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FOSTERING JAPANESE STUDENTS’ LOGICAL THINKING TO FORMULATE A COMMON UNDERSTANDING OF LOGICS BETWEEN TEACHERS AND STUDENTS

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Abstract

Japan’s MEXT’s (The Ministry of Education, Culture, Sports and Technology) survey in 2016 shows that Japanese high school students have difficulty writing their opinions logically in English. To foster students’ logical thinking in class, it is necessary to formulate a common understanding regarding logic between teachers and students. However, the image of logic is not always shared well among teachers, students, and between teachers and students in an L2 class. Very little is also known about the effective methods to share a common understanding of logic. The aim of this study is to explore a possible method. The experiment was conducted with 105 high school students (three groups with 35 members each) and 11 English teachers. Each group (L1 essay analysis, L2 essay analysis, and L1 and L2 essay analyses) received lessons on essay analysis (twice a week for 2–3 weeks) using task sheets which were purposefully developed. Before and after the experiment, teachers and students were asked to write their definition of logics and English writing tests were conducted for students. The results of the statistical analysis (a quantitative textual analysis, t-test and effect size analysis) shows that 1) a consensus on logics is necessary among teachers before instructing essay writing, 2) the instruction using
L1 essay contributes to eliminating the difference in the perception of logics between teachers and students, and 3) it enhances students’ logics in English essay writing. This study contributes well to progressing to the next step which supports students to write essays logically.

Keywords
Logical Thinking, Perception of Logics, L2 Writing, Argumentative Essay Analysis, Japanese High School

1. Introduction

When considering educational goals in Japan, equipping students with a good balance of both receptive and productive English skills has been discussed for a long time. However, with the process of globalization accelerating, there is now a serious focus on how to foster thinking abilities. Improving logical thinking ability is one of the goals MEXT demonstrates in the present course of study. In the near future, the new English subject “Logic and Expression” will be established in the newly revised course of study. The goal of fostering productive skills to express one’s ideas logically and coherently is clearly stated.

However, a nationwide survey on the current circumstances of English education, with third year Japanese high school students as participants, conducted by MEXT in June 2016 shows that they suffer weaknesses in writing their ideas and opinions logically (MEXT, 2016). As a result of this situation, our school (Kobe University Secondary School) has been exploring an effective teaching method to develop students’ logical skills so they can write their ideas clearly and persuasively with others.

Regarding logics, syllogism, developed by Aristotle, and the two broad approaches of deductive reasoning and inductive reasoning are referred to in general. When the definition of “a logical statement” is considered, there will be different points of view depending on various genres or aims of writing. In general, a deductive approach is adopted and “a logical statement” is defined as one whose “Claim” is clearly supported by “Reasons” with “Backing” and definite “Warrant” (Oi, 2010).

To teach “a logical statement” sounds difficult in an L2 (English) classroom in Japan. However, Tatsukawa (2012) suggests the importance of telling junior / high school students that constructing a logical argument is not difficult, and giving students “as many opportunities to practice logical thinking and expressing their ideas in class as possible.” Oi (2008) introduced
explicit writing instruction for junior high school students in Japan which used the Toulmin Model, a model of argument developed by Stephan Toulmin (1969), to enhance students’ awareness of the construction of an argument.

There are various teaching methods to develop learners’ thinking skills. For example, Lestari (2015) introduces the study of teaching critical reading in an EFL classroom in senior high school in Indonesia, which helps the learners to develop their critical thinking and to become the critical readers. Siallagan (2017) did a research regarding the implementation of British Parliamentary Debate. It showed that debate encouraged students to share their ideas, to oppose arguments which finally stimulated the students’ critical thinking. Khusnia (2015) introduced some strategies to engage students in peer feedback and self-assessment in Extended Speaking Course. Sharing the process of giving and receiving feedback among students enabled them to develop their critical thinking and feedback skills.

A large number of studies have investigated the transfer of writing skills across languages or language skills. Rinnert and Kobayashi (2009) investigated the transfer of writing ability from L1 to L2, which shows that “novice writers who had received intensive L1 training wrote more coherently organized L1 and L2 essays.” On the other hand, Higuchi (2010) investigated the transfer of logical thinking ability from L2 reading (paragraph reading instruction in argumentative essays) to L2 writing, which enabled participants to write a more logical and persuasive essay individually.

