English and Turkish pupils' understanding of decomposition

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Abstract

This study aimed to describe seventh grade English and Turkish students' levels of understanding of decomposition. Data were analyzed descriptively from the students' written responses to four diagnostic questions about decomposition. Results revealed

that the English students had considerably higher sound understanding and lower no understanding than the Turkish students while the he Turkish students' level of misunderstanding of decomposition was lower than those of the English students. The English and Turkish students' responses tended to show similar partial understanding in explaining decomposition. Difference between levels of understandings was significant according to result of chi-square test.

Keywords: Ecology, Decomposition, Misconceptions.

Introduction

Students construct their own knowledge themselves, but their ideas may differ from the scientific views. These ideas can be valid, invalid, or incomplete, and may have a considerable influence on how and what students learn from their classroom experiences. There are many researches investigating students' ideas related to several scientific concepts that they can be varied from scientific knowledge. This study area has recently attracted many researchers' interest on children's conceptions, misconceptions, understanding or conceptual change in science education (Gilbert & Watts, 1983; Driver, Squires, Rushworth, & Wood-Robinson, 1994). There were several researches investigating students' conceptions about biology concepts, such as diffusion and osmosis (Odom & Barrow, 1995; Christianson & Fisher, 1999), genetics (Wood-Robinson, Lewis, & Leach, 2000), genetics and ecosystem (Bahar, Johnstone, & Hansell, 1999).

As students' alternative ideas in science are resistant to change, it is very crucial to identify them before designing a science instruction or science curricula. Children's conceptions may originate from daily life experiences, formal school context, and from each other. However, children's ideas, language, tradition, cultural up-bringing of children, folklore, and myths are influencing factors on children's conceptual understanding in science (Khatete, 1995). If science teachers and curriculum designers knew students' alternative ideas related to science concepts, it might be helpful to prepare effective teaching schemes (Griffiths & Grant, 1985; O-Saki & Samiroden, 1990; BouJaoude, 1992).

Ecology is considered as one of the main topics in biology instruction and students have limited understanding and some difficulties about ecology. Many researches were carried out students' understanding and conceptions concerning the key concepts

of ecology, such as decomposition (Khatete, 1995); cycles of matter, flows of energy, and interdependency of organisms in ecosystems (Leach, 1995); greenhouse effect, CO_2 emissions, ozone layer depletion (Andersson & Wallin, 2000), food chain, energy flow, pyramid of number/energy, and carbon cycle (Adeniyi, 1985; Çetin, 1998), biotic and abiotic factors, food chain and food web, and environmental pollution (Çetin, 2003), wastes, and recycling (Malandrakis, 2003). For example, Leach (1995) identified the 'key ideas' related to the nature of living organisms, and relationship between organisms based upon matter cycling, energy flow, and other factors, then these key ideas were used to identify ecological phenomena of 5 to 16 age ranged students attending urban and semi-rural schools in the North England (n=499). He found that while the young children characteristically thought of organisms only in the context of human activity and they could not make any relationship between organisms in ecosystems. The older ones had a tendency to clarify simple relationship between individual organisms involving food and shelter.

Andersson & Wallin (2000) demonstrated that Swedish students in grade 9 and grade 12 did not fully understand what fundamental societal changes would occur as a result of a drastic reduction in CO_2 emission, but they knew well how injurious depletion of the ozone layer was to humans. Çetin (2003) also reported that 82 ninth grade students had some common misconceptions of the concepts of ecology; biotic and abiotic factors, food chain and food web, cycles of matters, and environmental pollution even after teaching ecology course. Secondary consumers provided food first to food chain. Produced foods were taken firstly by tertiary consumers that were animals. Phosphorus was substance that was found less in atmosphere layers. Animals in land started phosphorus cycle first, and then animals in sea started it again. After animals had taken phosphorus, they left it as compost to the nature. Then plants utilized it and animals ate plants again. Sometimes water seemed turbid because of bad weather conditions, not because of decay (Çetin, 2003).

Decomposition is carried out by micro-organisms; fungi and bacteria. Micro-organisms break down dead organic materials into inorganic materials. Thus, organic materials are made available for re-using in nature over and over again. Hellden (1992a) used an interview method with 2-6 grade students about decomposition in nature, conditions for growth and life, and plants in a meadow. A quantity of pupils at grade 4 and 6 thought that decomposition was a process in which no organisms took part. While some students mentioned that a piece of leaf or wood

was not turned into soil completely, only part of it, some pupils pointed out that the rest of them just disappeared or a little was tuned into nourishment. Several students revealed that nail would be rusty, but most of them indicated that the rusty nail would remain and a few of them it would go down into ground. Some students indicated that a plastic lid and a glass jar would remain on the ground without decomposition. He concluded that the students had many alternative explanations regarding decomposition, although they studied actively these scientific phenomena during the instruction, and the teaching could not lead to conceptual change in the pupils' conceptions.

