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Characteristics of Students Who Frequently Conduct Plant Observations: Toward Fostering Leaders and Supporters of Fixed-Point Observation of Forests

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Abstract: In order to foster leaders and supporters of fixed-point observation for sustainable forest management, it is considered effective to focus on students who have demonstrated potential for fixed-point observations of forests in the universal education stage. This study aims to identify the characteristics of students who frequently conduct plant observations, which is the basis for the fixed-point observation of forests, including methods involving photography. We conducted a questionnaire survey, which consisted of 19 questions that provided insight into junior high school students' experiences, opportunities, and interests related to plant observation. We compared students who have conducted plant observations with those who have not, using Fisher's exact test and multiple comparisons using the Benjamini and Hochberg method. The ratio of students who frequently conducted plant observations was significantly higher among female students than male students, and their characteristics differed by gender. The significant characteristics of male students included farm work experience and niche hobbies such as camping and lighting a bonfire, as well as using digital single-lens reflex cameras for photography; female students had relatively niche hobbies such as enjoying science. Students who increased the frequency of plant observations after the lecture about fixed-point observations of forests had an inclination toward social studies and tended not to use a smartphone for photography.

Keywords: forest education; fixed-point observation; plant observation; long-term perspectives

1. Introduction

In order to achieve the sustainable management of forests, it is important to understand forests from multiple viewpoints, including those beyond traditional forestry topics [1]. Sustainability here refers to the need for a long-term perspective of creating more desirable forests for future generations. If we try to maximize the present generation's profits without a long-term perspective, it can cause various problems, such as the deterioration of the forest ecosystem and the accompanying decrease of biodiversity [2,3]. Many studies have been conducted to predict long-term changes to biodiversity and carbon fixation in order to manage forests with a long-term perspective considering future generations [4,5]. It is also important to verify the validity of forest management, which is influenced by external factors with high uncertainty such as climate change and human society [6,7]. As a fundamental means of verification, it is considered effective to continue to observe forests holistically as a landscape over the long term [8]. In this context, fixed-point observation by

photography can provide people with increased opportunities to observe slow and gradual events, because it enables them to view the past without having to be present on location at the time of capture [9,10]. For example, time-lapse images taken from a fixed point enable us to grasp phenological forest dynamics on a time scale of up to decades [11–13].

However, although many experts recognize the importance of long-term observation, it often involves difficulties in terms of funding, human resources, infrastructure, etc. [8,14]. In this research, we focus on human resources, that is, leaders and supporters of fixed-point observation of forests over the long-term. Specifically, it is desirable for future forest managers to include human resources who recognize the importance of fixed-point observations of forests, and practice such methods, including photography. In this research, forest managers who can practice such fixed-point observations are called fixed-point observation leaders. Furthermore, it is also important to foster fixed-point observation supporters who do not practice fixed-point observations of forests, but recognize its importance and support fixed-point observation leaders in terms of funding and infrastructure.

In order to foster these fixed-point observation leaders and supporters, it is considered effective to focus on students with potential for fixed-point observations of forests in the universal education stage, before proceeding to specialized education in forestry. As a concrete expression of their potential, this study focuses on students who frequently observe plants, which are the main constituent element of forests, and change gradually. It is generally understood that people develop observation literacy depending on their experiences, opportunities, and interests [15–17]. For instance, it was reported that young people from rural areas are more perceptive of wildflowers than young people from urban areas [18]. However, there is insufficient knowledge on the characteristics of students who frequently conduct plant observations. Identifying these characteristics can make it possible to provide more effective interventions for students with the potential of becoming fixed-point observation leaders and supporters.

In this study, we aimed to identify the characteristics of students who frequently conduct plant observations, which is the basis for fixed-point observations of forests and includes both scientific and aesthetic observation. All kinds of plant observations may lead to recognizing the significance of fixed-point observations of forests.

2. Materials and Methods

2.1. The Target of This Research

This research examined a group of junior high school students aged 12 to 15 in one school that is located close to the sea in Japan. Most students have relatively little experience of the forest, because there is no large forest in the region. It is suitable for this research to focus not only on specialized forestry education, but also on universal education. In Japan, junior high school is the highest level of education that all children receive, and it is expected to diversify students' experiences, opportunities, and interests. Ethics approval for this research was granted by the junior high school.

In December 2016, one of the authors gave a 50-min lecture about his research at the school, where he introduced two topics related to fixed-point photography. One was about a time-lapse camera that had recorded several plants in the school since May 2016. The other was about a time-lapse camera that had been placed in a faraway forest (Shiga Height in Japan) and had sent its pictures in approximately real-time through the Internet [10,19]. The lecturer announced to the students that he would display papers with summarized pictures of the time-lapse camera placed in the school and would place a digital signage that displayed the approximately real-time pictures of the latter time-lapse camera after the lecture. The paper and digital signage were displayed in the school until March 2017 (in Figure 1). This allowed students an approximate three-month window to view the items they were asked about in the questionnaire.

(**a**) (**b**)

Figure 1. Pictures captured by a fixed-point camera displayed at the junior high school: (**a**) Pictures of several plants in the school taken by a time-lapse camera since May 2016; (**b**) Digital signage in the school displaying the approximate real-time pictures taken by the time-lapse camera placed in a faraway forest (Shiga Highlands in Japan); pictures were sent in approximately real-time through the Internet.

2.2. Questionnaire Survey

We conducted a questionnaire survey to evaluate the students' experiences, opportunities, and interests related to plant observation. In this research, we treated not only direct observation but also observation via photography. With this in mind, we designed a questionnaire that consisted of 19 questions (Table 1). The questionnaire survey was conducted in March 2017 with 319 students.

Fifteen questions were about the students' experiences, opportunities, and interests; these questions covered the following areas: the students' gender and grade as basic information, school subjects (in Table A1) as an indicator of their interests, means and required time to commute as opportunities for plant observation, habits for walking and bicycle riding as opportunities for plant observation, their experience of outdoor activities and farm work as ways in which they may have observed plants, their interest in phenology as an element of fixed-point observation, their habits and means of photography as the means of observation in this research, their interests in the pictures of the time-lapse camera placed in their school and of the time-lapse camera in the forest as interest in the means of gathering data, and their conversations about the two time-lapse cameras with their friends and families.

