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Prospective Teachers' Perceptions on Protein Synthesis: Recommended Solutions versus Learning Difficulty

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Abstract

Protein synthesis is a difficult topic to learn among students and teachers in literature. Also detailed research has not been found about the cause and nature of the difficulties encountered in the learning and teaching of this subject. From this point of view, the purpose of this study is to determine the reasons for the learning difficulties that the prospective biology teachers experienced in protein synthesis and the suggested solutions from the perspective of the prospective biology teachers. The sample was 42 fourth grade prospective teachers who attend to department of biology education at Kazim Karabekir Faculty of Education at Ataturk University in Turkey. In this study, using qualitative research method, prospective teachers were asked to response two open-ended questions. (1) What are the factors that cause you to be forced to learn protein synthesis? (2) What do you recommend to come up with these difficulties? According to the findings obtained the variables affecting the prospective teachers' learning include classroom settings, textbook, teacher, student and subject. In addition, the findings also indicate that solutions recommended by prospective teachers included in the variables related to classroom setting, textbook, teacher and teaching process.

Keywords: Protein synthesis, prospective biology teachers, learning difficulties, solutions.

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Öğretmen Adaylarının Protein Sentezine Yönelik Algıları: Öğrenme Güçlüğüne Karşı Önerilen Çözümler

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Öz

Protein sentezi öğrenci ve öğretmenler arasında öğrenme güçlüğü çekilen konular arasındadır. Bununla beraber bu konunun öğrenimi ve öğretiminde karşılaşılan zorlukların nedeni ve doğasına yönelik detaylı bir araştırmaya rastlanılmamıştır. Buradan hareketle bu çalışmanın amacı biyoloji öğretmen adaylarının protein sentezi konusunda karşılaştıkları öğrenme güçlüklerinin nedenleri ve önerilen çözümleri öğretmen adaylarının bakış açısıyla saptamaktır. Çalışmanın örneklemi Türkiye'de Atatürk Üniversitesi, Kazım Karabekir Eğitim Fakültesi, Biyoloji Eğitimi A.B.D.' nda öğrenim gören 42 dördüncü sınıf öğretmen adayı oluşturmaktadır. Nitel araştırma yönteminin kullanıldığı bu çalışmada öğretmen adaylarına iki açık uçlu soru sorulmuştur: (1) Protein sentezini öğrenmenizde zorlanmanıza sebep olan faktörler nelerdir? (2) Bu zorlukların üstesinden gelmek için neler tavsiye edersiniz? Elde edilen bulgulara göre öğretmen adaylarının öğrenmede güçlük çekmesine sebep olan faktörler arasında sınıf ortamı, ders kitabı, öğretmen, öğrenci ve konu yer almaktadır. Bununla beraber öğretmen adaylarının bu sorunları gidermede önerdikleri çözümler içerisinde de sınıf ortamı, ders kitabı, öğretmen ve öğretim sürecine ilişkin değişkenlerden kaynaklanan sorunların düzeltilmesi ile mümkün olabileceğini belirtmişlerdir.

Anahtar kelimeler: Protein sentezi, biyoloji öğretmen adayları, öğrenme güçlüğü, çözümler.

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1. Introduction

Biology is a subject that is difficult for students to learn and for teachers to teach. For example, many researches regarding to the biology in literature have foundlearning difficulties and misconceptions in biology topics such as photosynthesis, osmosis-diffusion, cell divisions, ecology, evolution, body systems and genetics (Özay and Öztaş, 2003; Öztas, Özay, and Öztas, 2003).

The difficulty might be caused by a lot of factors such as misconceptions, teachers, student's background, lack of resources, difficulty in finding relation between biology topics and the nature of the topic in general etc. (Diki, 2013; Sozbilir, 2004). Because many of the topics covered by biology are abstract, it is difficult for students to perceive and understand it. Similarly, because protein synthesis involves some unobserved and independent mechanisms, it is a difficult subject to be understood by students (Lewis and Wood-Robinson, 2000).

Protein synthesis is traditionally taught in a lot of biology courses at undergraduate level in Turkey. The subject is discussed in a variety of courses such as introduction to biology, molecular biology, sitology, genetics, biochemistry etc. For teaching such a subject as protein synthesis which is difficult to learn, it is very important to place the activities which help students to comprehend events in their minds. It is also important to avoid them from using only traditional methods in teaching process (Öz-Aydin, Şahin-Pekmez, and Sicaker, 2014).