Malandrakis (2003) has attempted to enlarge the children's active participation to realize the degradability of organic materials and the non-degradability of others. He verified that the children realized the role of sun, water, and air to decay of materials, and they increased speed the decomposition process. The children figured out the environmental consequences from the dispose of these materials and recycling as the most appropriate solution for them. The students perceived wastes and recycling as two major environmental issues, and the students comprised them as an integral part of the environmental education curricula worldwide.

As mentioned above there have been few researches on decomposition and they concluded that the concepts of decomposition were not well understood by some students in general. Although there were some cross-cultural studies to measure how science concepts understood in different countries (Bogdanov & Viiri, 1999; Sağlam & Robin, 2006), there have not been observed any cross-cultural studies about ecology, specifically on decomposition according to the review of the literature. For example, Bogdanov & Viiri (1999) reported the preliminary results of the study of students' understanding of the force concept. The students in the experimental Finnish group achieved a significantly higher level than the Russian group, although two groups showed to be almost equal. Sağlam & Robin (2006) explored the Turkish and English high school students' understanding of electromagnetism. They figured out that many students showed misunderstandings and inconsistencies without a coherent framework of ideas about electromagnetism. Students common errors involved confusing of electric and magnetic field effects, seeing field lines as indicating a flow, using cause-effect reasoning in situations where it did not apply, and dealing with effects associated with the rate of change of a variable.

As a conclusion, the students belonged to each country had some common errors or difficulties of various science concepts and there was a need for further cross-cultural studies examining students' alternative ideas about ecological concepts, specifically decomposition in different countries. As the students' alternative ideas on decomposition could be independent of differences in curriculum or language of science instruction, they could be reached in other samples (Sağlam & Robin, 2006).

The main aim of this study was to explore seventh grade English and Turkish students' levels of understandings of decomposition in two countries, in England and in Turkey, not to make a comparison the students' achievements. It attempted to diagnose mainly how seventh grade English and Turkish students understood and explained decomposition of organic molecules, decomposition of biodegradable materials and non-biodegradable materials, decomposition in environment, producer, consumer and decomposer relationships in the cycle of materials, and environmental conservation in different everyday contexts after teaching ecology concepts. This study also indented to find out what the similarities of the English and the Turkish students' understandings of the concepts of decomposition.

Method

Schools and subjects

To conduct the study regarding seventh grade students' understanding of ecology, the researcher desired to study with two public schools, one from England and the other from Turkey. One of the comprehensive elementary schools in the Leeds area was chosen for England sample and then, the other elementary schools, from Turkey was selected from one of the public elementary schools in the Marmara region in Turkey.

The sample was a total of 96 seventh grade students had mixed ability with the age ranging from 14-15 years. After permissions were taken from the schools to conduct the study, the researcher did not intervene with their ongoing practices of teaching ecology in both seventh grade classrooms. Seventh grade English and Turkish children learnt similar concepts of decomposition; decomposition of environment, producer, consumer and decomposer relationships in matter and some cycles of materials, food chain and food web, and environmental conservation. All students were taught about those concepts in deep and they had learnt more about the cycles of materials at high school level. At the end of their ecology teaching, the Ecology Test

developed by Çetin (1998) was administered to 54 English students from two classes taught by two science teachers from the selected public school in England. Subsequently the Ecology Test was administered to 42 students from two classes taught by one science teacher from the selected school in Turkey. At the same time a questionnaire about the ecology test was given to two teachers in the selected British school and one science teacher in the selected Turkish school.

Although students were expected to have some conceptions might differ from acceptable scientific views on ecology, it was assumed that the level of the questions in the Ecology Test was appropriate for the seventh grade students; therefore each student was considered having the capacity to answer the questions in measuring. However, a student's ability to answer the questions successfully depended upon the student's previous knowledge, skills, and experience (Germann & Aram, 1996). The Ecology Test was administered following the same instructions given by the researcher in both selected schools in England and in Turkey. All students answered the questions in the Ecology Test seriously and sincerely. However, the sample of the study was limited to 96 seventh grade students at the public elementary school in Turkey and the public elementary school in England in the Spring Semester of 1997-1998. This study was also limited to the Ecology concepts in the Turkish science curricula and the English science curricula in seventh grade level.

Data Collection

Students' levels of understanding of decomposition were determined by four diagnostic questions related to some concepts of decomposition. Those questions were selected from an Ecology Test developed by Çetin (1998). Figure 1 shows four test items regarding decomposition involved two multiple-choice questions required reasoning and two open-ended questions related to some basic concepts of decomposition from seventh grade English and Turkish science curricula. Question 1-3 assessed the students' understanding of decomposition of organic molecules, decomposition in environment, producer, consumer, and decomposer relationships in the cycle of materials. Question 4 examined how the students realized the decomposition of biodegradable materials and non-biodegradable materials, and environmental conservation.

