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A New Approach in Teaching the Features and Classifications of Invertebrate Animals in Biology Courses

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This study examined the effectiveness of a new learning approach in teaching classification of invertebrate animals in biology courses. In this approach, we used an impersonal style: the subject jigsaw, which differs from the other jigsaws in that both course topics and student groups are divided. Students in Jigsaw group were divided into five "subgroups" since teaching the features and classification of invertebrate animals is divided into five subtopics (modules A, B, C, D and E). The subtopics are concerning characteristics used in classification of invertebrate animals and fundamental structures of: phyla porifera and cnidarians (module A), annelid (module B), mollusks (module C), arthropods (module D) and Echinodermata (module E). The data obtained in the tests indicated that the the new learning approach was more successful than teacher-centered learning.

Introduction

Most people have a limited awareness of the wild world and are concerned chiefly with the organisms that influence their lives. More than 2.1 million species of organisms live on Earth (Starr and Taggart, 2001). The science of classification continues to change as the knowledge about living things expands, especially concerning invertebrate animals (Grimaldi and Engel, 2005; Prokop et al., 2011).

Although biology teachers in introductory and upper level high school courses generally present principles of taxonomy as an important part of the biology curriculum, they say that taxonomy is not only one of the most difficult topics to teach but is also not popular for students (Dunn, 2003; Guerra-Garcia et al., 2008). Additionally, it is being reported that students at every age level have many misconceptions about the classification of living beings in particular, which is one of the main subjects of biology and which to closely connected to other fields in biology and ecology. For example, college students often classify crawfish as vertebrates, penguins as mammals, and turtles and reptiles as amphibians or invertebrates (Kubiatko and Prokop, 2007; Prokop, et al. 2007a; Yen et al., 2004). In order for taxonomy to be fashionable again, Wheeler and Valdecasas (2005) propose ideas to transform taxonomy such as establishing a federation of taxonomy societies and institutions, increasing the variety and levels of outreach and education, expanding the identification tool chest, etc. Although modern classification has introduced new data and techniques, Dunn (2003) claims that morphology should continue playing a major role in taxonomy in identifing living or herbarium specimens, or in other fieldwork. Additionally, we think that students need new methods and approaches in learning taxonomy. Teachers can introduce representative groups

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to students through purposeful activities that are planned within the limits of required curricula and available instructional time.

In science education, learning methods are as important as teaching strategies. The most commonly used among these learning methods is cooperative learning (Doymus 2008; Hennessy and Evans, 2006).

The most important element of cooperative learning is the establishment of successful cooperative groups. Only within a structured and meaningful group can students really be helped to understand how they can work together, contribute, accept responsibility for completing their part of the task and assist each other's learning in an environment that is supportive of its members (Colosi and Zales, 1998; Gillies, 2007; Miller and Cheetham, 1990). An examination of numerous research studies suggests that cooperative approaches to learning can lead to higher academic achievement than individual or competitive approaches (Hornby, 2009; Yi and LuXi, 2012). It has also been found that cooperative learning has positive social and motivational effects (Hornby, 2009; Littleton and Häkkinen, 1999).

The main aim of this study is to examine the impact of the subject jigsaw technique (Doymus, 2007) on the teaching of the subject: 'the features and classification of invertebrate animals', a difficult part of a general biology course.

Methodology of Research

The experimental design for this study is a post-test only control group designed for multiple meaning. This experimental design was chosen to eleminate any interaction that could occur between a pretest and the end results. Although elmination of the pretest makes it impossible to show statisticaly that the groups are equal according to prior knowledge, it was important to avoid the experimental contamination that could have occurred from interaction between the present and the treatment (Creswell, 2003).

Sample

The sample of this study consisted of a total of 66 undergraduates from two different classes enrolled in the general biology course for the 2011-2012 academic year at Ataturk University. One of the classes was selected randomly as the Control Group (CG) (n=41; in control group, the course has been processed as part I n=20; part II n= 21), in which the teacher-centered learning was applied; the other was selected as the Jigsaw Group (JG) (n=25), in which the jigsaw cooperative learning method (subject jigsaw) was applied. During the training period, instruction for the treatment groups was delivered by the researchers. Before the beginning of the treatment, the researcher gave information about the learning objectives, instruction process, rules of working in JG and CG, and assessment strategies.

