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EXPLORING LOWER-SECONDARY SCHOOL STUDENTS' IMAGES AND OPINIONS OF THE BIOLOGIST

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Abstract. *In the past decades much research on the image of the scientist has been conducted, but the image of the specific scientist who does biological work, namely, the biologist, is under researched. Without this aspect of research school biology education may operate nowhere near to promoting the growth of students' appropriate image of the biologist. Drawing on previous approach, this research presents students' images of the biologist by administering a Draw Biologist Test (DBT) to 121 lower-secondary school students from the 7th, 8th and 9th grades. Findings indicate that when compared with the images elsewhere, the lower-secondary school students exhibit similar patterns regarding gender, teamwork and general attitude, but tend to include more descriptors of white lab coat, tidy hairstyle, microscope, other ethnicities, serious looking, practical activities and indoor contexts, fewer descriptors of knowledge and technology symbols and less gloomy side of biological work. It is suggested that school biology education should mitigate the gendered image of the biologist, duly expose students to more theoretical and outdoor biological activities, value cooperation and collaboration as well as transform students' positive attitude into future engagements.*

Key words: *lower-secondary school, Draw Biologist Test, image of biologist, educational implications.*

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Introduction

Students gradually shape their images and opinions of the biologist as a result of cumulative learning and accumulation of biology and biologist-related knowledge and information from inside and outside school. For lower-secondary school students, school is one of important venues that shape their images and opinions of the biologist. In school the discourse about biology and biologist can play out through interactions with peers, teachers and textbook content in class instruction and activities, and thereby framing students' images and opinions of the biologist. Thus, the image of the biologist is closely coupled with their knowledge, information of and attitudes toward the biologist acquired in school biology education. If the images and opinions of the biologist come into being, it can subsequently enact in students' subject learning in positive or negative ways. Related research suggests, superficial, ambiguous and inaccurate images, if unfortunately formed, will translate into impairment in appreciation of, attitudes towards and engagement in subject learning (Boylan, Hill, Wallace, & Wheeler, 1992; Finson, Beaver, & Cramond, 1995; Krajkovich & Smith, 1982, Scherz & Oren, 2006). The formed image of the biologist and related biological subject learning mutually interplay. Positive image of the biologist is likely to positively promote and enact in subject learning, while negative image may hinder. Basing on the significance of such interplay, school biology education should know what the image of the biologist is being held in students' minds during and after biological subject learning.

Literature Review

In the past decades science education community saw a flurry of research documenting the images of the scientist (Chambers, 1983; Finson, 2002; Koren & Bar, 2009; Newton & Newton, 1998; Schibeci & Sorensen, 1983; She 1995; Song & Kim 1999; Zhai, Jocz, & Tan, 2014). The seminal work by Mead and Metraux (1957) shows that the typical image of the scientist primarily points to a male wearing a lab coat with chemistry instruments. Chambers (1983) found socioeconomic and gender impacted images of the scientist. Later, Newton and Newton (1998) revealed the relatively high frequency of

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beards and baldness in students' drawings. Fung's (2002) research discloses that research symbols, knowledge symbols and technology symbols in students' drawings are mainly related to laboratory equipment, books, shelves or stationery and computers. In Maoldomhnaigh and Hunt's (1988), Song and Kim's (1999) and Turkmen's (2008) research, the respective Irish, Korean and Turkish students are found exhibiting a strong gender-oriented image of the scientist, predominantly being males. Mead and Metraux's (1957) and Turkmen's (2008) results show that the scientist is middle aged or elderly. The facial expression of the scientist at work can be described as less smiling in Hebrew students' drawings (Pazit & Varda, 2009).

However, the above research mainly centers on how the image of the scientist (general scientist), but the image of the specific scientist who does the sub-categorized biological work, namely the biologist, has not been placed under the spotlight. If the general scientist is disintegrated into various constituent specific scientists, the trouble will be pronounced that past research is not bothered by the thought of whether the images of the general scientist contribute to the understanding of the biologist. Considering that biological courses in secondary education in respectable number of countries are actually disciplined as a separate subject, much previous research (e.g. Chambers, 1983; Maoldomhnaigh and Hunt, 1988; She, 1998; Song and Kim, 1999) on the images of the general scientist can not necessarily equal to how the biologist is imaged. Given that past literature regarding the scientist's images cannot be informative of the biologist, it entails an exploration of how the biologist is imaged and viewed by lower-secondary school students.

Research Problem

An exploration of lower-secondary school students' image of the biologist enables us to understand how students see the biologist and to know the differences between the images of the biologist and the general scientist as well as problems about the images of the biologist, thereby both science and biology educator can tweak their practices accordingly to promote the formation of appropriate images and opinions of the biologist if necessary. To this end, a Draw Biologist Test (DBT) for measuring students' images of the biologist was developed in order to address the questions as follows:

1. What are the images of the biologist being held by the Chinese lower-secondary school students?
2. What are the differences between the images of the biologist in this research and the images of the general scientist in previous literature?
3. What are the problems regarding the images possessed by the Chinese lower-secondary school students and their implications for biology education practitioners?

Methodology of Research

This research was involved with qualitative and quantitative approaches (Creswell, 2003) to explore students' images of the biologist. The qualitative approach includes group interviews and an open-ended instrument of Draw Biologist Test (DBT) which was administered to students to obtain multiple indicators and descriptors of their drawn biologists. The quantitative approach relates to the calculation of the numbers and frequencies of the indicators and descriptors in order to mosaic the prominent image of the biologist with the high frequencies of indicators and descriptors. This research was carried out in the autumn semester, 2016.