To construct the Ecology Test, a concept map of ecology related to food chain, food web, and decomposition was drawn. The test items were designed to assess students'

ability to interpret and apply some ecological concepts. The researcher was aware of the fact that many Turkish questions in elementary school exam papers only assessed recalled knowledge. All questions in the Ecology Test were modified versions of some of the questions obtained from Key Stage 3 level exam papers as well as English science textbooks, and Ph.D. thesis about ecology (Leach, 1995). The test was phrased in English and later translated to the Turkish Language. Much care was taken to ensure that the level of language used was suitable for the Turkish students and some Turkish colleagues evaluated the suitability of the language used. Two biology educators; one British and one Turkish performed the content validation of the items. Finally, the Ecology Test included some multiple-choice questions required justifying each response made, and open-ended items required short answers. The data were collected from the English students first and then, they were collected from the Turkish students by post. All students were told the test was not an achievement test, but not to copy one another's work during the test. The test duration was one hour.

Additionally, a questionnaire involving six items was administered to one British and one Turkish science teacher to determine which of the selected concepts taught in class, and to obtain their opinions of the level of difficulty of test items. It also aimed to elicit methods used by the teachers to determine the students' understanding of the ecological concepts and lastly the problems that students might face during the test administration.

Data analyses

The aim of the study was to explicate the ideas of the English and Turkish students concerning decomposition, not to compare their achievements of decomposition. In order to attain the students' opinions about ecology, the students were expected to choose one alternative from four alternatives given in the multiple-choice question, and then to explain why they made that choice in brief given blank space in the Ecology Test. In open-ended question the students were expected to express their ideas about the question in short given blank space in the Ecology Test. Here the students' responses/explanations to four questions regarding decomposition were scored and coded as like other questions in the Ecology Test.

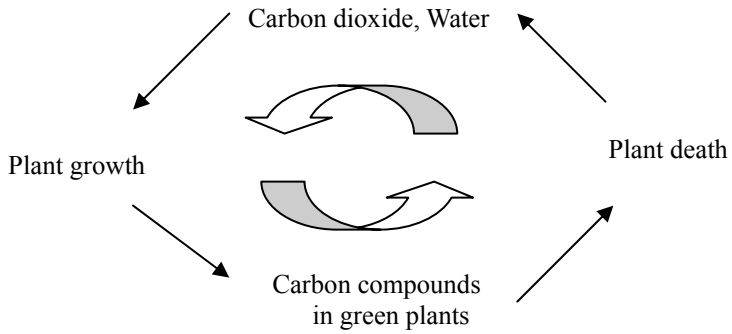
Question 1. Complex organic molecules are broken down and recycled in an ecosystem. Carbon dioxide and
mineral ions are made available for re-use.

a) Which one of the following is mainly responsible for breaking down complex molecules in an ecosystem?

A producers
B consumers
C micro-organisms
D soil

b) Explain your answer briefly.

Question 2. This diagram below represents a part of the carbon cycle.



a) How is carbon compounds released from plants after death?

A decay
B evaporation
C photosynthesis
D reproduction

b) Explain why you made that choice.

Question 3. John put four apples in a glass bowl, but then he forgot to eat them for two weeks. He noticed that they have a bad smell and have lost their original shape.
Explain briefly why they can smell and lost their original shape.

Question 4. Although some rubbish can be decomposed (broken down) in a short time some cannot.
This table below shows how long some rubbish takes to decompose.

Cigarette ends……..1 to 5 years
Orange peels……..2 years
Plastic bags…… 10 to 20 years
Tin cans…….50 years
Nylon fabrics……30 to 40 years

Explain why orange peel is broken down in 2 years but tin cans can take 50 years to break down.

Figure 1: Question 1-4 Related to the Concepts of Decomposition

A test paper of each student was numbered from 1 to 96 and then, the students' responses to each question in the Ecology Test were scored between 0-3. If a student responded to the multiple-choice part correctly and provided an explanation with sound understanding, the score "3" was given to the student. If a student responded to the multiple-choice part correctly and provided an explanation with partial understanding, the score "2" was given to the student. When a student responded to the multiple-choice part correctly and provided an explanation with misunderstanding, then the score "1" was given. When a student responded to the multiple-choice part wrongly, the score "0" was given without accounting for the response provided in the second part. If a student gave no response to both parts for the item asked, then the score "0" was used.

In addition, students' ideas obtained from the students' responses to the test items were identified and classified according to a coding scheme generated by the researcher (Keng, 1997; Simpson & Marek, 1988). A student's response to each question could involve more than one idea, so a student's idea as a part of the response was chosen as the unit of analysis. Each student's idea was collected from their explanations in the reasoning parts of multiple-choice and open-ended questions in the Ecology Test. These ideas were listed in order and similar ideas for each question were linked together. An extended list of ideas in response to each question was generated in mutually exclusive categories as much as possible.