Table 1. The questions in the questionnaire survey.

Q_No.	Question		Options
1	What is your gender?		(a) Male/(b) Female
2	What grade are you in?		(a) First/(b) Second/(c) Third
3-01	What subjects do you like? (multiple selection)	Japanese Language	(a) Selected/(b) Not selected
3-02		Social Studies	(a) Selected/(b) Not selected
3-03		Mathematics	(a) Selected/(b) Not selected
3-04		Science	(a) Selected/(b) Not selected
3-05		Foreign Languages	(a) Selected/(b) Not selected
3-06		Music	(a) Selected/(b) Not selected
3-07		Art	(a) Selected/(b) Not selected
3-08		Health and Physical Education	(a) Selected/(b) Not selected
3-09		Technology and Home Economics	(a) Selected/(b) Not selected
3-10		The Period for Integrated Studies	(a) Selected/(b) Not selected
4	How do you usually go to school?		(a) By foot/(b) By bicycle/(c) By others
5	How long does it usually take to go to school?		(a) 1–5 min/(b) 6–10 min/(c) 11–15 min/(d) 16–20 min/(e) 21 or more min
6	How often do you usually take a walk when not commuting to school?		(a) Almost every day/(b) Several times a week/(c) Several times a month/(d) Several times a year/(e) Never
7	How often do you usually take a bike ride when not commuting to school?		(a) Almost every day/(b) Several times a week/(c) Several times a month/(d) Several times a year/(e) Never

Table 1. *Cont.*

Q_No.	Question		Options
8-01	How many times have you taken part in the following outdoor activities?	Camping	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
8-02		Mountain climbing or hiking	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
8-03		Fishing	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
8-04		Lighting a bonfire	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
8-05		Cookout	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
8-06		Picking acorns	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
9-01	How many times have you taken part in following farm work?	Sowing	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
9-02		Taking care of crops	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
9-03		Cropping	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
9-04		Cooking that uses harvest foods	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
9-05		Eating harvested foods	(a) Never/(b) One to four times/(c) Five to nine times/(d) 10 or more times [1]
10	How often do you usually check the blooming of a neighbor's Japanese cherry?		(a) Almost every day/(b) Several times a week/(c) Once per the blooming season/(d) Never
11	How often do you usually take a picture?		(a) Almost every day/(b) Several times a week/(c) Several times a month/(d) Several times a year/(e) Never
12-01	What do you usually use to take a picture? (multiple selection)	Smartphone	(a) Selected/(b) Not selected
12-02		Tablet computer	(a) Selected/(b) Not selected
12-03		Feature phone	(a) Selected/(b) Not selected
12-04		Compact digital camera	(a) Selected/(b) Not selected
12-05		Digital single-lens reflex camera	(a) Selected/(b) Not selected
12-06		Film camera	(a) Selected/(b) Not selected
13	How many times have you looked at pictures taken by the fixed-point camera displayed at a science room or in the hallway?		(a) Never/(b) Glance in passing/(c) Fixed gaze once/(d) Fixed gaze twice or more times
14	How many times have you looked at the digital signage of Shiga Highlands displayed in the library room?		(a) Never/(b) Once/(c) Two or three times/(d) Four or more times
15	How many times have you talked with your friends or family about the pictures taken by a fixed-point camera or the digital signage of Shiga Highlands?		(a) Never/(b) Once/(c) Two or three times/(d) Four or more times
16	How often have you observed plants before the lecture on December 2016?		(a) Never/(b) Once/(c) Several times/(d) Two or three times a month/(e) Further
17	How often have you photographed plants before the lecture on December 2016?		(a) Never/(b) Once/(c) Several times/(d) Two or three times a month/(e) Further
18	How often have you observed plants after the lecture on December 2016?		(a) Never/(b) Once/(c) Several times/(d) Two or three times a month/(e) Further
19	How often have you photographed plants after the lecture on December 2016?		(a) Never/(b) Once/(c) Several times/(d) Two or three times a month/(e) Further

[1] Classified based on the students' open-ended responses (number of times) to the questionnaire.

The remaining four questions asked the students whether they observe plants. As stated above, we treated not only so-called observation but also photography as observation, and attempted to consider the impact of the lecture on students' observation decisions. Therefore, two questions were about observing and photographing plants before the lecture, and two were about observing and photographing plants after the lecture.

Q_Nos. 1–12 were about the students' habits, and they were treated as independent on the time axis from Q_Nos. 13–19.

2.3. Data Analysis

We compared the students who had conducted plant observations and those who had not. First, we focused on the students who selected "two or three times a month" or "Further" in Q_No. 16 or in Q_No. 17 (in Table 1) as those who have conducted plant observations frequently before the lecture and are potential future fixed-point observation leaders and focused on the students who selected "Never" or "Once" in Q_No. 16 and in Q_No. 17 (in Table 1) as a comparison target. Whether these two classifications have a significant relationship with the answers to each question in Q_Nos. 1–15 was analyzed using Fisher's exact test, which is an effective method even when the sample size is small. Furthermore, as a result of multiple comparisons, the Benjamini and Hochberg method [20] was performed on those with significant relationships to identify which items had significant differences. We assumed that the lecture on December 2016 did not immediately affect the answers for Q_Nos. 1–12 because, although it might have encouraged plant observations, it did not affect students' interests, experiences, and opportunities relating to Q_Nos. 1–12.

After that, we focused on the students who increased the frequency of their plant observations after the lecture on December 2016, as per Q_Nos. 16–19 (in Table 1), to identify the characteristics of students who were encouraged to observe or photograph plants by the lecture. Since this increase in the frequency of plant observations was highly likely to be temporary, they were relatively inappropriate indicators of those who had the potential of becoming fixed-point observation leaders. However, it was worth considering them as having the potential of becoming fixed-point observation supporters. Whether this classification had a significant relationship with the answers to each question in Q_Nos. 1–17 was also analyzed using Fisher's exact test and the Benjamini and Hochberg method as a result of multiple comparisons [20].

