Annual Incomes of University Graduates and their Science Studies during High School Periods

JUNICHI HIRATA [1], KAZUO NISHIMURA [2], JUNKO URASAKA[3], TADASHI YAGI[4]
[1] College of International Management
Ritsumeikan Asia Pacific University
1-1 Jumonjibaru, Beppu, Oita, 874-8577, JAPAN
[2]Institute of Economic Research
Kyoto University
Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501, JAPAN
[3]Department of Social Studies
Doshisha University
Karasuma Imadegawa, Kamigyo-ku, Kyoto, 602-8580, JAPAN
[4]Department of Economics
Doshisha University
Karasuma Imadegawa Kamigyo-ku, Kyoto, 602-8580, JAPAN
nishimura@kier.kyoto-u.ac.jp   http://www.kier.kyoto-u.ac.jp

Abstract: - We survey the incomes of graduates of science or engineering departments of the Japanese universities. We also compare the incomes of three separate generations to analyze the impact brought about by changes in curriculum guidelines imposed by the Ministry of education, culture, sports, science and technology (MEXT). We find that science and mathematics have become weaker subjects for each succeeding generation. Also,We find that physics studies have contributed most to increases in income in every generation.

Key-Words: - Science studies, incomes of university graduates, physics, curriculum guidelines, relaxed education

1 Preface

In this paper we verify that the content of science subjects students study affect their competitiveness as workers and therefore their annual income in the labor market.

In the earlier studies Kane and Rouse [3] have looked at the relationship between credits acquired at university and annual income as a way of gauging the rate of return to a university education. Arcidiacono [1] studies the college education process, estimated the difference in earnings among majors, and discusses the factors which determine earnings. Then, he shows that the observed premiums are generated by both the learning of math and science and the abilities of individuals choosing the different majors. O'Leary and Sloane [5] examine income of university graduates in Great Britain according to their department of graduation. Wolniak et al. [6] also show that the statistically significant differences exist in earnings among college majors by using alumni data. Especially, Math/Engineering majors earn higher income, which is consistent with our results in this paper.

Hirata, Nishimura, Urasaka and Yagi [2] have identified income gaps between science graduates and humanities graduates empirically. The results of their research indicate that the fostering of scientific capabilities makes workers relatively more competitive in the labor market. Included in the "humanities" category were principally graduates of cultural and social sciences departments, while those in the "sciences" category included graduates of science and engineering, medical, agricultural and biological sciences and engineering departments.

Workers who have developed their science and mathematics capabilities have a competitive edge since only they can do a growing number of jobs. It is recognized that, in the labor market, such capabilities provide a sort of advantage.

Let's consider the significance of education in the molding of scientific and mathematical capabilities. An income gap later develops among successful applicants to university humanities departments, depending on whether or not they have studied mathematics (See [4]).

On the other hand, students who enter science department, where they are studying mathematics, have studied science to widely varying extents. However, if the student's learning level creates an impediment to study after entering college, there may be impacts on post-graduation career path selection and on income after securing employment.

In this study we seek to verify whether differences in the content of students' science studies impact the fostering of their personal capabilities and their competitiveness as workers in the labor market.

The paper is structured as follows: Section 2 outlines the data and the survey, while Section 3 discusses the changes in postwar government curriculum guidelines. Section 4 compares the good at subjects and the average income. Section5 concludes the paper.

2 Data

2.1 Survey outline

The analysis in this paper is based on the results of an Internet survey conducted by Nikkei Research in February of 2011, as a research project of the Research Institute of Economy, Trade and Industry (RIETI) " Fundamental Research for the Construction of a Vibrant Economy and Society in Japan". From the population of 169,536 monitors registered with Nikkei Research, 100,000 were randomly selected and asked to participate. In the end, only those who had graduated from university were selected, from whom 11,399 responses were received. We conducted the following analysis on these 11,399 respondents.

On the survey we asked respondents to name their graduated universities and departments. The response rate to this question was extremely high. Based on this data, we divided the respondents into science graduates and humanities graduates.

As for respondent classifications, 3,456 (average age: 43.7), or about 30 percent, were graduates of science and engineering departments, while 7,879 (average age: 42.5), or about 70 percent, were graduates of humanities departments.

2.2 Descriptive statistics

The average age of respondents was 42.9, with a standard deviation of 9.98 years. Average income was 4.833 million yen, with a standard deviation of 4.065 million yen. Age distribution generally follows the normal (Gaussian) distribution. As for sex, 59.7% of respondents were male, 40.3% female.