At the beginning of scoring and content analysis of the students' responses to the questions, acceptable scientific explanations were written for each question in the test by the researcher as a guide. Two experts; one English biology educator and one Turkish biology educator validated these scientific explanations. This guide formed the basis of the codes and the categorization process for the student's ideas extracted from the students' responses to each question. One English biology educator, one Turkish biology educator, and one English physics educator reviewed the codes and assigned categories for students' ideas according to their levels of understanding of decomposition. Necessary revisions were done accordingly until reaching an agreement. In this manner, the coding schemes were developed, and an initial coding was executed and experts validated those coded ideas before conducting an exhaustive coding of the students' ideas.

Finally students' ideas related to decomposition were classified under four categories: Sound understanding (SU), partial understanding (PU), misunderstanding (MU), and no understanding (NU). SU meant if the students' responses included the scientifically acceptable explanations about the questions, they were considered having sound understanding. PU meant if the students' responses were partly correct and did not include the scientifically acceptable explanations about the questions, they were considered having partial understanding. MU meant if the students' responses did not include acceptable explanations, it implied that the students had some misinterpretations or misjudgments about the questions. Some responses of the students were grouped as misunderstandings if they were clearly different from the scientific view. NU meant if the students could not make proper explanation(s) from the scientific point of view or restate questions for the multiple-choice questions and the open-ended questions, they were considered to have no understanding at all. In short, this broad category contained rewrite responses that restated the questions, non-sense or irrelevant responses that could not be coded meaningfully, and no response where the space was left empty or with the response, "I don't know". Table I-IV displays students' levels of understanding and percentages of response categories for the questions.

Results and discussion

After in depth examination of the students' responses to four diagnostic questions related to decomposition in different everyday contexts, seventh grade students' levels of understanding of decomposition were presented in three sections: decomposition of organic molecules, decomposition of biodegradable materials and non-biodegradable materials, and a general contrast of students' levels of understanding about decomposition.

Decomposition of organic molecules

To assess the students' understandings of decomposition of organic molecules, Question 1-3 was asked. Decomposition of organic molecules was also associated with other concepts: decomposition in environment, and producer, consumer and decomposer relationships in the cycle of materials.

Question 1 was multiple-choice question required reasoning and the aim of the question was to analyze patterns of students' understandings about decomposition of

organic molecules by micro-organisms in an ecosystem relating to the other concepts: producer, consumer, decomposer, recycle, and ecosystem. This question might contain the main idea: micro-organisms broke down organic, dead plants/animals, or they fed on organic materials. The students were expected to explain this question as three science teachers had taught ecosystem, decomposition, and decay. This probe was also referred to the concept of recycle that the students were familiar with this concept in everyday life too. Table I shows the students' levels of understanding of students' ideas for the first question.

According to Table I, a small minority of children gave some explanations with sound understanding relating to micro-organisms, for example micro-organisms like bacteria fed on the organic molecules and rot them away (27.7% English students and 14.2% Turkish students). The English students' level of misunderstanding was higher than the Turkish students (31.4% and 8.2%) assuming consumers, producers, and soil were responsible for breaking down complex molecules in an ecosystem in general. Students' level of no understanding was too high (39.2% English students and 65.3% Turkish students).

Table I: A Summary of Students' Levels of Understanding for their Ideas and their Percentage as a Response to Question 1

Understanding Categories of Students' Ideas	**ES %**	**TS %**
A. Sound Understanding	***27.4***	***14.2***
Explanations relating to micro-organisms:	13.7	2.0
• They fed on the organic molecules and rot them away.		
• They ate (broke down) all the dead materials.	7.8	12.2
• They waved though the soil to break down complex molecules.	5.9	0
B. Partial Understanding	***2.0***	***12.3***
Explanations relating to micro-organisms:		
• They were bacteria.	0	8.2
• They ate everything.	2.0	0
• Bacteria produced carbon dioxide and minerals.	0	4.1
C. Misunderstanding	***31.4***	***8.2***
Explanations relating to producers:	2.0	0
• Because producers made photosynthesis to make carbon dioxide available. When they died, they produced minerals.		

• Because producers used the carbon dioxide and mineral ions for photosynthesis.	2.0	0
• Because plants reproduced their food.	2.0	0
• Because producers were the source of a food chain.	2.0	0
Explanations relating to consumers:	9.5	0
• Because consumers ate molecules, animals, or plants.		
• Because humans were main responsible part for breaking down in an ecosystem.	2.0	3.7
• Because consumers passed their energy onto predators.	0	2.3
Explanations relating to micro-organisms:	2.0	2.2
• Micro-organisms broke down the soil when they digested it.		
Explanations relating to soil:		
• Because soil broke down everything natural.	3.9	0
• Because producers could not grow without soil.	2.0	0
• Because soil was not rich in vitamins and minerals.	2.0	0
• Because when plants died they broke down into the soil to fertilize the ground. So the system could start again.	2.0	0
D. No Understanding	***39.2***	***65.3***
• Non-sense	9.8	6.1
• Rewrite	13.7	26.5
• No response	15.7	32.7

(ES: English Students, n=54; TS: Turkish Students, n=42)

Question 2 was multiple-choice question required reasoning part and the aim of the question was to analyze children's ideas on key concepts of decay and carbon cycle related to other concepts: photosynthesis, evaporation, and reproduction. This probe was designed for how students understood the release of carbon compounds from plants after death. The main idea for Question 2 might include that carbon compounds were released from dead plants through micro-organisms ate them. The categories of responses are provided below in Table II on the basis of levels of understanding.