Protein synthesis is rich in terminology, but not all terms are necessary for adequate understanding. Furthermore, students are unwilling to memorize relevant terms. In addition, teachers and authors of curriculum materials do not always use terms consistently and explicitly. However, many students in biology classes are often overwhelmed by the terminology (what is a gene, base triplet, codon, and anticodon), its process (why does it happen in two steps, one in the nucleus and one in the cytoplasm), and the complex interrelationship between the nucleic acids (rRNA, mRNA, tRNA, and DNA) during transcription and translation (Sturges, Maurer and Cole, 2009). Students often have difficulty conceptualizing transcription, translation and gene expression (via protein synthesis) (Canal, 1999; Fisher, 1985, Lazarowitz and Penso, 1992; Rode, 1995; Sprehn, 1993; Templin and Fetters, 2002; Venville, Gribble and Donovan, 2005). But, protein synthesis is discussed somewhat with a general approach in a lot of studies. In addition, there aren't any researches specifically addressing factors lead to a more effective learning and teaching of protein synthesis.

As a result, although protein synthesis has been determined as a difficult topic to be learned among students or teachers, the nature and the cause of learning and teaching difficulties in this topic have not been investigated. Therefore, the purpose of this study is to determine the reasons of learning difficulties that the prospective biology teachers experienced in protein synthesis and recommend solutions from the perspective of prospective biology teachers. With this purpose, this study was designed to answer the following research questions:

1) What are the factors that cause you to be forced to learn protein synthesis?

2) What do you recommend to come up with these difficulties about protein synthesis?

2. Method

2.1. Research Design

The research, which is based a qualitative research design, was used content analysis. Content analysis extends far beyond simple word counts, however. What makes the technique particularly rich and meaningful is its reliance on coding and categorizing of the data (Stemler, 2001).

2.2. Study Group

The participants were totally 42 (32 female and 10 male) fourth grade prospective teachers who attended to department of biology education at Ataturk University in Turkey. The prospective teachers' average age was 22. The selection criteria of the participants were the following: they should be attended to biology course rather than science education. It was considered that these participants were more or less familiar the subject of protein synthesis. Another criterion was to select the study group from the prospective teachers because of the fact that they were considered to have a deeper understanding about the problems encountered during teaching and learning of this subject. For these reasons, prospective teachers were asked to response two open-ended questions towards the purpose of the research.

2.3. Data Collection and Analysis

Content analysis is especially useful for tabulating the results of open-ended survey questions and multiple interviews. In this perspective, the qualitative data obtained from the prospective teachers' written responses were analyzed via content analysis and the findings were summarized by using the descriptive statistics.

In the research, the authors worked together for coding of participants' responses that were to undergo descriptive content analysis process. Thus, main themes and sub-themes were identified by examining the responses one by one. And then, identified main themes and sub-themes that were reviewed with all aspects in detail were coded. After determining main and sub-themes, in order to provide the reliability of research, both researchers selected a response paper from each of the determined main themes randomly and examined them individually. Based on the self-identification of the researchers, the data were compared and researchers were found to be unanimous for majority of examined papers. In case of any inconsistency, the response papers were reviewed by researchers together and the inconsistencies were resolved. At the end of both researchers' controls, responses were tallied and finally similar themes/categories were combined and the final categorization was made and percentages were calculated. The prospective teachers' perceptions were then conveyed in diagrammatic representations, including the percentages. Perceptions of learning difficulties were categorized as classroom setting, textbook, teacher, student and subject (Figure 1) and also recommended solutions were categorized as classroom setting, textbook, teacher, teaching process (Figure 2).

3. Findings and Discussion

The research questions in the study investigates the learning difficulties perceived and solutions recommended by prospective biology teachers towards protein synthesis. Therefore, the findings were analyzed separately according to the research questions and were summarized in Figures 1 and 2.

3.1. The findings for the first research question

As shown in Figure 1, totally five main themes were determined related to learning difficulties.