Instruments

The Biology Course Information Test (BCIT), used as a pre-test, consists of 40 multiple-choice questions, each question worth five points. The BCIT was designed to assess understanding of basic concepts used in the General Biology Course. The BCIT was created by the researcher. The validity of the test was checked by a professor and two other biology teachers. With respect to reliability, the BCIT was given to students (n=60) who were not involved in the study but had previously taken the course in which the general biology courses mentioned above had been taught. BCIT describes the students' underlying conceptions related to the biology course before formal instruction in general biology courses.

Cronbach's alpha for the internal consistency reliability of the BCIT was .82. This test was used as a pre-test.

The Module Test (MT) was divided into five modules. Each module was composed of six multiple-choice questions and one open-ended question. The open-ended questions of the modules are provided in as an appendix. Multiple-choice questions were tested on undergraduates from two classes of college biology. Item analyses were performed for each question and confusing or vague questions were rewritten before the test was used in the study. The open-ended questions were evaluated according to quality analysis. The reliability coefficient (Cronbach alpha) for the multiple choice questions was 0.74. Also, to develop the validity of MT, opinions of the biology lecturers and researchers on the subject have been taken into consideration. Researchers have pointed out that the gains of MT related to the subjects of each topics used general biology course have been measured highly. This test was performed after explaining the subtopic.

The Features and Classification of Invertebrate Animals Test (FCIAT), used as a post test, consists of 18 multiple-choice questions, with each question worth five points. FCIAT was developed by the authors and four biology teachers. The validity of the test was checked by two professors and two biology teachers. FCIAT was piloted with undergraduates (n=30) who had studied the features and classification of invertebrate animal the year before. Item analyses were calculated for each question and confusing or vague questions were rewritten prior to use. The overall reliability coefficient (Cronbach's Alpha) for the FCIAT was calculated as 0.63. This test was performed as a post-test.

Process

In treatment groups, this study was carried out during four weeks (four hours per week) to order to teach the features and classifications of the invertebrate animals' phylum. The teaching in treatment groups was carried out by the author, a biology instructor. As indicated in Figure 1, the students in the subgroup were divided into five groups since invertebrate animals' phylum are divided into five subtopics: Modules A, B, C, D, and E. Each subtopic group consisted of five students. The students in each modules (subgroups) directly examined on diad animals belonging to that module in order to study.

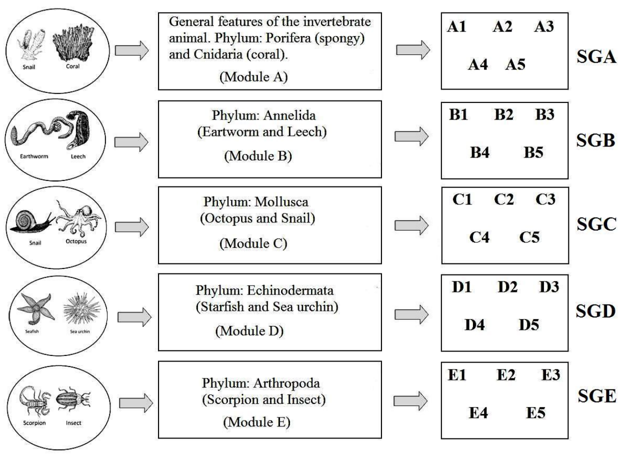

Figure1. Subtopics (modules) of the features and classifications of the invertebrate animals and subtopic groups representing these modules. Each phylum, A1, A2, A3, etc., stands for an individual student from the group.

These modules are described below:

- Subgroup A (SGA): The students in SGA prepared the characteristics of the invertebrate animal. Which characteristics (symmetry, segmentations, coelom, digestive systems, appendix, reproductive, habitat etc.) are used in the classification of animal? The students interpreted similarities and differenties of these structures among organisms in all modules. Phyla Porifera and Cnidaria (spongy, coral) were presented in the class (Module A).