As seen in Table II, the students' partial understanding about this question was higher than the students' sound understanding, with more English students (26.8%) showing a partial understanding than the Turkish students (11.1%) according to the results of the Question 2. The students' level of misunderstanding was too high (32.1% English students and 15.6% Turkish students), and one striking point here was the explanation relating to evaporation: "When a plant died, the carbon and water were released by evaporation" (16.1% English students). The level of no understanding had the highest

level of understanding among other categories (39.3% English students versus 66.6% Turkish students).

Question 3 was an open-ended question, and it was set to find out students' ideas on decomposition related to decomposer, decomposition of natural or organic materials. Two main ideas for the response to the question might be: the apples had a bad smell and they loose their original shape because they rot (or they loose their original shape because they loose moisture and dried up), they smelt because of gas being given off a result of decay, and they became soft and collapsed because of decay. The students had a wide rage of responses, and they explained their ideas by either giving separate reasoning for loosing shape and having bad smell of apples, or giving general comments (See Table III).

Table II: A Summary of Students' Levels of Understanding for their Ideas and their Percentage as a Response to Question 2

Understanding Categories of Students' Ideas	**ES %**	**TS%**
A. Sound Understanding	***1.8***	***6.7***
Explanations relating to decay: • After plants died, they were decayed by micro-organisms.	1.8	6.7
B. Partial Understanding	***26.8***	***11.1***
Explanations relating to decay: • When plants died, they were decayed away to nothing leaving minerals and nutrients in the soil. • If plants were dead, they could not reproduce, photosynthesize, or evaporate. • Plants became part of the earth and soil.	5.4 16 5.4	0 8.9 2.2
C. Misunderstanding	***32.1***	***15.6***
Explanations relating to decay: • The oxygen would eat them and disposed of them. Explanations relating to evaporation: • Carbon dioxide was a gas and it was with which could be rain. • When plants died, the carbon and water were released by evaporation. Explanations relating to photosynthesis: The water and the sun still produced photosynthesis.	1.8 1.8 16.1 1.8	0 0 2.2 0

• After plants died, carbon compounds were released and they made photosynthesis.	5.2	2.2
• After plants died, photosynthesis let carbon compounds out.	0	6.6
• Plants gave carbon dioxide out by photosynthesis.	0	2.2
• Plants could not get carbon dioxide without photosynthesis. Thus, the carbon dioxide levels increased.	0	2.2
Explanations relating to reproduction:	1.8	0
• The dying plants took in oxygen and passed out carbon dioxide when They were dead.		
• New plants seeded from the dead plant would produce carbondioxide in photosynthesis.	1.8	0
• They were released because of the seeds.	1.8	0
D. No Understanding	***39.3***	***66.6***
• Non-sense	0	4.4
• Rewrite	33.9	31.1
• No response	5.4	31.1

(ES: English Students, n=54; TS: Turkish Students, n=42)

Table III: A Summary of Students' Levels of Understanding for their Ideas and their Percentage as a Response to Question 3

Understanding Categories of Students' Ideas	***ES %***	***TS %***
A. Sound Understanding	***78.9***	***64.6***
Explanations relating to the apples losing their original shape and having a bad smell:		
• Because they were put outside and decayed by micro-organisms (they were not kept in cool place or a fridge).	0	18.7
• Because the apples would start to decay by micro-organisms. The apples went soft and have a bad smell.	5.5	39.6
Explanations relating to the apples losing their original shape:	44.0	2.1
• Because the apples were decayed by micro-organisms and started to shrivel up.		
• Because the apples' water was drying out by the sun. Thus, they loose air inside them and they shriveled up.	16.0	2.1
Explanations relating to the apples having a bad smell:	13.4	2.1
• Because they were decaying.		
B. Partial Understanding	***9.4***	***24.8***
Explanations relating to the apples losing their original shape and having a bad smell:	8.0	22.7
• Because they loose molecules that kept them fresh and they had no food supply.		