When we pay attention to teachers and students in an L2 class, questions would arise, such as “When teachers read two different English essays written by different students, do teachers have the same opinion when they are asked which English essay is more logical?” or “Even if a teacher repeatedly emphasizes the importance of logics in English writing, a few students might not understand what the teacher says at all.” These questions show that the image of logic may not always be shared well among teachers, among students, and between teachers and students. Before starting to teach forming a logical statement, it is necessary to formulate a common understanding regarding logics between teachers and students. However, very little is known about the effective methods to achieve this. The aim of the current study is to explore a possible method.

In this study, the research is explored from two points: 1) exploring an effective method to teach “a logical statement” before instructing argumentative English essay writing, 2)
designing three steps to achieve this. The steps are as follows: 1’) Teachers establish a consensus on a logical statement; 2’) Students establish the same perception on logical statements as teachers; and 3’) Teachers support students to write argumentative essays logically. Regarding these three steps, 1’) and 2’) are the focus of this study.

2. Purpose of the Study

The research reported here was used to explore an effective teaching method to share a common understanding of logics between teachers and students, and enhance students’ logics in English essay writing. In the exploration, three different types of essay analyses were adopted: L1 (Japanese) essay analysis, L2 essay analysis, and L1 and L2 essay analyses. This study was conducted in a natural L2 classroom context in a Japanese high school.

3. Research Method

3.1 Research Questions

The three research questions that guided this study were as follows:

RQ 1: Before starting essay analyses, are there any differences in the image of logic among teachers, among students, and between teachers and students?

RQ 2: What differences can be found in the students’ awareness of logics through the three different types of essay analyses?

RQ 3: Which essay analysis contributes the most to enhance students’ logics in English essay writing?

3.2 Participants

Participants were 105 third-year high school students and 11 L2 teachers in Japan. The students have studied English as a foreign language for six years. Their English proficiency varied from low to advanced levels (around CEFR Level A1 to B1). The teachers have different backgrounds, such as age (23 to 46 years), years of working as a teacher (2 to 25 years).

3.3 Task Sheets for Logic Training

In this study, for the first step, L2 teachers shared a common understanding of “a logical statement,” which is defined as one whose “Claim” is clearly supported by “Reasons” with “Backing” and definite “Warrant.” For the second step, to investigate the effects of L1 and L2 essay analyses, original task sheets for logic training were developed (see Appendix). L1 and L2 task sheets consisted of three lessons each. Each lesson had some questions with two alternatives,
where participants were required to read two essays and then choose the more logical one. Each lesson had its own theme, such as “Claim setting,” “Backing and Warrant to support Claim” and “Leap in logic.” As to the materials used in L1 and L2 task sheets, a book written by Tomioka (2003) and GTEC Step up Notebooks published by Benesse Corporation were adopted as a reference.

3.4 Setting Three Groups

105 students were divided into three experimental groups: Group A for L1 essay analysis, Group B for L2 essay analysis, and Group C for L1+L2 essay analyses. Each group had 35 members. All students took GTEC for Students beforehand, which is a test designed for junior and senior high school students that measures the skills of Listening, Reading and Writing. A one-way Analysis of Variance (ANOVA) was conducted to investigate the difference of the GTEC test score. It confirmed that there was no significant difference of test score among three groups, $F(2,102)=0.34, p=.71, \eta^2=.01$.

3.4 Instructional Treatments

Training for logical thinking with the prepared task sheets was conducted twice a week as part of the English Expression II class. The training session took about 20 minutes and included the following four steps: 1) answering the questions individually, 2) checking their own answers with their partner, 3) discussing why one essay was more logical than another in class, and 4) checking the answers with the teacher. Group A (L1 essay analysis) and Group B (L2 essay analysis) received three training sessions each, and Group C (L1+L2 essay analyses) received six training sessions in total.

3.5 Data Collection

This study had a pretest-treatment-posttest design. The pretest and posttest participants (105 students and 11 teachers) were asked to write the definition of “a logical statement” in Japanese. The aim of collecting this data was to trace detailed changes in the participants’ awareness in logics that could not be captured by quantitative research tools.