Instrument

A number of instruments were employed in the literature on scientist's images. Mead and Metraux (1957) adopted the instrument of writing to elicit perceptions of scientists from high school students. Krajkovich and Smith (1982), Reis and Galvao (2004), Samaras, Bonoti and Christidou (2012) and Schibeci (2006) probed the students' images of the scientist by the means of interviews and questionnaire. Dikmenli (2010) employed a qualitative instrument of free word-association for stereotypical images of the scientist. Chambers' (1983) Draw-A-Scientist Test (DAST) is, perhaps, the most popular qualitative instrument to examine scientists' images. In the DAST, participants are invited to "draw a scientist at work." Then, drawings are evaluated in terms of a number of indicators and descriptors. Drawing is a popular qualitative technique (Ahi, 2017; Aronsson & Andersson, 1996; Chang, 2005; Ehrlen, 2009; Fung, 2002; Silver & Rushton, 2008) in that it advantages in presenting features of a person that may hardly be accurately described by language or texts and less being constrained by researchers' predetermined constructs.

The instrument in this research is framed from Chambers' (1983) Draw-a-Scientist Test which has been widely used with good reliability and validity since much research have validated the persistence of typical indicators (e.g. Buldu, 2006; Losh, Wilke, & Pop, 2008; Samaras, Bonoti, & Christidou, 2012). The adapted instrument was referred to as Draw Biologist Test (DBT). A checklist was adapted from previous research (Finson, Beaver, & Cramond, 1995; Christidou, Hatzinikita, & Samaras, 2012) to design a scoring rubric. The other frequently shown-up indicators and descriptors during our pilot were also added in the checklist. The indicators and categories in the checklist are as follows: (1) wear (objects worn), (2) facial physical features (facial hair and hairstyle), (3) gender, (4) ethnic background and age, (5) research symbols, knowledge symbols, technology symbols and captions (mainly involving laboratory instruments, books, products of modern technology and supplemented descriptions), (6) working background, (7) activities, and (8) teamwork and facial expression.

As some descriptors, for example age, could hardly be accurately judged simply by looking at their drawings, six question items were attached to the DBT for clarification, including "please identify the gender of your drawn biologist!", "please identify the ethnicity of your drawn biologist!", "please assert the age range of the biologist!", "Please detail the types of the objects worn on the biologist!", "please describe the background and activities of the biologist!" and "please state the facial expressions of the biologist!".

Follow-up group interviews were conducted after drawing for supplementary information about the indicators, overall attitude and career intention. The interviews contained five semi- structured questions including "can you explain why you draw such gender and age of the biologist?", "what motivates you to draw the ethnicity of the biologist?", "can you tell why you draw such types of clothes and other worn objects ?", "can you tell why your drawing includes such background and activities?" and "what are the implications of the biologist's facial expression?" as well as two open-ended questions including "what are your overall attitudes toward the biologist? and why? " and "do you want to pursue a biological careers and why?" The information from these instruments can largely secure the validity of this research.

Participants

China's basic and secondary education system is generally characterized by the 6-3-3 format, that is, six-year primary schooling, three-year lower-secondary schooling and three-year senior high schooling. The participants in this research aged about 13 to 15 years old and are composed of 56 females and 65 males from three classes in a state-funded lower-secondary school. There are 43 students from grade 7, 41 from grade 8 and 37 from grade 9 respectively. Although the limited demographic groups of students may affect the representativeness, this research can reasonably reflect the prominent features of the biologist in small scale.

Procedure

Prior to being administered to the DBT, the students were instructed that what they had drawn or written in the DBT was confidential and that they should feel free to draw. Then the students were provided a blank paper of A4 size with a title of "draw biologist at work". To avoid possible vagueness, they were required to answer the attached question items regarding their drawings in written form. The students took one to three days to finish the DBT. In the collecting phase, some reported that their DBTs had not been fully completed due to the take-up of the time by various after-class activities and scholastic homework. Hence, some returned DBTs were found being not well done. After removing those lost, blank and largely uncompleted, 93 relatively well-responded DBTs (31 from grade 7, 40 from grade 8 and 22 from grade 9) were obtained. The well-responded rate is 77%.

After the drawing activities, the author took two weeks to conduct follow-up group interviews based on their drawings with all the students from the three grade levels. All interviewees consented that notes of conversation content could be taken. Interviews mainly centered on the information that cannot be obtained by the drawing, including students' underlying motivations for the indicators of gender, age, ethnicity, worn objects, background, activities and facial expressions as well as students' perceptions of overall attitudes and career intentions.

Analysis of the Drawings

The students' drawings were scored in accordance with the above mentioned checklist of descriptors and indicators (see Tables 1-7) in the following manner.

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If a drawn descriptor of the respective indicators is found, one score will be inscribed. For instance, for the wear indicator, each of us will carefully look for any descriptor that is worn by the drawn biologist in individual drawings and score them. If multiple examples of a descriptor are found, only one score will be inscribed. For instance, if a drawing presents more than one cap, it will be scored as having one. Similarly, the descriptors of the research, knowledge and tool symbols will be scored as one even if multiple examples are presented. For instance, if a drawing contains a book, one score will be awarded to the knowledge symbol. If multiple examples (for example, two pencils and/or two books) are presented, they will be still scored as one. If a drawing is found with a textual description, it will be scored as having one caption. Multiple textual descriptions in a drawing will be still scored as one caption.