Explanations relating to the apples losing their original shape: • Because they loose their freshness and they were wrinkly.	0	2.1
Explanations relating to the apples having a bad smell: • Because moulds smelt bad.	1.4	0
C. Misunderstanding	***6.3***	***2.2***
Explanations relating to the apples losing their original shape and having a bad smell:		
• Because the sun looked away all the energy, so it died.	1.3	0
• Because the vitamins and minerals were eaten by oxygen.	1.3	0
• Because the atoms and molecules in the air attacked the apple and they caused decay after a while.	1.3	0
Explanations relating to the apples losing their original shape: • When air got inside of an apple, it caused to decay. Thus, the apple got small and wrinkly.	2.4	2.2
D. No Understanding	***5.4***	***8.4***
• Non-sense	0	0
• Rewrite	0	0
• No Response	5.4	8.4

(ES: English Students, n=54; TS: Turkish Students, n=42)

According to Table III, although students showed a high sound understanding, students demonstrated a fewer misunderstanding and no understanding. The English students' performances were much better than the Turkish students for this question. The number of the students' ideas indicating sound understanding was extremely high. The English students (78.9%) provided more sound understanding ideas compared to the Turkish students (64.6%). Many English students indicated that "the apples loose their original shape because the apples were decayed by micro-organisms and started to shrivel up", while most Turkish students stated that "the apples loose their original shape and had a bad smell because the apples would start to decay by micro-organisms. They went soft and had a bad smell". However, the Turkish students (24.8%) provided more partial understanding ideas compared to the English students (9.4%). One of the excellent points for the study both the Turkish students' ideas including misunderstanding (2.2%) and the English students' ideas including misunderstanding (6.3%) were the lowest level. Furthermore, the percentages of ideas showing no understanding were very low (5.4% for the English students and 8.4% for the Turkish students).

Decomposition of biodegradable materials and non-biodegradable materials

To assess the students' understanding of decomposition of biodegradable materials and non-biodegradable materials, the Question 4 was asked. It was an open-ended question. Also ecosystem, recycling, and environmental conservation were related to decomposition of biodegradable materials and non-biodegradable materials. This question included four main acceptable ideas: orange peels were biodegradable materials (natural or organic material); micro-organisms decomposed organic materials; tin cans were biodegradable materials; and micro-organisms did not decompose tin cans and they would rust.

As seen in Table IV, the students responded to Question 4 successfully indicating while micro-organisms decayed orange peels that were biodegradable (natural) material, micro-organisms could not decompose tin cans that were non-biodegradable and rusting could break down tin cans. However, it was observed that the English students' sound understanding level about this question was higher than the Turkish students' ideas (34.3% versus 11.1%). Moreover, both the English students' partial understanding and the Turkish students' partial understanding concerning the Question 4 were very high (48.6% English students versus 54.0% Turkish students). While the English students mainly stated that "tin cans were metal, so bacteria would not be able to eat them away (25.7% English students) and the Turkish students stressed out that "tin cans had stronger molecules in them and they did not soak up water" (19.0%). The present study had an agreement with the results of Malandrakis (2003), which showed that the children realized the role of sun, water and air in the decay of materials and their effect in increasing the speed of the decomposition process.

In Question 4, students' level of misunderstanding were considerably low for both samples (the English students 17.1% and the Turkish students 27.0%). Some students were not aware of micro-organisms could not decompose tin cans as tin cans were non-biodegradable materials. The students also mentioned "tin cans were decayed by bacteria in longer time than the orange peels" (the English students 17.1% versus the Turkish students 17.5%). However, students' level of "no understanding" was extremely low (the English students 0% versus the Turkish students 7.9%). These results of the current study were also in accordance with the study of Khatete (1995), which reported that the children were more familiar with decomposing of meat at home if the meat were not well preserved. He stressed that younger children tended to use mainly daily knowledge and experiences for responding to the questions. Children at school level 10 and 12 tended to give a wider variety of explanations although

through more focused answers than those in years 5 and 8. This present study was in concurrent with the study results of Hellden (1992a) mentioned beforehand in theoretical framework session.

Table IV: A Summary of Students' Levels of Understanding for their Ideas and their Percentage as a Response to Question 4

Understanding Categories of Students' Ideas	ES %	TS %
A. Sound Understanding	***34.3***	***11.1***
Explanations relating to orange peels: • They were biodegradable (natural) materials.	24.8	11.1
Explanations relating to tin cans: • They were not biodegradable materials.	1.9	0
• They could be broken by oxygen and water (rusting) but they did not rust easily.	7.6	0
B. Partial Understanding	***48.6***	***54.0***
Explanations relating to orange peels: • They were living things, but the tin cans were not.	5.8	9.6
• They were soft and soaked up water.	1.9	11.1
• They were more reactive than the tin cans.	1.9	0
Explanations relating to tin cans: • They were metal, so bacteria would not be able to eat them away.	25.7	14.3
• They were hard, had stronger molecules in them, and they did not soak up water.	9.5	19.0
Explanations relating to insects: • They could not digest metal.	1.9	0
Explanations relating to insects, oxygen and water: • They ate away at orange peels.	1.9	0
C. Misunderstanding	***17.1***	***27.0***
Explanations relating to orange peels: • They entered the soil quickly, but the tin cans could not.	0	3.2
Explanations relating to tin cans: • Bacteria decayed them in longer time than the orange peels.	17.1	17.5
Explanations relating to nature: • Nature could not break down the tin cans in short time as they were much resistant to nature as they had hard materials.	0	6.3
D. No Understanding	***0***	***7.9***
• Non-sense	0	1.6
• Rewrite	0	0
• No response	0	6.3