- Subgroup B (SGB): The students in SGB prepared and presented Phylum Annelida. A few examples of the most well-known are: sand worm, leech, and earthworm (Module B).

- Subgroup C (SGC): The students in SGC prepared and presented Phylum Mollusca. A few examples of the most well-known are: octopus, squids, and small squids (Module C).

- Subgroup D (SGD): The students in SGD prepared and presented Phylum Echinodermata. A few examples of the most well-known are: starfish, brittle stars, sea cucumbers, and sea urchins (Module D).

- Subgroup E (SGE): The students in SGE prepared and presented Phylum Arthropoda. Insects (Classs Insecta). A few examples of the most-well known are: grasshoppers, houseflies. Arachnids (Class Arachnida). A few examples of the most well known are: scorpions, and spiders (Module E).

Each subgroup studied their subjects out of class. Subgroups made detailed research, discussed among themselves, and completed the shortcomings on their issues. Each group was then given 30 minutes to present their work in the class on samples representing each phylum. They examined the samples' anatomy (whether or not there was segmentation, symmetry, digestive, and excretory systems) and the morphological (whether or not there were body compartments, antenna articulated members, and the number of legs). Later, using these features, they tried to learn the properties of the appropriate phylum. Then, each group led a 20 minute discussion with the class. During the discussion time, the subgroup answered the class' questions. The subgroups then broke apart, like pieces of a jigsaw puzzle (Doymus, 2007; 2008; Goodwin et al., 1991), and students moved into unit groups consisting of members from the other subgroups who had been assigned the same portion of the material (Figure 2).

Following the presentation of all subtopics of the features and classification of the invertebrate animals one student from each subgroup was selected to form unit groups, UG1, UG2, UG3, UG4, and UG5, as illustrated in Figure 2. In these unit groups, the members were asked to familiarize themselves with their subtopics.

Then, each unit group worked with their respective modules. After studying each module, students were enrolled in the test only related to that module.

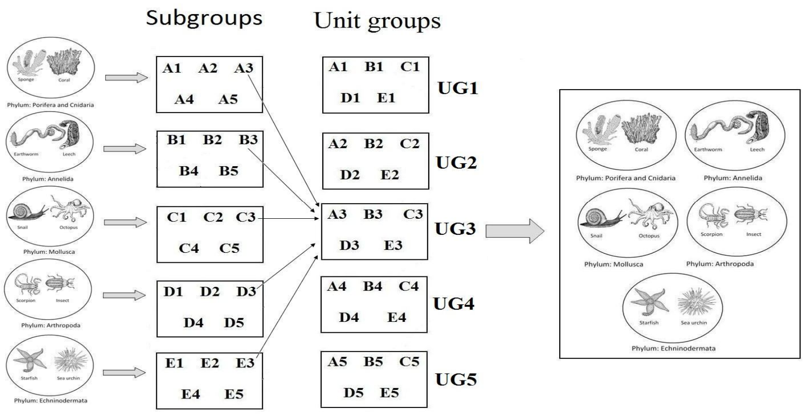

Figure 2. Formation of the unit groups from the subgroups.

In the CG, the subjects of the features and classification of the invertebrate animals were taught by a researcher using teacher centered methods. The researcher explained each module in the classroom and displayed the topics on the slide. Students then examined the animals for each module. After studying each module, students enrolled in the test only related to that module. Once the teaching was completed on the subjects of the features and classification of the invertebrate animals over four weeks, the FCIAT was applied to both the jigsaw and controlgroups as a post-test. Following the presentation of the subjects, the data obtained was evaluated using SPSS 18 and according to significance level $p<0.05$.

Results and Discussion

The tests' scores obtained from the BICIT, FCIAT, and MT were compared by the use of Independent t test. Also, students' responses to the open ended questions of all modules were qualitatively analysed. All the students' responses were gathered and summarized in tables by the researcher. The data obtained from module tests are given in the Table 1.

Table1. Results of independent sample t test analysis of multiple-choice questions of all modules.