During the analysis, some drawn objects were found too vague and illegible to be recognizable. These unrecognizable objects will be ignored if no written explanations for them are available. If an object is absent or unrecognizable in a drawing, but it can be identified in the attached written explanations, the object will be sorted into their respective indicators and be scored as having one. For the information regarding students' perceptions of overall attitude and career intentions, a content analysis and categorization of their responses regarding these aspects (see Table 8). Three categories were identified for the content analysis of overall attitude including "positive", "negative" and "neutral" and three for career intentions including "having an intention", "having no intention" and "uncertainly".

To secure good reliability, the analysis was independently conducted by the authors and the inter-rater agreement reached 93%. Discrepancies arising from the analysis were settled through discussion. When scoring the drawings, each descriptor and indicator was scored either 1 or 0 depending on the presence or absence of the descriptor and indicator. The total number and frequency of each descriptor is determined by summing all the scores from each grade (see Tables 1-7). The summed scores of indicators in their drawings indicate the extent to which stereotypic image of the biologist is framed in the students' minds. A high score of descriptor suggests a highly stereotypical image, whereas a low count signals less stereotypical one.

Results of Research

Wear

The descriptors of the wear indicator include hat, cap, eyeglass, mask and different types of clothes (Table 1). The type of worn clothes is of relevance with the settings, the clothes other than lab coat are more coupled with lab-independent settings like jungle, home and islands. Of these descriptors, the most frequently emerged one is "lab coat" (60.2%), followed by "suit" (18.3%) and "other undeterminable casuals" (14.0%). Figure 1 shows a lab coat worn by a young biologist in a lab. "Eyeglass" enjoys the second highest presence (30.1%). Other descriptors account for a small portion. When asked why to draw such descriptors, typical responses were that the biologist should wear a lab coat to keep themselves from being stained when doing experiments in the lab, and that wearing eyeglasses was indicative of the biologist reading much, learnedness and erudition.

Table 1. The descriptor of wear indicator by grade level (number and percentage, N (%)).

Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Other undeterminable casuals	3(9.7)	7(9.7)	3(9.7)	13(14.0)
Lab coat	20(64.5)	25(62.5)	11(50.0)	56(60.2)
Shirt	2(6.5)	1(2.5)	1(4.5)	4(4.3)
Protective clothing	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Suit	6(19.4)	6(15.0)	5(22.7)	17(18.3)
Sweater	1(3.2)	0(0.0)	0(0.0)	1(1.1)

Wind coat	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Leather clothes	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Hat	1(3.2)	3(7.5)	1(4.5)	5(5.4)
Cap	2(6.5)	2(5.0)	0(0.0)	4(4.3)
Eyeglass	10(32.3)	11(27.5)	7(33.3)	28(30.1)
Mask	1(3.2)	2(5.0)	0(0.0)	3(3.2)
Leather shoes	0 (0.0)	1 (2.5)	0 (0.0)	1 (1.1)

Figure 1: A drawn young biologist in white lab coat.

Facial Physical Features

The descriptors of facial features relate to facial hair and various hairstyles. As shown in Table 2, the most commonly drawn descriptor by the students is "tidy hair" (43%). The next is "long hair" (see Figure 1 or 2), which appears in 23.7% of the students' drawings. The third highest is "standing hair" (11.8%). The percentage of facial hair is 8.6%. Other descriptors are marginal. Some students reasoned for drawing the facial features such as:

> "The biologist, as a learned and respectable person, ought to present with a nice appearance in the public; thus, the facial physical features of the biologist should be tidy and cleanly shaved."
> "The standing hair indicates that the drawn biologist is very cool."
> "The female biologist will look pleasant with long hair."

Table 2. The descriptor of facial physical feature, ethnicity and age indicators (number and percentage, N (%)).

Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Facial hair (beard / moustache/ sideburns)	2(6.5%)	1(2.5)	5(22.7)	8(8.6)
Tidy hair	15(48.4)	17(42.5)	8(36.4)	40(43.0)
Standing hair	0(0.0)	5(12.5)	6(27.3)	11(11.8)

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Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Messy hair	1(3.2)	2(5.0)	1(4.5)	4(4.3)
Braid	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Bald	2(6.5)	2(5.0)	2(9.1)	6(6.5)
Ponytail	2(6.5)	1(2.5)	0(0.0)	3(3.2)
Curled hair	2(6.5)	1(2.5)	1(4.5)	4(4.3)
Long Hair	8(25.8)	11(27.5)	3(13.6)	22(23.7)
Han Chinese	24(77.4)	32(80.0)	15(68.2)	71(76.3)
Foreign white	7(22.6)	6(15.0)	6(27.3)	19(20.4)
Chinese minority	1(3.2)	2(5.0)	1(4.5)	4(4.3)
20s	14(45.2)	22(55.0)	8(36.4)	44(47.3)
30s	13(41.9)	8(20.0)	9(40.9)	30(32.3)
40s	3(9.7)	8(20.0)	3(13.6)	14(15.1)
50s	1(3.2)	1(2.5)	1(4.5)	3(3.2)
Above 60	1(3.2)	1(2.5)	1(4.5)	3(3.2)

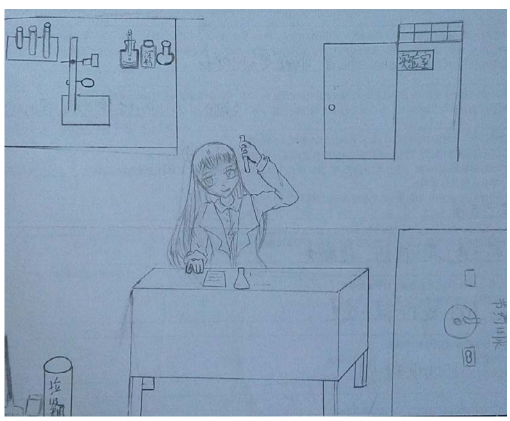

Figure 2: A female biologist with long hair is experimenting.