Looking at the distribution of the entire sample, as well as at employed workers (i.e., income earners), we see that the largest number mention biology as a science subject they are good at, followed by chemistry, physics, and earth sciences, in that order.

	All sample			Employed respondents		
	Responses	%	Cumulative %	Responses	%	Cumulative %
Physics	2350	20.6	20.6	2183	21.9	21.9
Chemistry	2822	24.8	45.4	2504	25.1	47.0
Biology	4506	39.6	85.0	3771	37.8	84.8
Earth Science	1707	15.0	100.0	1516	15.2	100.0
Total	11385	100.0		9974	100.0	

Table 1 Good at Science Subjects

3 Changes in government curriculum guidelines

The reason for the changes that have occurred in the high school science curriculum, is the changes in the government curriculum guidelines. As is widely known, the introduction of a more "relaxed" curriculum in particular has limited the learning of subject matter and has resulted in the widening of academic deficiencies. To verify that impact, we have first identified the major changes in curriculum guidelines imposed by MEXT.

Table 2 summarizes the changes in postwar government curriculum guidelines, focusing on high schools. The birthdates of the sample for this paper range from 1945 to 1986.

Policy objectives of government guidelines		Revision (High School)	Implemen-tation (High School)	Targets	Applicable sample size	Applicable sample size (Employed)
A		12/ 1955	1956	Born 4/1940 or later	5016 (Prior to "Relaxation")	4520
	Systematics of subject learning	10/ 1960	1963	Born 4/1947 or later		
	Modernization of the educational curriculum	10/ 1970	1973	Born 4/1957 or later		
B	Relaxation and enrichment	8/ 1978	1982	Born 4/1966 or later	4440 ("Relaxation")	3771
C	New vision for scholastic attainment	3/ 1989	1994	Born 4/1978 or later	1943 (New vision for scholastic attainment)	1696

Table 2 Changes in Government Curriculum Guidelines

4 Good at subjects and average income

To verify that revisions of curriculum guidelines have impacted post-graduation employment, we classified all respondents by generations into three groups according to the curriculum guidelines; Generation A (respondents with birthdates up to March, 1966), B (birthdates from April 1966 to March 1978) and C (birthdates from April 1978 and after). The corresponding samples (with the percentage of the total sample in parentheses) were 5,016 (44.0%) for Generation A, 4,440 (39.0%) for B and 1,943 (17.0%) for C. To analyze only employed respondents (.i.e., income earners), we established a corresponding sample, with 4,520 (45.3%) from Generation A, 3,771 (37.8%) from B and 1,696 (16.9%) from C.

Tables 3 and 4 show the actual amounts (in units of 10,000 yen) of the average incomes as well as the actual numbers of those favoring each subject.

About the favorite subjects of the three generations in Table 3, the first point to mention is that both generations A and B liked mathematics best. And only ten percent of Generation C chose science as a favorite subject, while the other four subjects are chosen by the 20 percent. Secondly, the numbers of respondents naming mathematics and science as favorite subjects decline with each succeeding generation, while the numbers selecting English and Japanese as favorites increase (See Figure 1).

Good at subject	All sample			Generation A			Generation B			Generation C		
	Responses	Average income	Average age	Responses	Average income	Average age	Responses	Average income	Average age	Responses	Average income	Average age
English	1869	519.3	41.8	756	651.6	52.0	725	476.6	38.1	388	341.2	28.8
Japanese	1764	437.4	42.3	742	518.6	52.0	693	409.7	38.2	329	312.8	29.2
Math	2649	619.9	43.9	1304	724.2	52.2	961	560.6	38.4	384	414.1	29.0
Science	1214	607.6	44.4	626	707.7	52.6	413	544.6	38.5	175	398.3	28.9
Social studies	2036	575.7	42.7	870	689.7	52.2	825	540.0	38.3	341	371.6	29.1
Not in particular	455	473.6	43.7	222	548.6	52.4	154	426.0	38.7	79	355.7	29.2
Total	9987	551.7	43.0	4520	660.8	52.2	3771	504.9	38.3	1696	364.9	29.0

Table 3 Average Income by Good at Subject (in 10,000 yen)