In addition, differences between gender in observational ability [21], cognitive abilities [22], and forestry perception [23] have been reported. If there was a significant relationship with gender in the analysis above, we analyzed separately for each gender.

3. Results

3.1. Simple Tabulation of the Questionnaire Survey

Of the total 309 students, 301 valid responses were obtained. Of the valid responses, there were 148 male students and 153 female students. We conducted simple tabulations of the entire response group, as well as for male students only and female students only (Figure 2).

There were few first-grade students. Less than half of the students liked each subject, except for health and physical education. Male students tended to like social studies and science, while female students tended to like Japanese language and foreign languages. Most students went to school by bicycle. About three quarters of the students had a commute time of less than 10 min. Nearly half of the students took a walk or rode a bike ride several times a month or more, when not commuting to school. In outdoor activities, the students had the most experience with cookouts and the least experience with lighting bonfires. Female students tended to have more experience in farm work than male students. About a quarter of the students observed a neighbor's Japanese cherry bloom several times a week or more, while more than half of the students observed it once per blooming season or more. Female students tended to take a picture more frequently than male students, and most students tended to use a smartphone to take a picture. About a quarter of the students had a fixed gaze at pictures taken by the fixed-point camera displayed at a science room or in the hallway once or more. About one-third of the students had looked at the digital signage of Shiga Highlands displayed in the library room twice or more, and had talked with their friends or family about the pictures taken by the fixed-point camera or the digital signage of Shiga Highlands once or more.