Ethnic Background and Age

Around 76% of the drawn biologists' ethnic backgrounds are chiefly Han Chinese (Table 2). The most popular motivation for drawing a Han Chinese is the patriotism and their familiarity with Chinese biologists, as sizable students articulated:

> "How can biological work be without a Chinese, drawing a Chinese biologist will honor our country"

"I am a Chinese, thus naturally I draw a Chinese biologist."
"I only know Chinese biologists."

Followed by Chinese minority (4.3%), foreign white (20.4%) is the second predominant ethnicity (see Figure 3). This is in part due to the students' exposure to the outperformance of foreign biologists in the media and their textbooks. Those students presenting a foreign white stated:

"In the history, the successful foreign biologists are more famous and attained than the Chinese counterparts."
"Foreign biologists are more careful and rigorous in doing things, and so are their attitudes to work."
"Foreign biological technologies are more advanced and there are more research institutions that can facilitate biological research in foreign countries."
"I am inspired by the image of a western biologist in the biology textbook."
"I sometime watch BBC documentaries. I suppose that the biologist should look like what these videos present."

The biologist in 20s pervades in 47.3% of drawings, followed by the one in 30s (32.3%) (Table 2). The students argued that biological research was a long march necessitating strong stamen. Thus, they associated biological work with the biologist in such age range who is more capable of sustaining the highly physically and mentally demanding biological research.

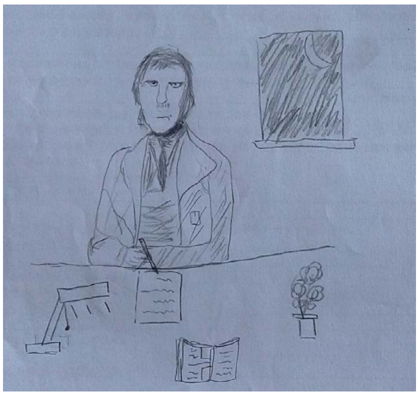

Figure 3: A drawn foreign white biologist in his 40s.

Drawn Biologists' Gender

It can be drawn from Table 3 that over 65% of the students portrayed a male biologist and nearly 35% did a female biologist (see Figure 1 or 2) who was mainly produced by the girl students. Female biologist is less likely to be drawn by the upper level students—about 42% in grade 7, 40% in grade 8, and dipping to 18.1% in grade 9. Girl students nearly drew five times more female biologists than boy students did. Overall, the number of the drawn male biologists outnumbers the drawn female biologists almost two times.

Table 3. The drawn biologist's gender indicator by grade level and student gender (number and percentage, N (%)).

Descriptor	Grade 7(N=31)		Grade 8(N=40)		Grade 9(N=22)		Total (N= 93)	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Male biologist	12(38.7)	7(22.6)	14(35.0)	10(25.0)	11(50.0)	7(31.8)	37(39.8)	24(25.8)
Female biologist	3(9.7)	10(32.3)	2(5.0)	14(35.0)	1(4.5)	3(13.6)	6(6.5)	27(29.0)

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Research, Knowledge, Technology Symbols and Captions

As shown in Table 4, various lab instruments such as test tube, microscope, bottles, breakers were depicted by the students (74.2%) as the descriptors of research symbol (see Figure 4). The common response for drawing these indicators is that the biologist should do various indoor practical and analytical experiments and observations which necessitate these lab instruments, typically the microscope. About 19% and 14% of students' drawings present the descriptors of captions and knowledge symbols respectively. The captions are mainly biology-related, for example, "plant and insects' specimens" or "protecting living organism". The descriptors of knowledge symbol mainly relate to graphic molecular model, books, pencils or blackboard. The descriptors of technology symbol were produced by the least number of students (4.3%).

Table 4. Research, knowledge, technology symbols and captions (number and percentage, N (%)).

Indicator	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Research Symbols (test tube, flask, microscope, measuring cylinder, balance, magnifier, bottles, breakers, scalpel, light reflector or funnel)	29(93.5)	26(65.0)	14(63.6)	69(74.2)
Knowledge Symbols (graphic molecular model, books, pencils or blackboard)	5(16.1)	4(10.0)	4(18.2)	13(14.0)
Technology Symbols (computer)	1(3.2)	2(5.0)	1(4.5)	4(4.3)
Relevant captions (plant and insect specimen, protecting living organism, biology is very important, plant taxonomy, forms of animal movements, butterfly specimens, African rhinos, Windows XP, products for lab experimenting, Casimir Fabre, national biological lab, be quiet, specimens, observation diary, poacher, gene, studying grass or danger and don't touch)	4(12.9)	9(22.5)	5(22.7)	18(19.4)

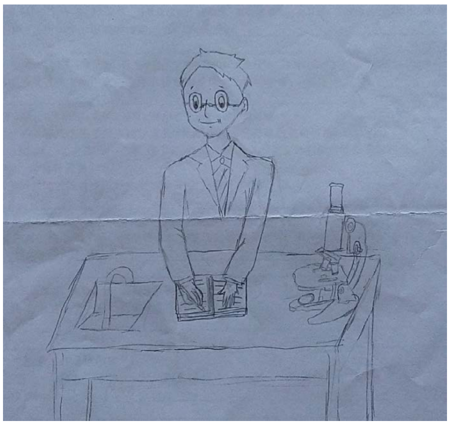

Figure 4: A microscope, descriptor of research symbol, was depicted in a lab room.