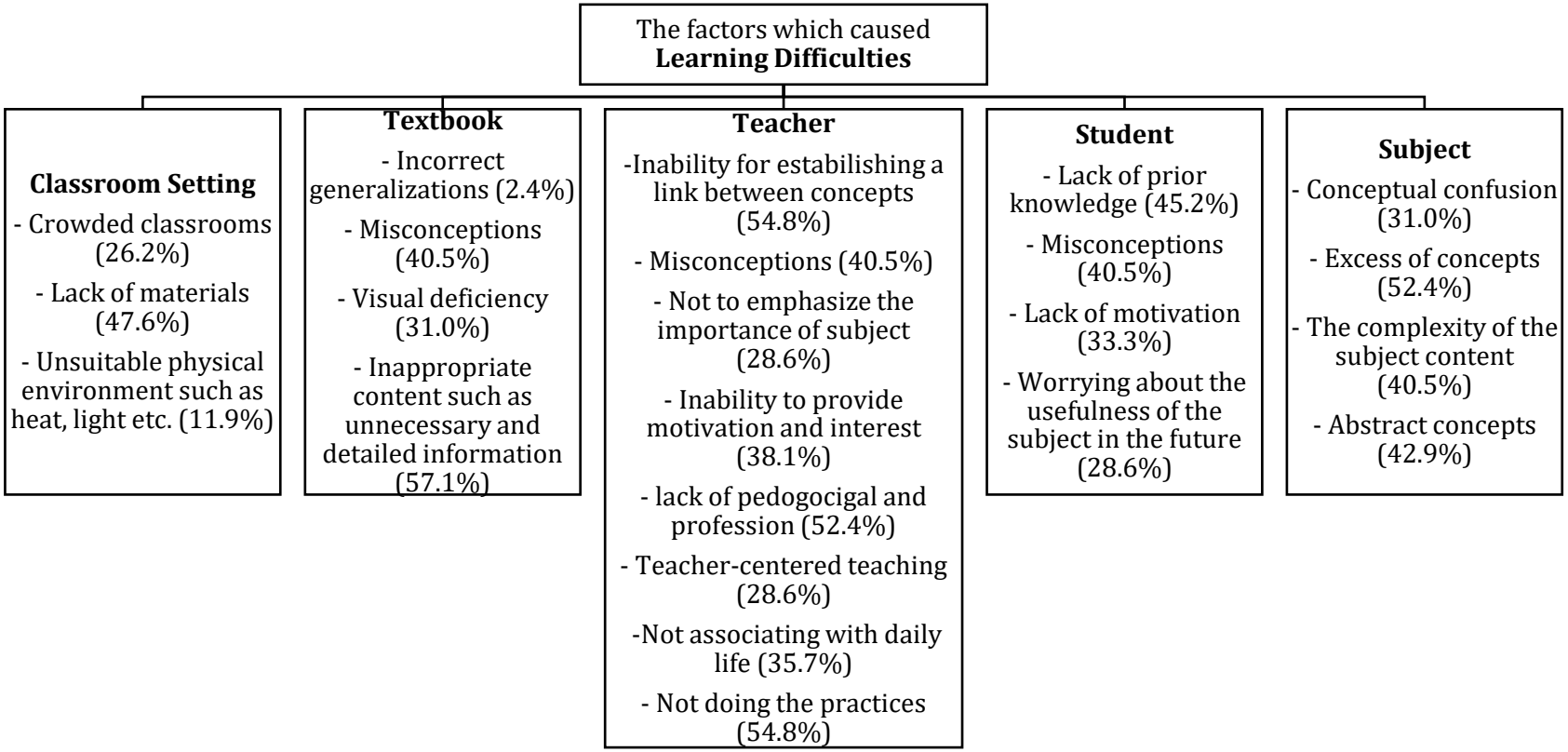

Figure 1. The factors which caused learning difficulties

As can be seen from Figure 1, totally five themes determined related to the factors which caused learning difficulties (classroom setting, textbook, teacher, student and subject). The most frequently stated learning difficulties as classroom setting were 'Lack of materials (47.6%)', followed by 'Crowded classrooms (26.2%)'. As textbook, 'Inappropriate content such as unnecessary and detailed information (57.1%)' was in the first place and it was followed 'Misconceptions (41.5%)' and 'Visual deficiency (31.0%)'. Figure 1 also indicated that most learning difficulty comes from teacher and a significant percentage of them was 'Inability for establishing a link between concepts (54.8%)', 'Not doing the practices (54.8%)', 'Lack of pedagogical and profession (52.4%)', 'Misconceptions (40.5%)', 'Inability to provide motivation and interest (38.1%)' and 'Not associating with daily life (35.7%)' respectively. Similarly, investigating theme "student" in detail, it seemed that 'Lack of prior knowledge (45.2%)' and 'Misconceptions (40.5%)' have been mostly stated factors caused learning difficulties. Moreover, 'Lack of motivation (33.3%)' had a significant percentage. In addition, the findings from Figure 1 indicated that the most frequently stated learning difficulties as subject were 'Excess of concepts (52.4%)' and it was followed by 'Abstract concepts (42.9%)', 'the complexity of the subject content (40.5%)' and 'Conceptual confusion (31.0%)' respectively.

As can be seen from Figure 1, it has been found out that the least stated factors caused learning difficulties were 'Unsuitable physical environment such as heat, light etc. (11.9%)' and 'Incorrect generalizations (2.4%)'.

3.2. The findings for the second research question

As shown in Figure 2, totally four main themes (classroom setting, textbook, teacher and teching process) were determined related to the recommended solutions for overcoming the learning difficulties.