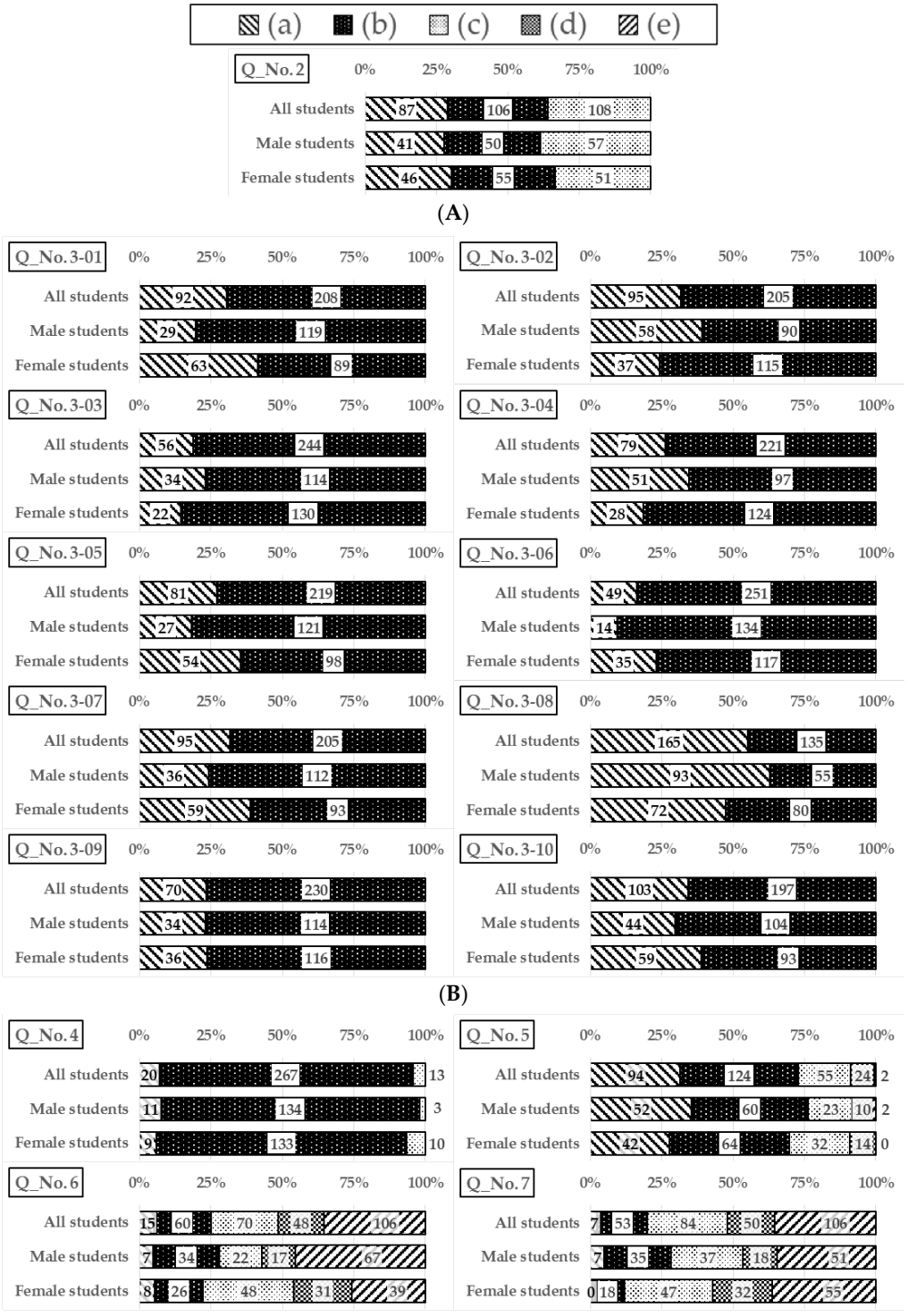

Figure 2. *Cont.*

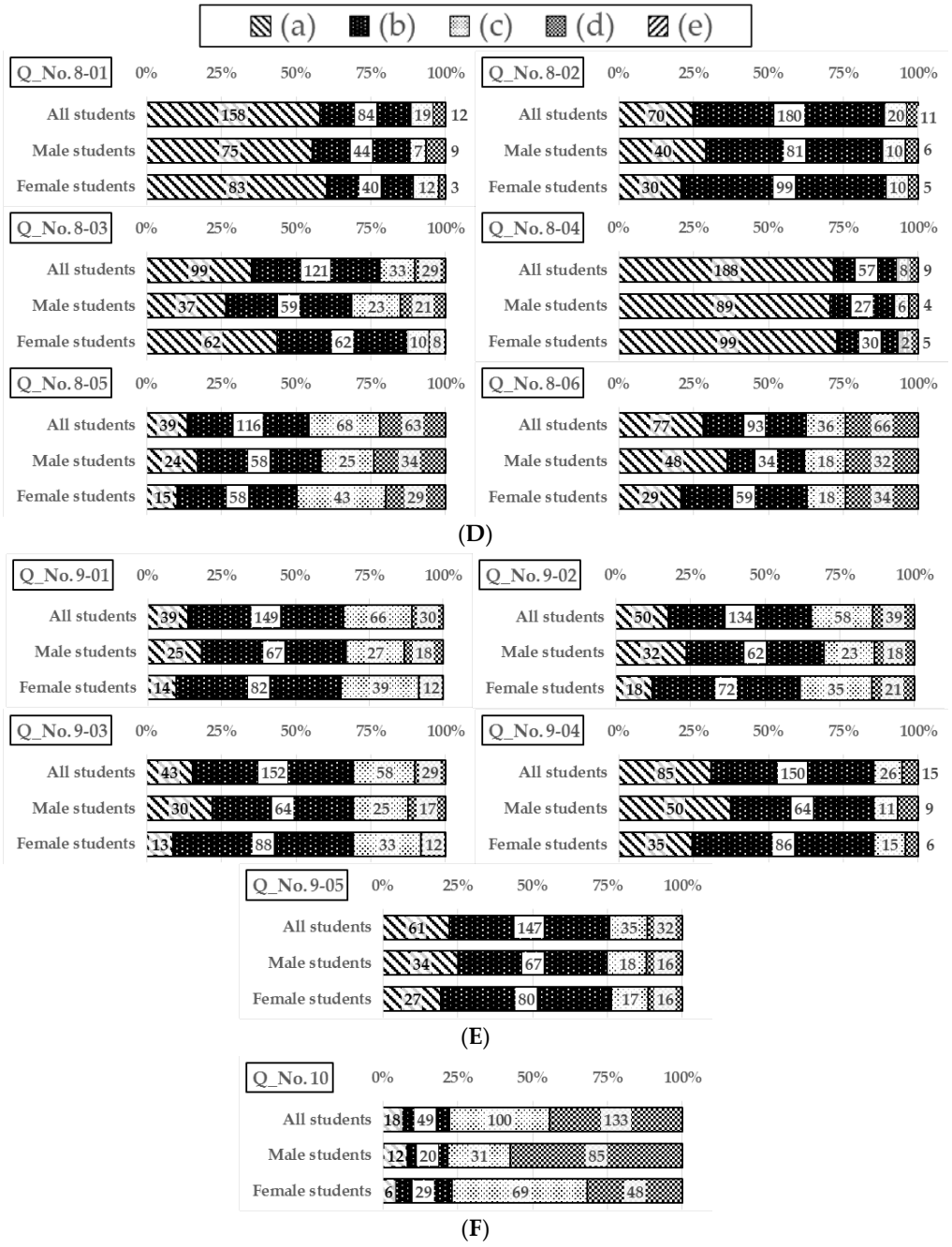

Figure 2. *Cont.*

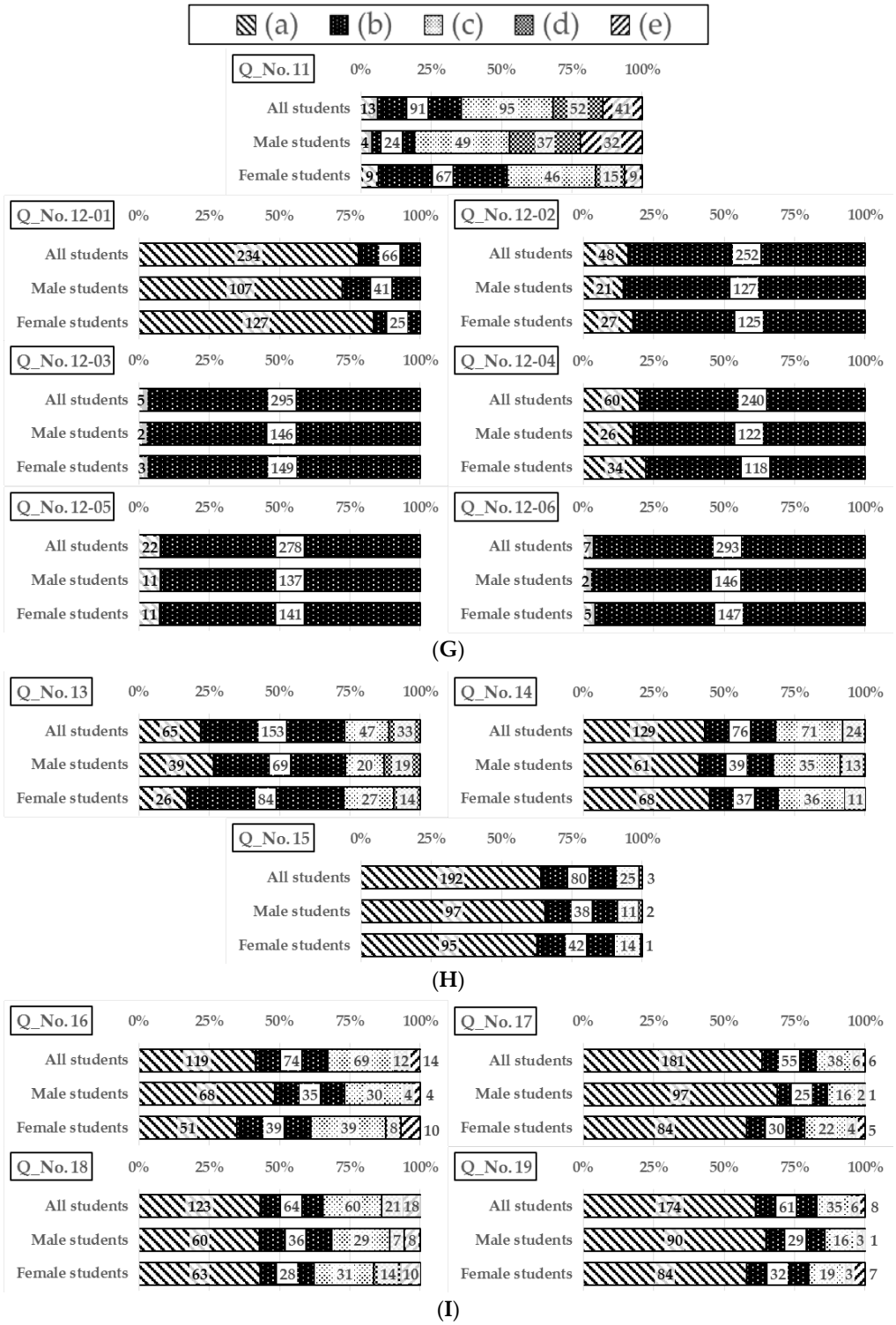

Figure 2. Simple tabulation of each question categorized by rate: (**A**) about gender and grade; (**B**) about school subjects; (**C**) about means and required time to commute, and habits for walking and bicycle riding; (**D**) about experience of outdoor activities; (**E**) about experience of farm work; (**F**) about interest in phenology; (**G**) about habit and means of photography; (**H**) about their interests in the pictures of the time-lapse camera placed in their school and of the time-lapse camera in the forest, and conversations about the two time-lapse cameras with their friends and families; and (**I**) about observing and photographing plants before and after the lecture on December 2016. The letters (a)–(e) are the options' codes (in Table 1).

3.2. Characteristics of the Students Who Had Conducted Plant Observations Twice or More before the Lecture

There were 26 students who had observed plants "two or three times a month" or "Further", and 12 students who had photographed plants "two or three times a month" or "Further" before the lecture on December 2016 (in Figure 1), for a sum set of 31 students who had conducted plant observations frequently before the lecture. There were 193 students who had observed plants "Never" or "Once", and 236 students who had photographed plants "Never" or "Once" before the lecture on December 2016 (in Figure 1), for a product set of 192 students for comparison target. Applying these results to Fisher's exact test, this classification had significant relationships with Q_Nos. 8-04, 8-06, 9-01, 9-02, 9-03, 9-05, 10, 12-05, and 15, with a significance level of 1%, and with Q_Nos. 1, 3-06, 3-07, 6, 8-01, 9-04, 13, and 14, at a significance level of 5%.

The relative characteristics of the students were interpreted as follows, including the results of multiple comparisons (in Table 2): there were more female students than male ones; many students liked the subjects of music and art; many students had experienced lighting a bonfire, picking acorns, and farm work; more students usually checked the blooming of a neighbor's Japanese cherry almost every day; and many of them usually used a digital single-lens reflex camera for taking pictures.

Table 2. List of significant relationships with the students who frequently conducted plant observations before the lecture.

Q_No.	Significant Relationship (All Students)		Significant Relationship (Male Students Only)		Significant Relationship (Female Students Only)	