Working Background

Table 5 strongly suggests that the three-level students' popular image of the working background of the biologist is lab room bound, and with 65.5% depicting the biologist in such a context. This is similar to Mead and Metraux's (1957) result suggestive of the scientist's workplace being limited to indoor labs. The other various working backgrounds do not take up much portion. More indoor than outdoor settings were drawn by the students.

Notably, the students may take the biology teacher as a biologist rather than an educator as a handful of students (4.3%) drew the classroom as the biologist's working background. A marginal number of cases (2.2%) appear to draw portraits with a blank background in which neither contextualized background nor textual explanations regarding the background are available.

Table 5. The descriptors of working background indicator by grade level (number and percentage, N (%)).

Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Lab room	26(83.9)	20(50.0)	15(68.2)	61(65.5)
Office	0(0.0)	2(5.0)	1(4.5)	3(3.2)
Classroom	1(3.2)	2(5.0)	1(4.5)	4(4.3)
Home	2(6.5)	1(2.5)	0(0.0)	3(3.2)
Zoo	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Forrest or Jungle	0(0.0)	3(7.5)	0(0.0)	3(3.2)
Prairie	1(3.2)	3(7.5)	2(9.1)	6(6.5)
Unidentifiable outdoor context	1(3.2)	2(5.0)	0(0.0)	3(3.2)
Grassland	0(0.0)	2(5.0)	1(4.5)	3(3.2)
Panda reservation	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Oceanarium	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Desert	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Galapagos Islands	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Blank background	0(0.0)	1(2.5)	1(4.5)	2(2.2)

Activities

"Experimenting" (see Figure 2) and "observing" (23.7%, 12.9%) are the two major activities (Table 6). Other activities are marginal and very diverse, largely embodying the practical side of biological work. The students' descriptions of the activities of the biologist vary:

"The biologist is observing animals and plants."
"He is taking notes of the biological experiment."
"He is fully lost in reading literature"
"He is investigating in Africa to figure out how to protect the rhinos from poachers."

Some drawings reveal the sedentary and theoretical side of activities like "sitting and pondering over problems or reading books". A few activities are generic and unspecified, for example, "doing research" which is less informative of the specific content of the activity.

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Table 6. The descriptors of activities indicator by grade level (number and percentage, N (%)).

Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Experimenting (unspecified)	5(16.1)	9(22.5)	8(36.4)	22(23.7)
Observing (cells, plants, seeds or insects and etc.)	3(9.7)	7(17.5)	2(9.1)	12(12.9)
Studying animal specimens	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Collecting samples	0(0.0)	1(2.5)	1(4.5)	2(2.2)
Teaching	1(3.2)	2(5.0)	1(4.5)	4(4.3)
Studying dogs	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Taxonomizing plants	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Writing a paper	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Recording findings	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Collecting DNA of endangered species	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Preparing an important experiment	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Studying fungi	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Disassembling cells	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Studying or reading (literature or books)	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Investigating Darwin's finches	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Recording fish behaviors	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Organizing data	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Pondering over problems	2(6.5)	0(0.0)	2(9.1)	4(4.3)
Doing research	3(9.7)	2(5.0)	0(0.0)	5(5.4)
Studying cells of rhinos	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Studying specimens	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Conducting Penicillin test	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Checking lab instruments	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Anatomizing a dead animal	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Protecting endangered animals	1(3.2)	0(0.0)	0(0.0)	1(1.1)

Descriptor	Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Observing through microscope	3(9.7)	1(2.5)	1(4.5)	5(5.4)
Making notes of experiments	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Examining the contamination in the Staphylococcus culture medium	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Studying animal behaviors	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Protecting rhinos from poachers	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Studying gene mutation	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Extracting a mouse's DNA	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Studying the impacts of light on sea turtles	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Feeding a panda	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Writing an experimental report	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Studying an onion's cells	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Watching out the experiment	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Studying grasses	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Studying cells	0(0.0)	0(0.0)	1(4.5)	1(1.1)
Collecting plant or animal speci-mens	0(0.0)	0(0.0)	2(9.1)	2(2.2)
Sucking iodine with a dropper	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Making insect specimens	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Formulating a medicament	1(3.2)	0(0.0)	0(0.0)	1(1.1)
Formulating an agent	0(0.0)	1(2.5)	0(0.0)	1(1.1)
Looking up literature	0(0.0)	1(2.5)	0(0.0)	1(1.1)

Teamwork and Facial Expression

A vast number of the three-level students (97.8%) portrayed the biologist as working alone (Table 7), typically experimenting or observing alone. Two biologists teaming up together were depicted only in 2.2% of their drawings. The students reasoned that when working alone the biologist would not be disturbed and could be fully devoted to studying problems. This may suggest that biological work is perceived as a solitary activity rather than a collaborative one that entails teamwork.