In addition to the above, essay writing tests were conducted. In these tests, students were asked to complete their essay expressing their thoughts on a given theme: (1) If you were given a chance to do whatever you want for one month, what would be your plan? and (2) After graduating this school next spring, do you want to live alone without your relatives? They were encouraged to express their opinion persuasively with reasons based on their own experiences or
some examples in 20 minutes. They were not allowed to use English dictionaries during the tests. Each essay was evaluated independently by one native user of English, using one or more criteria to rate “claim,” “reason,” “backing,” and “warrant.” The maximum score for logics in English essay writing was 10 points. The aim here was to investigate how students’ logics in English essay writing had changed.

3.6 Data Analysis

As for RQ 1, answers from the pretest were textually processed separately. Using the Japanese text mining software KH Coder (Higuchi, 2013), the frequency of Japanese nouns and verbal nouns was obtained within the dataset. These nouns made it easier to identify meaning within the content by word unit.

As for RQ 2, answers from the posttest, were also textually processed and the frequency of Japanese nouns and verbal nouns was obtained within the dataset. In addition, means of the number of words in Japanese comments from the pretest and posttest were obtained, and correspondence analysis was carried out with teachers, student groups and words that were used more than a certain frequency (top 20 words). According to N. Souria et al. (2010), “Correspondence Analysis is a multivariate graphical technique designed to explore relationships among categorical variables.”

As for RQ 3, to test the difference in logics in English essay writing from the pretest and posttest, a paired-sample t test was carried out. Furthermore, to verify the results of the t test, the effect size was calculated using Cohen’s d. With reference to Mizumoto and Takeuchi (2008), criteria for small (d > .20), medium (d > .50), and large effect size (d > .80) were determined.

4. Result and Discussion

4.1 RQ 1: Comparison of the Image of Logic among Teachers, Among Students, And Between Teachers and Students in the Pretest

Table 1 shows the examples of answers in which the teachers were asked to define “a logical statement.”
Table 1: Examples of Answers on “A Logical Statement” (Teachers)

- It is a statement which achieves a goal fully in writing the passage.
- It is a statement whose logical development (the flow of one’s thought, logical structure) is clear and well organized, which has paragraphs that construct a passage and the writer’s definite intention for delivering his or her “claim” more clearly.

Table 2 shows the nouns or verbal nouns that appeared in answers of each teacher (teacher A to teacher K).

Table 2: The Nouns or Verbal Nouns Used by Teachers in Defining “A Logical Statement”

| Teacher A | Teacher B | Teacher C | Teacher D | Teacher E | Teacher F | Teacher G | Teacher H | Teacher I | Teacher J | Teacher K |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Knowledge | Reader | Reason | Example | Statement | Position | Reason | Word | Warrant | Statement | Stateme |
| Background | Stateme | Self | Writer | Comfort | Sentenc | Thought | Statem | Paragraph | Full | Logic |
| Statement | Understanding | Subjectivity | Reader | Cause And | Effect | Writer | Warrant | One | Reason | Goal | Constru |
| Reason | Backing | Stateme | Reason | Reader | Myself | Theme | Structu | Accompli | Paragra | Flow |
| Issue | Science | Argument | Claim | Stateme | Gathing | Order | Reader | Flow |
| Opinion | Thought | Objectiv | WARRANT | Logic | Parts | Stateme | Structu | Flow |
| Understanding | Speed | Understanding | Subjectivity | Objectiv | Reason | Claim | Intensio | Flow |
| | Survey | Story | Statement | Understanding | Logic | Explanat | Thought | Claim |
| | Exception | Establish |ment | Argument | Understanding | Claim |
When the types of nouns and verbal nouns were considered, 62 different nouns and verbal nouns were obtained. However, there was no common noun or verbal noun used by all teachers. This suggested that “a logical statement” was defined differently among teachers.

Table 3 shows the examples of answers which the students wrote to define “a logical statement.”

**Table 3: Examples of Answers on “A Logical Statement” (Students)**

- It is a statement where the ideas are closely related to each other.
- It is a statement which describes one’s opinion or thought with expert or technical knowledge so that others can understand it with ease.
- It is not an emotional statement but a persuasive statement which has some steps to let others understand the idea clearly.