(ES: English Students, n=54; TS: Turkish Students, n=42)

In this study, one of the interesting results was that, although students should be familiar with the concepts of the recycle in everyday context, no students used one of these concepts of recycle to explain one of the four questions. Another reason might be the wording of the Question 1. One of the British teachers commented on this question and indicated that students would find it difficult "due to its wording". According to the questionnaire, only one British science teacher taught the concept of carbon cycle. Therefore, this question was responded a few students. Leach (1995) also reached similar results stating while many older students used numerous factors to explain decay phenomena or causation of decay with age, they did not have a tendency to describe how various physical factors related to the action of micro-organisms and autolytic activity. In addition, students' aged in 5-16 did not give explanation that matter was entirely conserved and recycled in decomposition. Most of them referred to only the role of decay in the cycling of matter via the soil. On the other hand, some of students aged 7-16 mentioned about a partial conservation and cycling of matter as a result of enrichment of soil. In contrast, Malandrakis (2003) figured out that the children comprised the environmental consequences from the dispose of these materials and recycling as the most appropriate solution for them.

A general contrast of students' levels of understanding about decomposition

A summary of students' levels of understandings of decomposition could be given by using their percentages of occurrences in each group. The numbers of students' ideas obtained from the students' responses to each four question about decomposition. Although this study involved 54 English students and 42 Turkish students, the number of ideas of students generated for each question was not limited to one. These ideas indicated students' levels of understanding. Therefore, the percents were calculated for each levels of understanding counting their total numbers of occurrence for both samples. These percents were used to represent their distribution for both groups and to make more sound contrast in between. The results of this analysis were given in Figure 2. As an example, the total numbers of students' ideas indicating sound understanding were 142 for the English students and for 95 the Turkish students. The percents of the English students' sound understanding were 35 and the percents of the Turkish students' sound understanding were 24.

In general, there was a pattern emerging from the total numbers for different levels of understanding for each population. Figure 2 displays that the English students showed more promising results related to levels of sound understanding and no understanding of decomposition than the Turkish students. However, the Turkish students demonstrated high potential for the level of misunderstanding of decomposition. When the English and Turkish students had partial understanding they seemed to demonstrate parallel ideas in explaining decomposition.

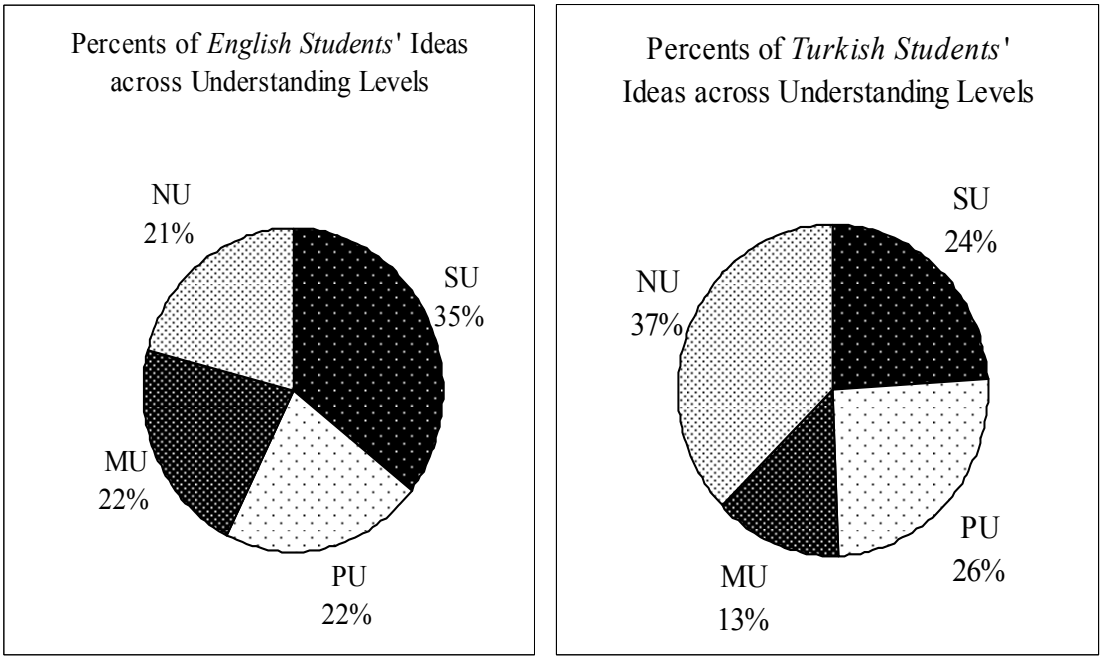


Figure 2: Students' Levels of Understanding of Decomposition according and Overall Percent of the Students' Ideas for Each Level (Level of Understanding - SU: Sound Understanding, PU: Partial Understanding, MU: Misunderstanding, NU: No Understanding)

These emerging patterns were needed more explorations to see if there was a difference between the English and Turkish students' understanding levels of decomposition. The raw frequencies were tabulated for students' ideas of decomposition for each level of understanding as shown in Table V. A chi-square (X^2) statistics were used to test the differences of the categories of data. In the previous examination, the English students appeared to perform better than the Turkish students in providing more ideas with higher levels of understanding levels of decomposition. The difference was significant, $X^2(3, N=798)=36.4$, $p \leq 0.001$.