	Group	**N**	**Mean**[a]	***SD***	***t***	**p**
Module A	JG	25	14.00	6.61	5.641	0.000
	CG	41	6.00	4.90		
Module B	JG	25	23.80	5.64	-3.809	0.000
	CG	41	17.93	6.32		
Module C	JG	25	18.60	5.50	7.025	0.000
	CG	41	9.27	5.07		
Module D	JG	25	12.20	5.42	-3.724	0.000
	CG	41	7.80	5.01		
Module E	JG	25	19.80	6.21	-4.325	0.000
	CG	41	13.12	5.96		

[a]Maximum score for each module= 30

Test's scores in Table 1 indicate that there are statistically significant differences between jigsaw and control groups (Module A: $t_{(64)}$ = 5.641; p= 0.000; Module B: $t_{(64)}$ = -3.809, p= 0.000; Module C: $t_{(64)}$=7.025, p =0.000; Module D: $t_{(64)}$= -3.724, p= 0.000; Module E: $t_{(64)}$= -4.325, p= 0.000). Achievement in the JG is higher than that in the CG in all modules. But, achievement scores of the both groups in module B (annelids) and E (insects) are higher than the others (A,C,D), because they belong in terresrial environments. Accordingly, students may be less familiar with marine forms such as sponges, corals, octopus etc. These results are supported by previous findings abouth lesser-known taxa (Snaddon and Turner, 2007; Yorek et al., 2009). The data obtained from BCIT and FCIAT are provided in Table 2.

Table 2. Results of independent sample t test analysis of BCIT and FCIAT.

	Group	N	Mean[a]	*SD*	*t*	p
BCIT	JG	25	57.12	19.58	-0.517	0.607
	CG	41	59.46	16.73		
FCIAT	JG	25	64.24	10.08	3.374	0.001
	CG	41	52.28	19.12		

[a]Maximum score= 100

BCIT, provided in Table 2, demonsrated that there is no a statistically significant difference between groups ($t_{(64)}$=-0.517; p= 0.67). This shows that the levels of prior knowledge of the general biology of both groups are the same. In this table, there is a statistically significant difference between two groups, according to the results of FCIAT ($t_{(64)}$=3.374; P=0.000). Thus, it is understood that JG was more successful than CG, according to mean value (Mean JG=64.24; Mean CG= 52.28).

On the other hand, open-ended questions on the MT were qualitatively evaluated, and the results are shown below in each module, respectively.

Module A

For Module A, Table 1 shows that there is a statistically significant difference between the two groups with respect to achievement scores (t = 5.641; p = .001). Achievement in the JG is higher than that in the CG. Students' responses in both groups to the open-ended question of this module are presented as qualitative data. 4% of the students in the JG had no response, 12% of those gave complete response, 64% of those drew only a shape of spongy, 20% of those both drew a shape and wrote a description of spongy to this module. The structures named from the most to the least by the students in the JG as such: osculum, ostium (por), coanisit, mezoglea (mezoderm), ectoderm and endoderm etc. 34% of the students in the CG had no response, 34% of those both drew and named a part of the general shape of spongy, 32% of those drew only a part of the general shape of spongy to this module. The structures named from the most to the least by the students in the CG as follows: water intake, water outlet, coanosit, spicules (skeletal elements), pores etc. The correct answers that the students in both the CG and JG gave to the multiple-choice questions for Module A are consistent with the correct answers given to the open-ended question for this module. Relating to 'porifera and cnidaria' concepts, students have difficulty in learning spongy and coral. This indicates that the students holding this idea have difficulty in understanding these phylums. The results obtained in Module A are consistent with those of previous studies (Reiss and Tunnicliffe, 2001; Prokop, et al., 2008; Prokop et al., 2009a).

Module B

Students' responses in both groups to the open-ended question in Module C are presented in Table 3.

Table 3. Students' responses tothe open-endedquestionin theModuleB.