When the types of nouns and verbal nouns were counted, 135 different types of nouns and verbal nouns were obtained. However, no common noun or verbal noun was used by all
students. This meant that each student had a different idea about logics. These results indicated that the image of logics varied among teachers, among students, and between teachers and students in the pretest.

This finding suggests that 1) to build a consensus on an image of logics is necessary among teachers before starting lessons and 2) an effective method should be explored so that students have the same images about logics as teachers.

4.2 RQ 2: Comparison of the Changes of Students’ Awareness of Logics throughout Three Different Types of Essay Analyses

In RQ 1, a considerable difference about the image of logics was confirmed among both teachers and students, and between teachers and students in the pretest. Here in RQ 2, we checked how students’ awareness of logics changed in response to three different types of essay analyses conducted among three different students’ groups A to C. This will give hints to explore an effective method to allow students and teachers to share the same images about logics.

Table 4 shows the mean values of the number of words in Japanese comments from both the pretest and posttest.

|                      | M   | SD  |
|----------------------|-----|-----|
| Pretest (All students)| 58.6| 33.8|
| Posttest Group A (L1 Analysis) | 85.1 | 26.7 |
| Posttest Group B (L2 Analysis)   | 75.4 | 53.3 |
| Posttest Group C (L1+L2 Analyses) | 114.4 | 54.9 |

When the number of words in Japanese comments was examined, the figures showed some increase in all posttest groups A to C. This suggested that the students grasped more concrete image of logics through the essay analyses.

Next, when each group was compared, the number of words in Group C increased the most, with Group A and Group B following. This result showed a possibility that L1 analysis contributed to the enhancement of the students’ awareness of logics more than L2 analysis.

When answers from the three posttest groups were textually processed, common nouns or verbal nouns were used in Group A and Group C (“warrant” and “claim” were used by all students in Group A, “claim” was used by all students in Group C, however, no common noun or verbal noun was found in Group B). Some concrete image of logics was shared well in the
groups which included L1 analysis.

Table 5 shows the top ten nouns or verbal nouns that appeared most frequently for all students (the pretest) and three groups (the posttest) in the comments when they were asked to define “a logical statement.”

| Rank | Pretest (Total) | Posttest (Total) | Group A (L1 Analysis) | Group B (L2 Analysis) | Group C (L1+L2 Analyses) |
|------|-----------------|------------------|-----------------------|-----------------------|--------------------------|
| 1    | Coherence       | Claim            | Claim                 | Claim                 | Claim                    |
| 2    | Warrant         | Warrant          | Warrant               | Coherence             | Warrant                  |
| 3    | Claim           | Conclusion       | Conclusion            | Conclusion            | Myself                   |
| 4    | Myself          | Coherence        | Myself                | Content               | Reason                   |
| 5    | Conclusion      | Leap             | Reason                | Warrant               | Leap                     |
| 6    | Opinion         | Myself           | Opinion               | Leap                  | Conclusion               |
| 7    | Content         | Reason           | Leap                  | Information           | Explanation              |
| 8    | Understanding   | Opinion          | Coherence             | Consistency           | Relation                 |
| 9    | Reason          | Content          | Example               | Example               | Backing                  |
| 10   | Structure       | Example          | Backing               | Theme                 | Example                  |

When we compare the pretest (Total) with the posttest (Total), two nouns were transferred (“understanding” and “structure” → “leap” and “example”). In addition, nouns or verbal nouns transferred in three different groups were observed as follows; “content” → “backing” in Group A, “myself, opinion, reason” → “information, consistency, theme” in Group B, and “content, opinion, coherence” → “explanation, relation, backing” in Group C. These results suggested that the different types of essay analyses influenced students’ awareness of logics differently. Here, a question arises: which group came close to the teachers’ awareness of logics after its essay analysis?

The diagram in Figure 1 maps the Pretest (All students), three Groups A to C and teachers surveyed against the top 20 most frequently used nouns and verbal nouns based on Correspondence Analysis (CA).
In reference to “Dimension 1” (the vertical axis), which explains 63.6% of the data correlation, the distribution of the students’ groups can be described as follows: on the top of the axis, Pretest and Group A (L1 analysis) are mapped, and on the bottom of axis, Group B (L2 analysis) and Group C (L1+L2 analysis) are located. This suggests that the vertical axis divides the groups which have L2 analysis or not.