	Level	**Different options [1]**	**Level**	**Different options [1]**	**Level**	**Different options [1]**
1	*	Female > Male				
3-04					**	Like > Dislike
3-06	*	Like > Dislike				
3-07	*	Like > Dislike			*	Like > Dislike
6	*	Whole category	*	Whole category		
8-01	*	Whole category	**	Whole category		
			*	10 or more times > One to four times		
8-02			**	Whole category		
			*	Never > One to four times		
8-04	**	Whole category	**	Whole category	*	Whole category
	**	Five to nine times > Never	*	10 times and over > Never		
	**	10 times and over > Never	*	Five to nine times > One to four times		
	*	Five to nine times > One to four times	*	10 or more times > One to four times		
	*	10 or more times > One to four times				
8-06	**	Whole category			*	Whole category
	*	Five to nine times > One to four times				
9-01	**	Whole category	**	Whole category		
	**	10 or more times > Never	*	10 or more times > One to four times		
	**	10 or more times > One to four times				

Table 2. *Cont.*

Q_No.	Significant Relationship (All Students)		Significant Relationship (Male Students Only)		Significant Relationship (Female Students Only)	
	Level	**Different options [1]**	**Level**	**Different options [1]**	**Level**	**Different options [1]**
9-02	**	Whole category	**	Whole category		
	**	10 or more times > Never	*	10 or more times > Never		
	**	10 or more times > One to four times	**	10 or more times > One to four times		
9-03	**	Whole category	**	Whole category		
	**	10 or more times > Never	*	10 or more times > Never		
	*	10 or more times > One to four times	**	10 or more times > One to four times		
9-04	*	Whole category	*	Whole category		
9-05	**	Whole category	*	Whole category	*	Whole category
	*	One to four times > Never			*	One to four times > Never
	**	10 or more times > Never			*	10 or more times > Never
10	**	Whole category			*	Whole category
	*	Almost every day > Several times a week			*	Almost every day > Several times a week
	**	Almost every day > Once per the blooming season			*	Almost every day > Once per the blooming season
	**	Almost every day > Never			*	Almost every day > Never
12-05	**	Use > Not use	**	Use > Not use	*	Use > Not use
13	*	Whole category			**	Whole category
14	*	Whole category			**	Whole category
15	**	Whole category			*	Whole category

[1] "A > B" means that the proportion of A is significantly larger than B among the students who selected "two or three times a month" or "Further" in Q_No. 16 or in Q_No. 17 (in Table 1) compared to those who selected "Never" or "Once" in Q_No. 16 and in Q_No. 17 (in Table 1). * The Fisher's exact test showed a significant difference, with a significance level of 5%. ** The Fisher's exact test showed a significant difference, with a significance level of 1%.