The indicator of facial expression enables us to assess the emotions and feelings of the biologist at work. According to the students' drawings and responses, the most common facial expression depicted (33.3%) is "serious", which implies that the biologists drawn are tackling tasks seriously and rigorously (Table 7). "Smiling or happy", the second most common facial expression depicted, was portrayed in 32.3% of the students' drawings, suggesting that the drawn biologist has solved a problem or discovered something significant. "Neutral" being the third

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most common facial expression appears in 12.9% of the students' drawings, indicating that the facial expression is emotionless. The attentive facial expression (11.8%) was often displayed through drawing the biologist lost in observing or studying a phenomenon or problem (see Figure 5), while the facial expression of "perplexed" (5.4%) was demonstrated by drawing a biologist with a puzzled face solving tricky or thorny problems.

Table 7. The descriptors of teamwork and facial expression indicators (number and percentage, N (%)).

Indicator and Descriptor		Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
Teamwork	Work alone	29(93.5)	40(100)	22(100)	91(97.8)
	Work cooperatively	2(6.5)	0(0.0)	0(0.0)	2(2.2)
Facial expression	Smiling or happy	9(29.0)	14(35.0)	7(31.8)	30(32.3)
	Perplexed	2(6.5)	3(7.5)	0(0.0)	5(5.4)
	Neutral (emotionless)	3(9.6)	4(10.0)	5(22.7)	12(12.9)
	Attentive	6(19.4)	4(10.0)	1(4.5)	11(11.8)
	Excited	0(0.0)	0(0.0)	1(4.5)	1(1.1)
	Dejected or sad	1(3.2)	2(5.0)	0(0.0)	3(3.2)
	Serious	10(32.2)	13(32.5)	8(36.4)	31(33.3)

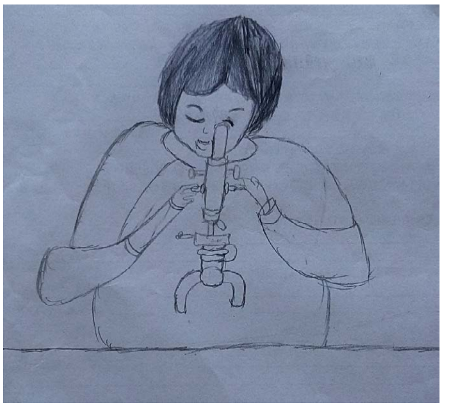

Figure 5: A biologist, with an attentive facial expression, is observing through a microscope.

Overall Attitude toward the Biologist and Intention for a Biological Career

A majority of the students (63.4%) hold a positive attitude toward the biologist (Table 8), as exemplified by some students' remarks:

"Biologists' contributions to our lives and the mankind will make our country pride and honored."
"Biologists invent many drugs to improve people's health."
"Biologists can help raise our awareness of the graveness of environmental problems and protect engendered species."

A relatively large percentage of students (35.5%) hold neutral attitude toward the biologist, meaning that they have no idea of the biologist or mixed positive and negative attitudes, as indicated by some students' statements that while the biologist brings blessings to the mankind they also inflict the mankind by vice inventions. Only one case (1.1%) articulates a negative attitude towards the biologist, claiming that the biologist gives rise to security issues in the world with invented bio-weapons.

With respect to their intention for becoming a biologist, it is regrettable that the students (62.4%) disfavoring a biological path outnumber those (37.6%) favoring. Those disfavoring a biological career expressed their various opinions such as:

"I am not doing very well in my school biology."
"I like physics and not interested in biology."
"A biological career will mean there is no free time for my private life. I don't want to lose freedom."
"I have a phobia of insects and bugs, and becoming a biologist is a mission impossible for me."
"The tedious and hard biological work does not suit me!"

The students preferring a biologist career justified diversely like:

"I love the content of biology and it is congenial to me."
"Doing biological work can serve my country and my well- done work will make my country pride."
"I am willing to engage in a biological career because it enables me to explore exotic animals and plants all over the world."
"Biological work can enable me to see the interesting micro-world that is invisible to naked eyes."

Table 8. Overall attitude and career intention (number and percentage, N (%)).

Item		Grade 7(N=31)	Grade 8(N=40)	Grade 9(N=22)	Total (N= 93)
General attitude toward the biologist	Positive	18(58.1)	26(65.0)	15(68.2)	59(63.4)
	Negative	1(3.2)	0(0.0)	0(0.0)	1(1.1)
	Neutral	12(38.7)	14(35.0)	7(31.8)	33(35.5)
Intention for a biological career	Yes	14(45.2)	9(22.5)	10(45.5)	35(37.6)
	No	15(48.4)	30(75.0)	11(50.0)	58(62.4)
	Uncertainly	2(6.5)	1(2.5)	1(4.5)	4(4.3)

Discussion

Using a projective drawing test, this research attempted to zoom in students' image of the biologist. Both qualitative and quantitative differences regarding the images between the Chinese students and those elsewhere emerge.

