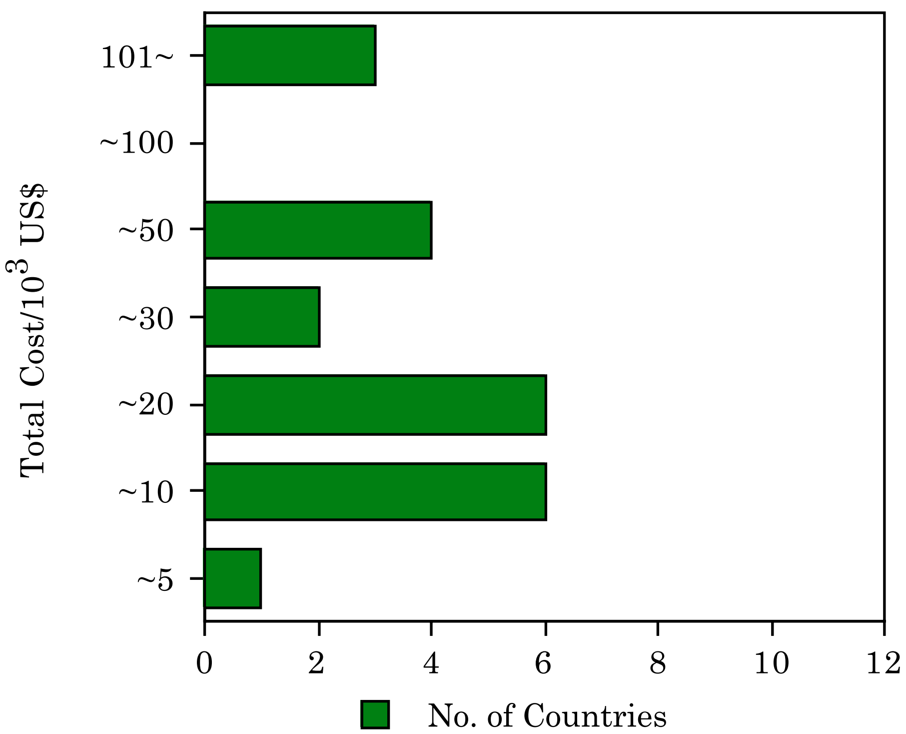

Figure 7 Distribution of Total Cost for IChO

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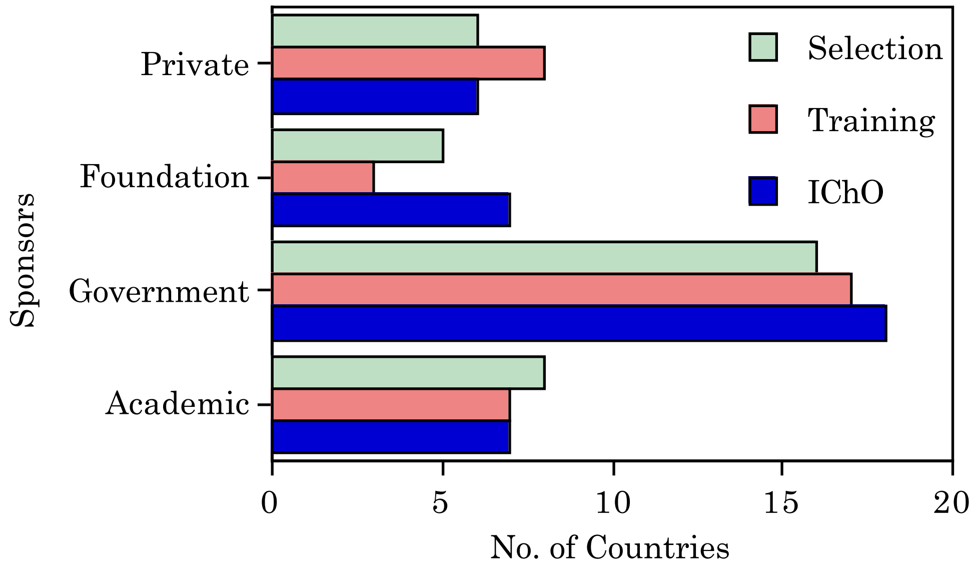

Figure 8 Sponsors for Selection and Participation to IChO

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URL = http://www.juen.ac.jp/scien/cssj/cejrnlE.html

概要

国際化学オリンピック（IChO）への参加国の実態を、24ヶ国の協力を得て調査した。代表の選考方法、訓練方法、およびこれらに要する経費の国別の分布を示した。IChOへの国代表の典型的な選考方法は一次選考への参加者の数によって２通りに分かれる。選考会（国内化学オリンピック）への参加者数が比較的少ない国では、第一段階で高等学校の応用問題レベルの筆記試験を課し、2～3 段階で選考している。参加者数が千人を超える国では、第一段階では高等学校の基本レベルの試験から始まり、3～4 段階かけて少しずつ難度の高い問題を課して選考している。代表候補者の訓練は、10～14 日の合宿を 6 月に大学で行い、問題演習、実験および講義をそれぞれ約 20 時間かけて行い、3～4 時間の試験を 1～3 回行っている。大学の教員が指導し、この期間に最終的な代表の選考を行っている場合が多い。選考、訓練および代表の派遣に要する経費は、多くの国では 50 万ドル以下である。参加国の約半数では、代表になった生徒は、無試験で大学に入学することができる。1995～1999 年の代表のほとんどは、大学では化学または化学系の学科に進学しており、医学およびコンピュータ関係の学科がこれに続いている。訓練が代表候補者に与える好影響と共に、参加国が直面している困難な問題（資金面など）に関する調査結果も示した。