Table V: Frequencies of Understanding Levels for the English and Turkish Students' Ideas on Decomposition

	Level of Understanding				
Students	**SU**	**PU**	**MU**	**NU**	**Total**
English Students	142	87	87	84	400
Turkish Students	95	102	53	148	398
Total	237	189	140	232	798

(ES: English Students, n=54; TS: Turkish Students, n=42; Level of Understanding- SU: Sound Understanding; PU: Partial Understanding; MU: Misunderstanding; NU: No Understanding)

Çetin (2003) also emphasized that ninth grade Turkish students' sound understandings were increased in both experimental had a conceptual change approach instruction and control group had a traditional instruction after the ecology teaching. While there was a noticeable increase in students' partial understanding for the experimental group after the treatment, the control group students' partial understanding slightly decreased. There was a small increase in the experimental group students' partial understanding with misconceptions and a small decrease for the control group after the treatment. Students' misunderstandings were decreased for both experimental and control groups after the treatment, but the decrease was more for the students in the experimental group. Students' no understandings were decreased for both experimental group and control group after the treatment.

Conclusion

This study presented the students' levels of understanding about decomposition after a traditional ecology teaching in England and in Turkey. Students have constructed their own ideas about decomposition and four questions explored students' ideas on that concept both in everyday and in school science context. Students were asked for four questions to probe understanding of decay or decomposition in different contexts. Students were expected to response the questions explaining micro-organisms broke down organic or dead plant/animals, and organic materials were recycled in the ecosystems and recycling was used more often in everyday life.

Despite the fact that the English students' responses showed greater sound understanding than the Turkish students' responses did, the English and Turkish students' responses tended to show similar partial understanding in explaining decomposition. In general, students gave more reasonable answers relating to decay for the Question 3-4 while they could not explain the same concepts properly in Question 1-2. The difficulty the students appeared to have was not in 'knowing' but in being able to 'use' their knowledge although such 'unfamiliar' instances required almost the same explanations. Students were more familiar with the decay of fruits, such as apples; pears or oranges at home or in nature, and also the decomposition through rusting of tin cans in nature. On the other hand, small minority students showed their knowledge that dead plants/animals or micro-organisms like bacteria broke down organic materials.

Students had also some common misconceptions, such as some students considered producers, consumers, and soil was responsible for decay in an ecosystem; tin cans were decayed by bacteria in longer time than the orange peels; the apples loose their original shape, decayed, and had a bad smell because of oxygen, sun, vitamins, and minerals. Adeniyi (1985) stressed that although some of misconceptions might have existed before instruction, a few of them appeared after instruction. Students' prior misconceptions tented to block understanding of new concepts. Students' misconceptions seemed to reflect an adequacy of the curriculum or instruction or both. To obtain meaningful learning, determining students' level of understanding of science concepts, such as decomposition, especially the students' misunderstandings could be very useful for improving teaching. "If we as teachers want to help pupils to obtain more extensive knowledge of the environment, we ourselves must know more about children's ideas about different phenomena, in order to learn about the pupils' own starting-points for learning. Then, we would be able to create teaching situations in which the children' ideas will be challenged" (Hellden, 1992b, p.1).

In conclusion, the English students appeared to perform better than the Turkish students in providing more ideas with higher levels of understanding of decomposition and the difference was significant according to the result of chi-square test. The students' levels of understandings should be considered by teachers and curriculum developers to remediate students' misunderstandings of decomposition and increasing understanding of science topics at different levels. Therefore, it was hope

that the results of the study to be helpful for designing science instruction in aiming to facilitate conceptual change about decomposition.

In recent literature, there were several researches about students' misconceptions on science concepts and their remediation by several conceptual change methodologies (Posner, Strike, Hewson, & Gertzog, 1982), such as conceptual change texts, concept maps, and analogy etc. have been used for the remediate students' conceptions. Stavy (1991) recommended using analogies to overcome misconceptions about conservation of matter. Özkan (2001) stressed that the conceptual change text oriented instruction increased seventh grade level students' ecology achievement. Çetin (2003) also reported that the conceptual change text oriented instruction accompanied by demonstrations in small groups was more effective to eliminate students' misconceptions in ecology, and increase understanding of ecology at ninth grade level than the traditional instruction.

Moreover, there have been observed few cross-cultural studies in science education (Bogdanov & Viiri, 1999; Aldridge & Fraser, 2000; Saglam & Robin, 2006) though there were many studies explored students' conceptions on science concepts in different countries. There was a need for further cross-cultural studies about ecology, especially on decomposition to see whether they would have similar findings or not.

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