Students' opinions (JG, n=25)	%
*When contraction of the ring muscles has caused prolongation of the body by appliying with pressure to fluid in the coelom, contraction of the longitudinal muscle is shortened in length. Peristaltic movement facilitates the digestion, blood circulation and excretory systems.	80
-Ring structure minimizes the water loss.	4
-Others incorrect answers	16
Students' opinions (CG, n=41)	
* The rings of the annelids can easily move forward under the soil'	56
-Ring structure helps protect them from predators and capture prey	10
-Others incorrect answers	34

* Scientific opinions. Each student has one or more replies.

For module B, Table 1 shows that there is a statistically significant difference between the two groups with respect to achievement scores ($t_{(64)}$= -3.809; p = 0.000). Students' responses in both groups to the open-ended question in Module B are presented in Table 3. This question was answered correctly by 80% of the students in the jigsaw group and by 56% of those in the control group. The control group responded 'The rings of the annelids can easily move forward under the soil', while the jigsaw group answered 'When contraction of the ring muscles has caused prolongation of the body by appliying pressure to the fluid in the coelom, contraction of the longitudinal muscle is shortened in length. Peristaltic movement facilitates the digestion, blood circulation and excretory system. Answers given by the JG is more scientific and descriptive than those by the CG. It may be concluded that they have not experienced these concepts (e.g. their digestive, circulatory, and nerve systems, common characters, and role in ecosystems) in daily life, even though earthworms are familiar animals to humans. Our results are consistent with those of previous studies (Prokop et al., 2007b).

Module C

Students' responses in both groups to the open-ended question in Module C are presented in Table 4.

Table 4. Students' responses tothe open-endedquestion in the Module C.

Students' opinions (JG, n=25)	%
* Torsion is a phenomenom characteristic to snails, where the visceral mass of the animal rotates 180° to one side during development, such that the anus is situated more or less above the mouth.	72
-Can be seen in all mollusks, hydra, sponges, coral and arthropoda.	28
Students' opinions (CG, n=41)	
* Can be seen in snails. Because the digestive tract rotates 180° to one side during development, anus is placed above the mouth.	40
- Can be seen in all mollusks, Water flow in through channels is called as torsion.	60

* Scientific opinions. Each student has one or more replies.

For module C, Table 1 shows that there is a statistically significant difference between the control and jigsaw groups with respect to achievement scores ($t_{(64)}$= 7.025; p = 0.000).

Achievement in the jigsaw group is higher than that in the CG. Some written responses in both groups to the open-ended question for this module are shown in Table 4. This question was answered correctly by 72% of the students in the JG and by 40% of those in the CG. The jigsaw group responded ' Torsion is a characteristic phenomenom to snails, where the visceral mass of the animal rotates 180° to one side during development, such that the anus is situated more or less above the mouth', while the control group answered ' Seen in snails. Because the digestive tract rotates 180° to one side during development, anus is placed above the mouth'. The correct answers that the students in both the control group and jigsaw group gave to the multiple-choice questions for Module C are consistent with the correct answers given to the open-ended question for this module. On the other hand, although the response ratio of the students in the JG is higher than in the CG, the average scores of both groups are lower than in other modules. Some of the reasons for this difficulty could be: lack of encountering this information before, lack of knowledge of some animals due to their terrestrial environment or countries belong to in different geographical zones, social and cultural differences, personal experiences with consuming foods and also some prejudices of the pupils (fear, aversion, dislike, disease, disgust, infection etc.). This shows that the students holding this idea have difficulty in understanding the mollusks.The results obtained Module C are consistent with those of previous studies(Randler, 2008; Prokop et al., 2011; Prokop and Tunnicliffe, 2008; Tunnicliffe et al., 2008; Zoldosova and Prokop, 2006).

Module D

Students' responses in both groups to the open-ended question in Module D are presented in Table 5.

Tablo 5. Students' responses tothe open-endedquestion in the Module D.

Students' opinions (JG, n=25)	%
* Water vascular system has a role in movement of the body. Water flows in through the madreporite, down through the stone canal, into the ring canal around the mouth, out to arms via radial canals, and into ampullae and tube feet, respectively. Water of ampullae causes pressure for the foot to extend.	77
- Water flows in through madreporite, into the stomach, out the anus, respectively.	23
Students' opinions (CG, n=41)	
* Water entering from madropor passes to through the stone canal. Taking water in causes the hydrostatic pressure that extendents the tube feet and the animal progresses in this way.	25
- This system operates by osmotic pressure.	75
* Scientific opinions. Each student has one or more replies.	