Good at science	All sample			Generation A			Generation B			Generation C		
	Responses	Average income	Average age	Responses	Average income	Average age	Response s	Average income	Average age	Response s	Average income	Average age
Physics	1397	681.4	44.9	768	762.2	52.4	452	645.6	38.3	177	422	29.1
Chemistry	1148	620.0	43.0	497	728.2	52.7	458	591.7	38.4	193	407.8	29.1
Biology	499	548.5	41.9	222	660.4	51.5	167	525.1	38.0	110	358.2	28.4
Earth science	162	646.9	47.0	106	707.52	53.1	41	582.9	38.0	15	393.3	28.9
Total	3206	636.9	43.8	1593	733.88	52.3	1118	603.20	38.3	495	401.4	29.0

Table 4 Average Income of Science Graduates by Good at Science Subject (In 10,000 yen)

About the average incomes of three generations of respondents by their favorite subjects in Table 3, we see that in all three generations those who named mathematics as their favorite subject have the highest income, followed by those mentioning science, social studies, English and Japanese.

As for each subject in science, Table 4 tells us that the numbers mentioning physics and earth sciences as favorites have shrunken, biology has grown in popularity. In fact, biology is the most popular subject in all three generations. We see in Table 4 that those favoring physics have the highest income, followed by chemistry, earth science and biology, in that order. This tendency is the same for all three generations (See Figure 2).

Figure 1 Good at Subject(Person at work)

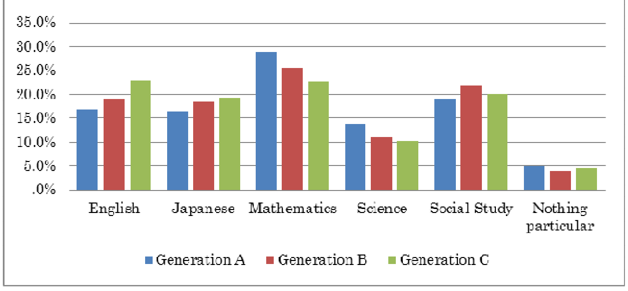
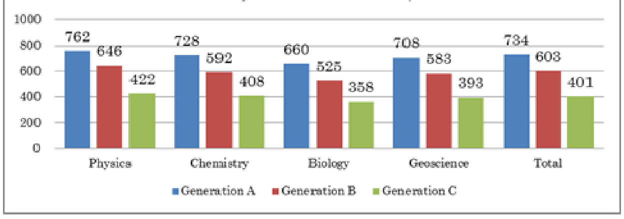


Figure 2 Average Income of Science Faculties Graduates by Good at Science Subject (10 thousand Yen, Person at work)



5 Conclusion

The younger the generation or, to put it another way, in line with curriculum cuts, the greater the drift away from the study of science and mathematics subjects and the fewer the respondents listing these subjects as favorites (while the more naming them as non-favorites). This tendency is especially marked with physics, among all science subjects: the number favoring this subject decreases. In line with succeeding government curriculum guideline revisions, severe academic insufficiencies seem to have developed in generations B and C in particular subjects.

Then we compared the income of the respondents depending on which subjects they are good at. In all three generations, those who named mathematics as their good at subject have the highest income, followed by those mentioning science, social studies, English and Japanese. If we limit the respondent to the science department graduates,

ISBN: 978-1-61804-180-7

those who are good at physics have the highest income, followed by chemistry, earth science and biology, in that order. This tendency is the same for all three generations.

Our research suggests that mathematics and physics are an important factor in the fostering of earning capacity in every generation.

References:

[1] Arcidiacono, P., Ability Sorting and the Returns to College Major, *Journal of Econometrics*, 121, 2004, pp. 343-375.

[2] Hirata, J., Nishimura, K., Urasaka, J., and T., Yagi, Mathematics & Science Education and Income: An Empirical Study in Japan, *Journal of Reviews on Global Economics*, 2, 2013, pp.1-8.

[3] Kane, T. J. and C. E. Rouse, Labor Market Returns to Two- and Four-Year Colleges: Is a Credit a Credit and Do Degrees Matter?, *American Economic Review*, 85(3), 1993, pp.600-614.

[4] Nishimura, K., Urasaka, J., Hirata, J., and T., Yagi, How do Parents' Educational Background and Subjects "Good-At" in Schools affect Income of University Graduates: An Empirical Study in Japan, *Japanese Economic Review*, 57(4), 2006, pp.533-546.

[5] O'Leary, N. O. and P. J. Sloane, The Return to a University Education in Great Britain, *National Institute Economic Review*, 193(1), 2005, pp.75-89.

[6] Wolniak, G. C., Seifert, T. A., Reed, .E J. and E. T. Pascarella, College Majors and Social Mobility, Research in Social Stratification and Mobility, 26, 2008, pp.123-139.