On the other hand, when looking at “Dimension 2” (the horizontal axis), which explains 20.4% of the data correlation, Pretest and Group B are mapped on the left of the axis, and Group A and Group C and teachers are concentrated on the right of the axis. This indicates that the horizontal axis represents the difference between groups with L1 analysis and groups without L1 analysis.

When focusing on “teachers,” teachers are mapped in the fourth quadrant (bottom right), where Group C is located just below them. This shows that Group C comes closest to teachers’ logical consciousness. This ensures that not only L2 essay analysis but L1 essay analysis greatly contributes to formulating a common understanding of logics between teachers and students.
4.3 RQ 3: Comparison of Increase in Students’ Logics in English Essay Writing for Each Essay Analysis in Group A to C

In RQ 2, it was confirmed that L1+L2 essay analyses contributed the most to sharing a common understanding of logics between teachers and students. Here, in RQ 3, the relationship between essay analyses and logical organization in actual English essay writing was examined.

Table 6 displays the descriptive statistics of logic scores in the English writing test for three experimental groups. As for the control group, which has no essay analysis, no significant difference in students’ logics in English essay writing was confirmed (Masumi, 2015). This shows that the changes in the logic scores of each experimental group A to C were caused by the process of essay analysis itself.

Regarding Group A, there was a significant difference between posttest and pretest and the effect size was medium, \( t(34) = 3.58, p < .01, d = 0.61 \). On the other hand, no significant difference was found in Group B, \( t(34) = 0.05, p = .48, d = 0.01 \). Regarding Group C, there was a significant difference between posttest and pretest and the effect size was large, \( t(34) = 4.96, p < .01, d = 0.85 \). When focusing on the effect size, Group C had the largest value, followed by Group A.

**Table 6: Means and Standard Deviation of Logic Scores in Writing English Essays from the Pretest and Posttest, The Result of the T-Test and Effect Size**

| Logic score (Pretest) | Logic score (Posttest) |  \( t \)  |  \( d \)  |
|-----------------------|------------------------|--------|--------|
| \( M \) | \( SD \) | \( M \) | \( SD \) |
| Group A (L1 Analysis) | 7.21 | 1.10 | 7.89 | 0.93 | 3.58** | .61 |
| Group B (L2 Analysis) | 7.60 | 1.07 | 7.61 | 0.88 | 0.05n.s. | .01 |
| Group C (L1+L2 Analyses) | 7.04 | 0.94 | 7.92 | 0.78 | 4.96** | .85 |

**\( p < .01 \)**

These results suggested that students’ logics in English essay writing improved significantly by the processes with L1+L2 essay analyses (Group C), followed by L1 essay analysis (Group A). It is considered that L1 essay analysis enabled students to gain a deeper understanding of logics and write more logically organized L2 essays.
5. Conclusion and Future Challenges

In this study, it was examined how three different types of essay analyses (L1 essay analysis, L2 essay analysis, and L1 and L2 essays analyses) contributed to the sharing of a common understanding of logics between teachers and students, and enhanced students’ logics in English essay writing.

Regarding RQ 1 (Before starting essay analyses, are there any differences in the image of logic among teachers, among students, and between teachers and students?), the result indicated that the image of logics varied among teachers, among students, and also between teachers and students.

Next, the results of RQ 2 (What differences can be found in the students’ awareness of logics throughout the three different types of essay analyses?) suggested two points: 1) there was a possibility that the different types of essay analyses influenced students’ awareness of logics differently, and 2) L1+L2 essay analyses would greatly contribute to the formulation of a common understanding of logics between teachers and students.

Lastly, in RQ 3 (Which essay analysis contributes the most to enhance students’ logics in English essay writing?), students’ logics in English essay writing improved significantly by the processes with L1+L2 essay analyses, followed by L1 essay analysis. Consequently, how can we make the best use of these findings in actual educational scenarios? Are there any hints as to how to develop students’ logical thinking in an ordinary L2 classroom in Japan? Based on the findings in this survey, three suggestions are stated below from the author’s point of view.