For the wear indicator, most of the students hold the image of white lab coat which is also found in Mead and Metraux's (1957), Koren and Bar's (2009), Painter, Jones, Tretter and Kubasko's (2006) research. However, the Chinese students' stereotypical image regarding lab coat is especially stronger. The presence of white lab coat is substantially greater than in the previous literature, for example, only 20% of Turkish students and around 5% of the Korean students drew lab coat (Leblebicioglu, Metin, Yardimci, & Cetin, 2011; Song & Kim, 1999). Song and Kim (1999) referred the low presence of lab coat to the less common practical work in Korean schools. But this correlation is not confirmed by our research. In the same vein, the hands-on practical work in Chinese schools is also very limited. The Chinese students nonetheless drew more lab coats than Korean counterparts, suggesting that the white lab coat is more deeply imprinted and rooted in these Chinese students' minds than their counterparts in other countries. In the Chinese culture, a person wearing eyeglasses is to some degree linked

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with erudition and learnedness. As such, the relatively high presence of eyeglasses is observed as the students endowed the biologist with these qualities.

The students' drawings do not appear such hair style like strange hair or crazy hair as described in Togrol's (2013) and Song and Kim's (1999) research. The drawings depicting the biologist as having messy hair are less than those in Avraamidou's (2013) research. Rather, tidy hair is relatively common and far more than that presented by Hebrew and Arabic students (Rubin, Bar, & Cohen, 2003). The higher frequency of female hair style like long hair than elsewhere cannot translate into the students' preference for this hairstyle as a whole. This phenomenon results from more girl than boy students' completion of the DBTs since girl students prefer to draw female biologist with long hair. The students present far less the facial hair of beard, moustache and long sideburns than the Turkish, Arabic and Greek students do (Christidou, Hatzinikita, & Samaras, 2012; Leblebicioglu, Metin, Yardimci, & Cetin, 2011; Rubin, Bar, & Cohen, 2003). A beard in the Arabic culture is viewed as a respected feature (Rubin, Bar, & Cohen, 2003). Interestingly, on the contrary, the Chinese students regarded beard, long sideburn and untidy hair as unfavorable. This signals that the framing of the images thereof is of relevance with their own culture.

The image on ethnic background shows that most students perceive the ethnicity of the biologist as being Han Chinese. This result is out of Chinese education traditionally placing a high premium on moral education of which the moral theme is to cultivate a devotion to the nation or a sense of national pride. The patriotism and their more familiarity with Chinese biologists drive the students to think that drawing a biologist with Chinese nationality would honor the country. This justification is rarely documented. The biologist of Chinese minority origin is more under presented than foreign white. However, the students seem a bit more inclusive than Turkish students regarding ethnic minority representation. In Turkmen's (2008) research, none of Turkish students' drawings presents ethnicities other than Turk. The Chinese students' inclusion of other ethnicities can be referred to their exposure to the more knowledge of foreign biologists in the media, their textbooks and foreign biologists' good performance. For those drawing foreign white, they tended to think foreign biologists and biological research do better than their Chinese counterparts both in the history and at present. This demonstrates the Chinese students' ambivalence toward the ethnic issue. On the one hand, their patriotism motivated them to draw the biologist with Han Chinese origin; on the other hand, their admission to the underperformance of the Chinese biologist drove them to include the foreign biologist in their drawings.

As for the age, the Chinese students perceive of the biologist much younger than those found in the previous literature in which the scientist is usually considered as being elderly or middle aged (35–55 years) because of more experiences (Avraamidou, 2013). Otherwise, the Chinese students place stamina over experiences as they associate the relatively young age of 20s and 30s with more capability of sustaining the demanding biological work.

The strong inclination for the male biologist in their drawings suggests their image of biology being chiefly reserved for males. This parallels Vockell and Lobonc's (1981), Kelly and Smail's (1986), Song and Kim's (1999), Losh's (2010), Christidou, Hatzinikita and Samaras' (2012) and Togrol's (2013) research. Girl and boy students are more prone to drawing the gender of the biologist same with their own (Matthews, 1996). This is confirmed by our research. Boy students tended to draw more male biologists, while girl students inclined to draw more female biologists. But differently, none of the drawings in our research presents the female biologist in an inferior role as found in Christidou, Hatzinikita and Samaras' (2012) and Medina, Middleton and Orihuela's (2011) research. The female biologist, mainly produced by the girl students, is depicted working independently. The overall percentage of the female biologist is declining with the grade level ascending, suggesting that the upper grade level students are more likely to perceive the biologist as masculine. Such strong gendered image of the biologist may jeopardize girl students' later choice of biological work and dishearten them from engaging in a biological career. However, girls' choice of career can indeed be changed after being exposed to female role models (Fox, Tobin, & Brody, 1981; Huber & Burton, 1995; Jones & Wheatly, 1988). It may be viable that school biology could introduce models of female biologists to engage girl students.

Research symbols and captions are relatively common in their drawings. Unlike the predominant chemical equipment found in Rubin, Bar and Cohen's (2003) research, the depicted biologists are frequently accompanied by a microscope, differing quite from the scientist who is depicted being accompanied by chemical instruments typical of test tubes and beakers (Ozel, 2012; She, 1995), indicating that microscope is a strong stereotypical image distinctive and tied to the biologist. In certain cases, the students' drawings are supplemented by captions relevant to their activities. Rather than the most common caption of "inventor" or "teacher" in Fung's (2002) research, the added captions in our research can be more indicative of the nature and activity of biological work as well as the testimony to and explanation of the drawn. For instance, the presentation of the name of the famous French biologist, Casimir Fabre, signifies entomologic research. In general, the distribution of the symbols in our research resembles Fung's (2002) research in which the frequency of research symbols is also high. However, the Chinese students drew less knowledge and technology symbols than their Hong Kong and Greek counterparts (Christidou, Hatzinikita, & Samaras, 2012; Fung, 2002). The Chinese students are less likely to be aware of the role of modern products such as computer in biological work than their counterparts elsewhere (for instance, Hong Kong students produce robots, more computers, infra-red eyeglasses and etc.), suggesting that biological work is viewed as conventional and classic. The previous research by Chambers (1983), She (1998) and Jarvis (1996) indicate that a far greater number of symbols is identified with grade level (or student age) ascending. However, our research seems not to collaborate with their findings. The number of symbols produced by the Chinese students does not exhibit such trend. Moreover, secrecy and mythical symbols found as stereotypical images in the former research (Finson, 2002) are also not identified in the present research.