Since there was a significant relationship with students' gender, we also analyzed separately for each gender. Of the 31 students who had conducted plant observations frequently before the lecture, 10 were male and 21 were female. The male students had significant relationships with Q_Nos. 8-01, 8-02, 8-04, 9-01, 9-02, 9-03, and 12-05 with a significance level of 1%, and with Q_Nos. 6, 9-04, and 9-05 with a significance level of 5%. The female students had significant relationships with Q_Nos. 3-04, 13, and 14, with a significance level of 1%, and with Q_Nos. 3-07, 8-04, 8-06, 9-05, 10, 12-05, and 15 with a significance level of 5% (Table 2).

The relative characteristics of the male students were interpreted as follows, including the results of multiple comparisons (in Table 2): many of them had the experience of camping, lighting a bonfire, and farm work, and did not have any experience of mountain climbing or hiking; and many of them usually use digital single-lens reflex camera to take pictures. The relative characteristics of the female students were interpreted as follows, including the results of multiple comparisons (in Table 2): many of them liked the subject of science and art; many of them had the experience of eating harvested foods; more students usually checked the blooming of a neighbor's Japanese cherry almost every day; and many of them usually used a digital single-lens reflex camera for taking pictures.

3.3. Characteristics of the Students Who Increased the Frequency of Their Plant Observations after the Lecture

Of the 301 valid responses, 63 increased the frequency of observing plants and 39 increased the frequency of photographing plants, for a total of 80 students who increased the frequency of plant observations after the lecture. As a result of Fisher's exact test, this classification had significant relationships with Q_Nos. 3-02, 12-01, 12-06, 15, and 16, with a significance level of 1% (Table 3).

Table 3. List of significant relationships with the students who increased the frequency of their plant observations after the lecture.

Q_No.	Significant Relationships (Students Who Increased the Frequency of Their Plant Observations after the Lecture)	
	Level	**Different Options [1]**
3-02	**	Like > Dislike
12-01	**	Not use > Use
12-06	**	Use > Not use
14	**	Whole
	*	Two or three times > Never
	*	Four or more times > Never
15	**	Whole

[1] "A > B" means that the proportion of A is significantly larger than B among the students who had not conducted plant observations twice or more before the lecture, but conducted plant observations after the lecture compared to those who never did so. * Fisher's exact test showed a significant difference, with a significance level of 5%. ** Fisher's exact test showed a significant difference, with a significance level of 1%.

The relative characteristics of the students were interpreted as follows, including the results of multiple comparisons (in Table 3): many of the students liked social studies; fewer students usually used a smartphone to take pictures; many of the students usually used a film camera to take pictures; more students looked at the digital signage of Shiga Highlands displayed in the library room twice or more often than those who never looked at it. In addition, the students who liked social studies tended to dislike science (with a significance level of 1% by Fisher's exact test), and the students who did not usually use a smartphone to take pictures tended to use a tablet computer, compact digital camera (with a significance level of 1% by Fisher's exact test), or film camera (with a significance level of 5% by Fisher's exact test).

4. Discussion

There were different characteristics between the students who frequently conducted plant observations before the lecture and those who conducted plant observations after, as well as differences in characteristics between genders. The ratio of female students who frequently conducted plant observations before the lecture was higher than that of male students. A previous study on students of the same age group as in this research reported that female students tended to have sufficient knowledge of plants [24]. The results of this study also showed that female students conducted plant observations more frequently than male students. Another study reported that girls aged five and 10 years were more interested in plant observations than boys [21]. This study showed a similar trend among students aged 12–15 years. The following discussion focuses on differences at a significance level of 1%.

As for the male students who had frequently conducted plant observations before the lecture, high levels of experience in farm work were related to higher numbers of plant observations (in Table 2), which was possibly because most female students had more experience in farm work (in Figure 2). This suggests that farm work provides important opportunities of plant observations for male junior high school students. Stated differently, male students have more room to increase their opportunities

for plant observations through farm work. In addition, the particular characteristics were also associated with relatively niche factors, such as those who had experienced camping or lighting a bonfire 10 or more times and who usually used digital single-lens reflex camera to take pictures. Here, "niche" means that it is an inconspicuous minority, but a field in which students can demonstrate their abilities. These niche hobbies, which might lead to plant observations, are rarely covered by universal education such as junior high schools in Japan. However, considering that the fixed-point observation of forests is also a niche activity for junior high school students, universal education should not ignore their inclination toward niche hobbies and encourage them to consider pursuing specialized education in forestry. Although there are many students who have not experienced mountain climbing or hiking, we do not discuss them in depth, because the possibility of error can be considered from the point that the significance probability of the multiple comparison result is 5%.

As for the female students who frequently conducted plant observations before the lecture, the particular characteristics were associated with those who liked the subject of science, which directly connected to plant observations and was a relatively niche factor for female students. The low female ratio in specialized forestry education has been indicated in the past [25,26], and this research result suggests that this situation should be improved. However, in this regard, since it has been found that girls demonstrate more knowledge of flowers than boys but less knowledge of trees [27], there should be increased effort to identify what female students have specifically observed.

The characteristics of the students who increased the frequency of plant observations after the lecture were partially different from the above. The particular characteristics were associated with those who like social studies. This might mean that social studies students are relatively affected by discourse, while science students are relatively affected by their opportunities and environments. The particular characteristics were associated with those who usually use a film camera to take pictures, rather than a smartphone. Considering that the students who do not usually use a smartphone to take pictures tended to use a tablet computer, compact digital camera, or film camera, they might be more into the niche hobby of photography itself, and they thus became more interested in including plants after the lecture. Since the students taking pictures with a smartphone formed the majority (in Figure 2) and had relatively few characteristics that made them enjoy photography itself, they are not considered suitable for niche activities, such as fixed-point observations of forests.

5. Conclusions

This research identified the following characteristics of junior high school students who frequently conducted plant observations, including photography.

The ratio of students who conducted plant observations at a high frequency of two or three times a month or more was significantly higher among female students than male students, and their characteristics differed by gender. The significant characteristics of male students included farm work experience and niche hobbies such as experience of camping and lighting a bonfire more than 10 times and using digital single-lens reflex cameras for photography. The significant characteristics of female students included relatively niche factors such as a liking for science. Students with these characteristics are considered to have the potential of becoming fixed-point observation leaders who can practice fixed-point observation as forest managers in the future.