First, it is of utmost importance that teachers achieve a consensus on logics before starting instruction on argumentative essay writing. In general, this consensus is omitted because it tends to be thought that all teachers already have a uniform understanding of logics. However, from this study, each teacher defines logics in their own different way. This step should not be avoided before teaching logics in argumentative essay writing.

Second, to eliminate differences in the perception of logics between teachers and students, the instruction on logics using an L1 essay is effective, especially followed by the instruction on logics using an L2 essay. In March 2009, MEXT announced “English classes are to be conducted in English in principle” in the New Course of Study for Senior High Schools. This means that not only should teachers conduct English classes in English, but should also focus on language activities to allow students to use English as much as possible in class. However, when
improving logical thinking is considered, the instruction using an L1 essay would possibly be recommended so that students gain a deeper understanding of the logics, which is in line with Rinnert and Kobayashi (2009). This method would also enhance students’ logics in English essay writing.

Third is the importance of introducing these L1+L2 essay analyses into a series of L2 writing instructions. If these analyses require a lot of time to take effect, it might be difficult to adopt this method into daily lessons. However, this survey showed that this method took at most three weeks, which was not a long period, and brought about a constant improvement in students’ awareness of logics and their logics in English essay writing. Therefore, this instruction could be taken into consideration when establishing a lesson plan on L2 augmentative essay writing.

As regards future challenges for this survey, to explore more effective methods to enhance students’ logical thinking ability, the following points should continue to be examined: 1) the level of English in the English materials used in the L2 task sheets, 2) the questions with two alternatives prepared in the task sheets, and 3) how to cooperate with other subjects (such as Japanese classes).

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Appendix: L1 and L2 task sheets for logic training (Excerpt)

| Page  | Text content                                                                                      |
|-------|--------------------------------------------------------------------------------------------------|
| Step 1 | 公共の乗り物に全く乗ることを選ばない方が良いです |
| Step 2 | 公共の乗り物に全く乗ることを選ばない方が良いです |
| Step 3 | 公共の乗り物に全く乗ることを選ばない方が良いです |

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【質問】
以下の2つの文を比べて、どちらが論理的な文でしょうか。論理的であると判断した文章の番号に〇をつけなさい。

### トピック
「成功は何を表すことである、という意見についてどう思うか」

|   |   |
|---|---|
| A | I don't think being successful means earning a lot of money. That is because judging success is a subjective matter and cannot be done using an objective standard such as a salary. If you think you are successful because you have helped people in need, your satisfaction can definitely be one way to judge your success. Or if you have finished what you first thought impossible, you can call yourself successful. A sense of accomplishment is another way to judge how successful you are. As both of these involve feelings, they are highly subjective. Likewise, any other subjective standard related to how you feel can be used to measure your success. Therefore, the amount of money needed to be considered successful differs from person to person. |
| B | I don't think being successful means earning a lot of money. Therefore, money, an objective way to measure, cannot be used to judge how successful one is. |

| Q2 | I think each local government should support a “produce locally, eat locally” campaign. That is because eating locally produced food improves local economies. For example, profits can be kept in the local area by cutting out other companies which sell the food at higher prices in other areas. As a result, local farmers and related businesses will benefit from this campaign. Moreover, eating locally produced food has a positive effect on the environment. Transportation of food across the nation consumes a lot of energy and contributes to global warming. In contrast, food that is grown and consumed locally causes less environmental damage. Thus, if consumers buy locally produced food, they can help preserve the environment. In order to improve local economies and the environment, it is important for each local government to encourage consumers to buy local produce. Therefore, encouraging a “produce locally, eat locally” campaign is important, so I believe that each local government should promote such a campaign. |
|---|---|
| A | I think each local government should support a “produce locally, eat locally” campaign. That is because eating locally produced food improves local economies. For example, profits can be kept in the local area by cutting out other companies which sell the food at higher prices in other areas. As a result, local farmers and related businesses will benefit from this campaign. Moreover, eating locally produced food has a positive effect on the environment. Transportation of food across the nation consumes a lot of energy and contributes to global warming. In contrast, food that is grown and consumed locally causes less environmental damage. Thus, if consumers buy locally produced food, they can help preserve the environment. In order to improve local economies and the environment, it is important for each local government to encourage consumers to buy local produce. Therefore, consumers must make the right decision to eat locally. |