For Module D, Table 1 shows that there is a statistically significant difference between the control and jigsaw groups with respect to achievement scores ($t_{(64)}$= -3.724; p = 0.000). Achievement in the JG is higher than that in the CG. Students' responses in both groups to the open-ended question of this module are presented in Table 5. This question was answered correctly by 77% of the students in the JG and by 25% of those in the CG. JG students in this study stated that 'Water vascular system has a role in movement of the body. Water flows in through the madreporite, down through the stone canal, into the ring canal around the mouth, out to arms via radial canals, and into ampullae and tube feet, respectively. Water of ampullae causes pressure for the foot to extend'. The success of the students in the JG obtained from the multiple-choice questions for Module D is mirrored by the correct answers given to the open-ended question for this module. Relating to ‘echinoderms’ concepts, students have difficulty learning echinoderms and the parts of their body. Control students in this study stated that ‘Water entering from madropor passes through the stone canal’ and ‘Taking water in causes the hydrostatic pressure that extends the tube feet and the animal progresses in this way’. Although people are familiar with some echinoderms such as sea stars, sea urchins, etc., they have no knowledge about the anatomy of these animals. It may be concluded that echinoderms have little value to humans as food, but have some economic value when sold in aquariums. The responds to open-ended question supports the test results. The results obtained Module D are consistent with those of previous studies (Prokop et al., 2008; Prokop et al.,2009a).

Modul E

The students’ responses to the open-ended question in the module E of both JG and CG students are given in the Table 6.

Table 6. Students’ responses tothe open-endedquestion in the Module E.

Students’ opinions (JG, n=25)	%
*The body of a scorpion is divided into prosoma, mesosoma and metasoma, respectively. The prosoma has a pair of chelicerae, pedipalp and four pairs of the walking legs. The mesosoma has no appendages. The metasoma has 5 segments and the anus is in front of the terminal sting.	82
-Body is divided into head, thorax and abdomen.	7
-Others incorrect answers	11
Students’ opinions (CG, n=41)	
*Scorpions have pincers, 4 pairs of walking legs, and no antenna. The last region of the body has 5-segments and a poison needle is in last segment.	58
! The body is divided into three sections.	15
-The body is divided into three segments: the cephalon, thorax and abdomen.	9
-Others incorrect answers	18

* Scientific opinions. Each student has one or more replies.

In this module, the students examined a beetle (insect) and a scorpion (archnids). For Module E, Table 1 shows that there is a statistically significant difference between the two groups with respect to achievement scores ($t(64) = -4.325$; $p = 0.000$). Achievement in the JG is higher than that in the CG. Students’ responses in both groups to the open-ended question of this module are presented in Table 6. This question was answered correctly by 82% of the students in the JG and by 58% of those in the CG. The correct answers that the students in both the CG and JG gave to the multiple-choice questions for Module E are consistent with the correct answers given to the open-ended question for this module. The jigsaw group answered ‘The body of a scorpion is divided into prosoma, mesosoma and metasoma, respectively. The prosoma has a pair of chelicerae, pedipalp and four pairs of walking legs. The mesosoma has no appendages. The metasoma has 5 segments and the anus is in front of the terminal sting’. Control students in this study stated that ‘Scorpions have pincers, 4 pairs of walking legs, and no antenna. The last region of the body has 5 segments and a poison needle is last segment’. Additionally, some of them stated that ‘‘The body is divided into three parts’’. But, scorpions are diffrent from insects according to body regions. While both animals have three body parts, scorpions have prosoma, mesososma, and metasoma, and insects have cephalon (head), thorax (chest), and abdomen. As a result, it is seen that the response ratio of the students in the JG is higher than in the CG, the percentages of both groups to respond to this question are quite high, according to other modules. Although most invertebrates are small and behaviourally and morphologically unfamiliar to humans (Davey, 1994; Prokop et al., 2011), arthropods include well-known animals such as the butterfly, fly, mosquito, spider etc. Scorpiones are generally considered very dangerous and most people have fear them. This may cause people to wonder about them. For these reasons, the rates of the students' responses in both groups to the open-ended question of this module may have increased. Relating to concepts of ''arthropods'', students have no difficulty learning about arthropods. And despite the great significance of the arthropods phylum, few studies have examined childrens' biological perception about them (Jambria et al., 2010; Prokop et al., 2008; Prokop et al., 2009a; Shepardson, 2002). The responds to open-ended question supports the test results.