Students who increased the frequency of plant observations after the lecture about the fixed-point observation of forests had different characteristics from those who frequently conducted plant observations before the lecture. Specifically, they had an inclination toward social studies and tend not to use a smartphone for photography. Students with these characteristics are considered to have the potential of becoming fixed-point observation supporters who can support fixed-point observation leaders in terms of funding and infrastructure.

Considering the above characteristics of students who frequently conducted plant observations, including photography, could further accelerate the fostering of fixed-point observation leaders and supporters. This research is significant in that it contributes to the fostering of the leaders and

supporters and potentially increases the possibility of more fixed-point observation data for the future validation of forest management.

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Appendix A

Table A1. Overall objectives of the subjects at the junior high school in Japan.

Subjects	Overall Objectives
Japanese Language	To develop in students the ability to properly express and accurately comprehend the Japanese language, to increase the ability to exchange their own ideas and opinions clearly, to develop cognitive and imaginative capacity and a sense of language, to deepen interest in the Japanese language and to cultivate an attitude of respect for the Japanese language [28].
Social Studies	From a broad perspective, to raise interest in society, to study from various angles using various materials, to nurture understanding of and love for our country's land and history, and to cultivate the foundations of citizenship necessary to be a creator of a democratic and peaceful nation and society, while living in international society [29].
Mathematics	Through mathematical activities, to help students deepen their understanding of fundamental concepts, principles and rules regarding numbers, quantities, geometrical figures and so forth, to help students acquire the way of mathematical representation and processing, to develop their ability to think and represent phenomena mathematically, to help students enjoy their mathematical activities and appreciate the value of mathematics, and to foster their attitude toward to making use of the acquired mathematical understanding and ability for their thinking and judging [30].
Science	To enable students to take an active interest in natural things and phenomena, and to carry out observations and experiments with a sense of purpose, while also fostering foundations for the ability to perform investigations scientifically and their positive attitude for doing so. To enable students to deepen understanding of natural things and phenomena, and to cultivate scientific ways of looking and thinking [31].
Foreign Languages	To develop students' basic communication abilities such as listening, speaking, reading and writing, deepening their understanding of language and culture and fostering a positive attitude toward communication through foreign languages [32].
Music	To encourage pupils to cultivate their sentiments, a love for music as well as enrich their sensitivity to music, develop fundamental abilities for musical activities and deepen understanding of music culture, through a wide variety of music-making and appraising activities [33].
Art	To enable students to savor the joy of artistic creativity and develop their sensitivity in the form of a love of art and, while doing this, to enrich the sentiments of students, extend their basic abilities in art, deepen understanding of artistic culture and nurture a rich fund of aesthetic sensitivity through a wide range of activities in art expression and appreciation [34].
Health and Physical Education	To enable students, through understanding of physical activity, health and safety, engaging in physical activity sensibly, and by considering physical and mental aspects in an integrated manner, to develop qualities and abilities to enjoy physical exercise throughout their lives and to help them cultivate practical abilities for the maintenance and improvement of health and improvement of physical fitness, and cultivate an appropriate attitude towards leading a happy and fulfilling life [35].
Technology and Home Economics	To deepen understanding of the relationship between our lives and technology through acquiring basic and fundamental knowledge and skills necessary for life, and to develop the ability to and a positive attitude toward planning and creating a proactive life [36].
The Period for Integrated Studies	To enable students to think in their own way about life through cross-synthetic studies and inquiry studies, while fostering the qualities and abilities needed to find their own tasks, to learn and think on their own, to make proactive decisions and to solve problems better. At the same time, enable students to acquire the habits of studying and thinking, and cultivating their commitment to problem solving and inquiry activities in a proactive, creative and cooperative manner [37].