Lab room is the most common working background threading through most of the students' drawings, suggesting their stereotypical image of biological work is indoor-related. This result distinctly deviates from that of the Greek students favoring outdoor settings (Christidou, Hatzinikita, & Samaras, 2012). The drawn biologists in our research set in other outdoor contexts such as jungle and prairie are quite sporadic. Interestingly, basement, prevalent in American students' drawings (Farland, 2009), is not found in any student's drawing as a background. In general, the students are less likely to perceive biological work as being outdoor-related. An interesting point astray from the earlier literature is classroom setting, indicating the Chinese students take the biology teacher as the biologist while the Greek students not considering the teacher as the scientist (Christidou, Hatzinikita, & Samaras, 2012).

The students' responses reveal that the activities are diverse and highly concentrated. The two most common activities of "experimenting" and "observing" do not share much commonality with Farland's (2003) and Ozel's (2012) research of the scientist that unveil American students' preference for portraying the activities about scientific process skills such as observing and measuring and Turkish students' tendency for plotting the activities relating to inventing and designing a new material. The Chinese students are more likely to present the practical aspect of scientific research (such as experimenting) than the Greek students (Christidou, Hatzinikita, & Samaras, 2012). The theoretical aspect of research (such as studying literature) is relatively under presented by the Chinese students.

Rather than the title of "draw a biologist" which may hint the students to draw a single person, the title of "draw biologist", which will not circumscribe the number of the drawn biologist, was adopted. Despite of this, the drawn biologist is still mostly working alone. Only a tiny number of the students drew two biologists working collaboratively. In this respect, the Chinese students are similar to the Turkish and Greek students whose drawings also predominantly depict a solitary scientist (Christidou, Hatzinikita, & Samaras, 2012; Togrol, 2013). The Chinese students barely conceive of collaboration, teamwork and mutual assistances among peers being intrinsic and inherent in biological work.

As regards the emotions, the major facial expression of the biologist is "smiling or happy" and "serious", suggesting that the biologist might be deemed as enjoying their work or doing work rigorously. In contrast to the mad or less smiling emotions in the previous research (Haynes, 2003; Weingart, Muhl, & Pansegrau, 2003), the occurrence of positive emotions like "smiling or happy" is higher in the Chinese students' drawings, indicating the less gloomy side of biological work.

The general attitude toward the biologist is predominantly positive. This positiveness can be traced from the recognition of biologists' contributions to the nation, the mankind and environment. Several researchers note that young people's positive attitude towards a scientist might considerably contract a later interest and will highly possibly translate into a related career (Buldu, 2006; Mason, Kahle, & Gardner, 1991; Song and Kim, 1999; Woodward & Woodward, 1998). However, this seems to be defied by our research. Disappointedly, the high percentage of positive attitudes toward the biologist does not naturally and necessarily convert into a high favor for a possible biological career. The reason can be attributed to their perceptions of the profession being demanding, low attainment in school biology, boringness, phobia and low salary. This might indicate more efforts needed to correct the students' misperceptions, to provide more positive information on biological work, and to transform students' positive attitudes into actual actions so as to warrant students' future engagement in biology.

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Conclusions

By mosaicking the frequent show-up indicators and descriptors, the Chinese students' prominent image of the biologist can be described as follows:

> "The biologist is a young Han Chinese male man with a tidy hairstyle and smiling/serious looking, wearing a lab coat with a microscope beside and experimenting or observing alone in a lab room."

The findings indicate that the Chinese students' images of the biologist share both similarities and dissimilarities with those of the scientist and those in countries or regions elsewhere. In contrast to those in Geek, Turkey, Hong Kong, South Korean and the U.S., the Chinese students exhibit similar patterns regarding gender, teamwork and general attitude. However, it appears that the Chinese students included more descriptors of lab coat, tidy hairstyle, microscope, other ethnicities, serious looking, practical aspects of biological activities and indoor lab-related contexts, and fewer descriptors of knowledge and technology symbols and gloomy side of biological work than those in other countries and regions. Noteworthily, the connotations for drawing some indicators between the Chinese students and their counterparts differ. For instance, although there appears the gendered image, the Chinese students do not conceive of the female biologist in an inferior role as found in the former research. The mixed sense of national pride and Chinese biologists' underperformance, rarely found, acts as a contradictory dichotomy for the inclusion of their own and other ethnicities.

This above prominent image indicates that the students have some problems with their perceptions of the biologist, and it implies that school practitioners still need to combat the gendered image of the biologist, duly expose students to more theoretical and outdoor biological activities rather than a single indoor lab room, help students appreciate cooperative and collaborative in biological work as well as convert students' positive attitudes into an actual engagement for a biology-related career.

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