Conclusion

This research investigated the effects of subject jigsaw cooperative learning supported laboratory activities on student learning. The goal was to understand how to foster better understanding of the principles of the taxonomy and classification in biology; Specifically, the following subtopics of the invertebrates animals' classification were investigated: pyhla porifera, cnidaria, annelida, arthropoda, mollusca, echinodermata. What are the main outcomes of this new approach?, What is the effectiveness of this new learning approach?'

In summary, our new approach is considered to be a system with different stages and goals. That the cooperative groups form from both students and topics processed has brought a new learning perspective. Classification of the invertebrate animals can be taught to students in a practical way in a course. This is very important, because it serves as a feedback input that keeps the process on the right track.

BCIT describes the findings about the students' underlying conceptions related to biology topics before formal instruction in courses. This test's scores indicate that there are no statistically significant differences between the students in the jigsaw and control groups. FCIAT, after jigsaw cooperative learning and teacher centered learning studies, was applied to the research groups as the post-test to compare the academic success of the students in the biology laboratory course. This test's scores indicate that there are statistically significant differences between the students in the jigsaw and control groups. The reason for the jigsaw group's having greater success than the control group in the classification of the invertebrates may have been the fact that the students, having experienced the learning processes themselves, formed real learning experiences since they applied the jigsaw technique themselves, researching and discussing the topics in depth. In many studies, it was determined that cooperative learning methods increase academic achievements and desire to learn (Akcay et al., 2012; Looi et al., 2010; Sezek, 2012).

The evaluation of the answers to the open-ended questions for each module showed that the jigsaw method (subject jigsaw) is an active method for improving students' understanding of the subject. Because, it can be said that students' own effort and discussion with friends about these topics is more effective than lectures by teachers. In the group, there is no authority, which means that everyone is equal: they work while learning, and teach and assess each other equally. From the cognitive perspective, students learn from each other because in their discussions of the content, cognitive conflicts arise, inadequate reasoning is exposed, and an enriched understanding eventually emerges. High level discussions and interactions also lead to better conceptual understanding (Springer et al., 1999). For example, in our observations, students are stimulated to think for themselves and during discussions they begin to think and organise their minds in order to do their work. They may also clarify and better understand the underlying theory after discussion or even argue with each other, but will finally come to a consensus (Yi and LuXi, 2012). On the other hand, the teacher is less able to devote time to each student during the individual learning in contrast to the students' attention to each other in the cooperative group (Sezek, 2012).

The main reasons for increasing success are that in the jigsaw group' the students present samples of each module, and that this approach gave an opportunity to examine on the samples. Thus, instead of memorizing, the students immediately learned by applying their knowledge. Additionally, it is reported that students with reported direct experiences with animals were more willing to learn about them than students without reported direct experiences. these experiences contribute the most to the high overall average (Prokop et al., 2009b; Tomažič, 2011). Accordingly, the students in the JG are more succesful with both the multiple-choice and the open-ended questions in the modules (Table 3-6).

Biology issues are difficult to teach and to learn. So, teaching using a modular basis rather than using a complete subject may be more appropriate for students. The students can learn better, because of issues confined and divided into subtopics. This approach also eliminates or minimizes the students' complaints. Additionally, we think that activities with classification and taxonomy through jigsaw cooperative learning have significant potential for improving pupils' knowledge about systematics topics in biology education. The results of this study provide a starting point for further research and for building curricular continuity and progression based on children's ideas and the scientific understanding of classification.

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