References

1. Nunez-Mir, G.C.; Desprez, J.M.; Iannone, B.V.; Clark, T.L.; Fei, S. An automated content analysis of forestry research: Are socioecological challenges being addressed? *J. For.* **2017**, *115*, 1–9. [CrossRef]
2. Christensen, N.L.; Bartuska, A.M.; Brown, J.H.; Carpenter, S.; D'Antonio, C.; Francis, R.; Franklin, J.F.; MacMahon, J.A.; Noss, R.F.; Parsons, D.J.; et al. The report of the ecological society of america committee on the scientific basis for ecosystem management. *Ecol. Appl.* **1996**, *6*, 665–691. [CrossRef]
3. Wätzold, F.; Drechsler, M.; Armstrong, C.W.; Baumgärtner, S.; Grimm, V.; Huth, A.; Perrings, C.; Possingham, H.P.; Shogren, J.F.; Skonhoft, A.; et al. Ecological-economic modeling for biodiversity management: Potential, pitfalls, and prospects. *Conserv. Biol.* **2006**, *20*, 1034–1041. [CrossRef] [PubMed]
4. Gardner, T.A.; Barlow, J.; Chazdon, R.; Ewers, R.M.; Harvey, C.A.; Peres, C.A.; Sodhi, N.S. Prospects for tropical forest biodiversity in a human-modified world. *Ecol. Lett.* **2009**, *12*, 561–582. [CrossRef] [PubMed]
5. Weng, E.; Luo, Y. Relative information contributions of model vs. data to short- and long-term forecasts of forest carbon dynamics. *Ecol. Appl.* **2011**, *21*, 1490–1505. [CrossRef] [PubMed]
6. Millar, C.I.; Stephenson, N.L.; Stephens, S.L. Climate change and forests of the future: Managing in the face of uncertainty. *Ecol. Appl.* **2007**, *17*, 2145–2151. [CrossRef] [PubMed]
7. Seidl, R.; Lexer, M.J. Forest management under climatic and social uncertainty: Trade-offs between reducing climate change impacts and fostering adaptive capacity. *J. Environ. Manag.* **2013**, *114*, 461–469. [CrossRef] [PubMed]
8. Kuebbing, S.E.; Reimer, A.P.; Rosenthal, S.A.; Feinberg, G.; Leiserowitz, A.; Lau, J.A.; Bradford, M.A. Long-term research in ecology and evolution: A survey of challenges and opportunities. *Ecol. Monogr.* **2018**, *88*, 245–258. [CrossRef]
9. Brownlee, M.T.J.; Powell, R.B.; Hallo, J.C. A review of the foundational processes that influence beliefs in climate change: Opportunities for environmental education research. *Environ. Educ. Res.* **2013**, *19*, 1–20. [CrossRef]
10. Nakamura, K.W.; Watanabe, R.; Fujiwara, A.; Saito, K.; Kobayashi, H.H.; Sezaki, K. Plant phenology observation by students using time-lapse images: Creation of the environment and examination of its adequacy. *Environments* **2018**, *5*, 7. [CrossRef]
11. Richardson, A.D.; Jenkins, J.P.; Braswell, B.H.; Hollinger, D.Y.; Ollinger, S.V.; Smith, M.-L. Use of digital webcam images to track spring green-up in a deciduous broadleaf forest. *Oecologia* **2007**, *152*, 323–334. [CrossRef] [PubMed]
12. Graham, E.A.; Yuen, E.M.; Robertson, G.F.; Kaiser, W.J.; Hamilton, M.P.; Rundel, P.W. Budburst and leaf area expansion measured with a novel mobile camera system and simple color thresholding. *Environ. Exp. Bot.* **2009**, *65*, 238–244. [CrossRef]
13. Ide, R.; Oguma, H. Use of digital cameras for phenological observations. *Ecol. Inform.* **2010**, *5*, 339–347. [CrossRef]
14. Hughes, B.B.; Beas-Luna, R.; Barner, A.K.; Brewitt, K.; Brumbaugh, D.R.; Cerny-Chipman, E.B.; Close, S.L.; Coblentz, K.E.; de Nesnera, K.L.; Drobnitch, S.T.; et al. Long-term studies contribute disproportionately to ecology and policy. *Bioscience* **2017**, *67*, 271–281. [CrossRef]
15. Tomkins, S.P.; Tunnicliffe, S.D. Looking for ideas: Observation, interpretation and hypothesis-making by 12-year-old pupils undertaking science investigations. *Int. J. Sci. Educ.* **2001**, *23*, 791–813. [CrossRef]
16. Johnston, J.S. What does the skill of observation look like in young children? *Int. J. Sci. Educ.* **2009**, *31*, 2511–2525. [CrossRef]
17. Eberbach, C.; Crowley, K. From everyday to scientific observation: How children learn to observe the biologist's world. *Rev. Educ. Res.* **2009**, *79*, 39–68. [CrossRef]
18. Lindemann-Matthies, P. Investigating nature on the way to school: Responses to an educational programme by teachers and their pupils. *Int. J. Sci. Educ.* **2006**, *28*, 895–918. [CrossRef]
19. Saito, K.; Nakamura, K.; Ueta, M.; Kurosawa, R.; Fujiwara, A.; Kobayashi, H.H.; Nakayama, M.; Toko, A.; Nagahama, K. Utilizing the cyberforest live sound system with social media to remotely conduct woodland bird censuses in central Japan. *Ambio* **2015**, *44*, 572–583. [CrossRef] [PubMed]
20. Benjamini, Y.; Hochberg, Y. Controlling the false discovery rate: A practical and powerful approach to multiple controlling the false discovery rate: A practical and powerful approach to multiple testing. *J. R. Stat. Soc. Ser. B* **1995**, *57*, 289–300.

21. Kos, M.; Jerman, J. Observing natural objects: Characteristics of flowering plants perceived as important by 5- and 10-year old children. *J. Balt. Sci. Educ.* **2015**, *14*, 109–120.
22. Mann, V.A.; Sasanuma, S.; Sakuma, N.; Masaki, S. Sex differences in cognitive abilities: A cross-cultural perspective. *Neuropsychologia* **1990**, *28*, 1063–1077. [CrossRef]
23. Gharis, L.W.; Laird, S.G.; Osborne, D.C. How do university students perceive forestry and wildlife management degrees? *J. For.* **2017**, *115*, 540–547. [CrossRef]
24. Lückmann, K.; Menzel, S. Herbs versus trees: Influences on teenagers' knowledge of plant species. *J. Biol. Educ.* **2014**, *48*, 80–90. [CrossRef]
25. Sample, V.A.; Bixler, R.P.; McDonough, M.H.; Bullard, S.H.; Snieckus, M.M. The promise and performance of forestry education in the United States: Results of a survey of forestry employers, graduates, and educators. *J. For.* **2015**, *113*, 528–537. [CrossRef]
26. Gilless, J.K. The Berkeley Summit—Looking to the future for forestry education. *J. For.* **2015**, *113*, 587–591. [CrossRef]
27. Gatt, S.; Tunnicliffe, S.D.; Borg, K.; Lautier, K. Young maltese children's ideas about plants. *J. Biol. Educ.* **2007**, *41*, 117–122. [CrossRef]
28. Japanese Language. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_2.pdf (accessed on 8 April 2018).
29. Parmenter, L.; Mizuyama, M.; Taniguchi, K. Citizenship education in Japan. In *SAGE Handbook of Education for Citizenship and Democracy*; Arthur, J., Davies, I., Hahn, C., Eds.; SAGE: London, UK, 2008; pp. 206–214, ISBN 1412936209.
30. Mathematics. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_4.pdf (accessed on 8 April 2018).
31. Science. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_5.pdf (accessed on 7 April 2018).
32. Foreign Languages. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_10.pdf (accessed on 8 April 2018).
33. Music. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_6.pdf (accessed on 8 April 2018).
34. Art. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_7.pdf (accessed on 8 April 2018).
35. Health and Physical Education. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_8.pdf (accessed on 8 April 2018).
36. Technology and Home Economics. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_9.pdf (accessed on 8 April 2018).
37. The Period for Integrated Studies. Available online: http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2011/04/11/1298356_12_1.pdf (accessed on 8 April 2018).