When the analysis results were examined, it was observed that, the most frequently recommended solution as classroom setting were 'Supply of materials (23.8%)', followed by 'Segmenting of overcrowded classrooms (14.3%)' and 'Improving the environment (11.9%)' respectively. The findings related to textbook, 'Removal of detailed and unnecessary imformation (57.1%)' was in the first place and it was followed 'To increase the number of image (31.0%)', 'Hierarchical presentation of the subjects (28.6%)' and 'To be interesting (11.9%)'. The findings also indicated that theme "teacher" had an important percentage. As related to teacher, the participants suggested that it is mostly important that the teacher should make student-centered teaching (28.6%) and also take into account individual differences (21.4%). Similarly, investigating theme "teaching process" in detail, it seemed that 'Usage of role-playing activities (61.9%)', 'Usage of materials (54.8%)', 'Usage of instructional technology (38.1%)', 'Usage of experiment, laboratory application etc. activities (38.1%)', 'Associating with daily life (35.7%)' and 'Usage of concept map (35.7%)' have been mostly the recommended solutions for overcoming the learning difficulties, respectively. Moreover, 'Usage of analogy (11.9%)' and 'Homework (11.9%)' had a considerable percentage. In addition, the findings from Figure 2 indicated that the least recommended solutions were 'Emphasize the important concepts (7.1%)', 'Self-development in terms of profession and pedogogical aspects (7.1%)' and 'Emphasizing the importance of subjects (7.1%)', respectively.

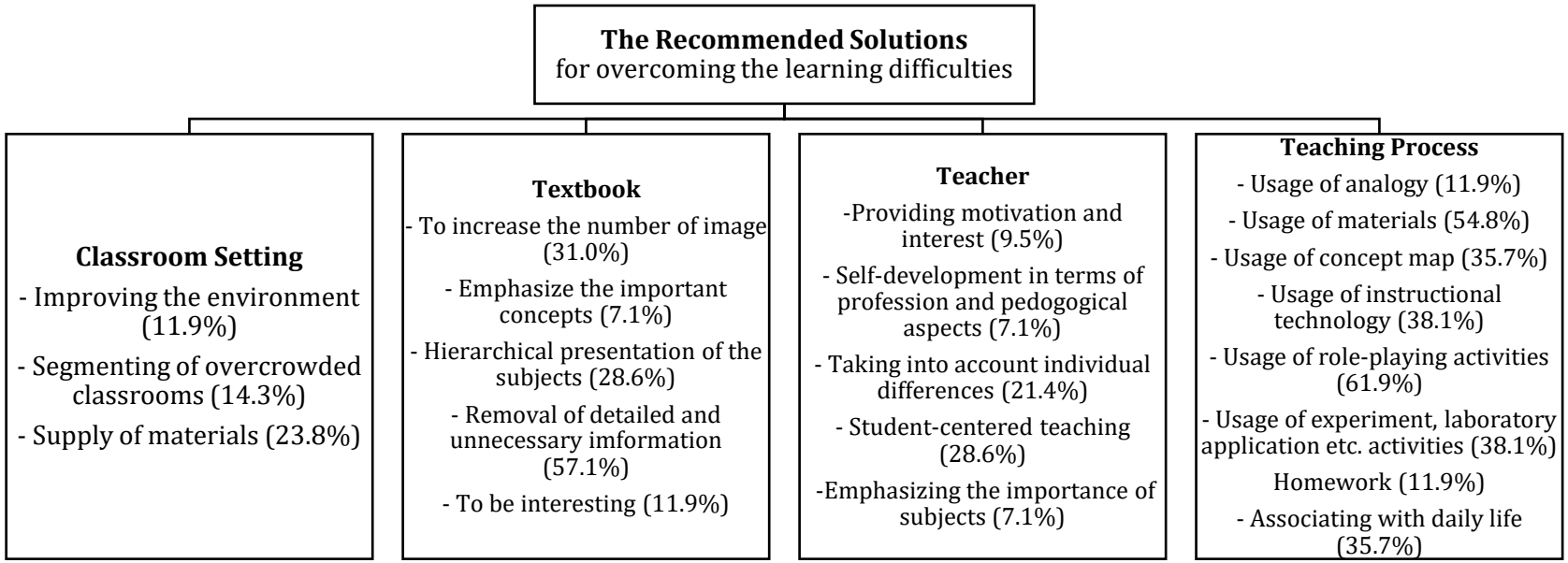

Figure 2. The recommended solutions for the learning difficulties

When the findings in Figure 1 and Figure 2 are compared in general, it seems that although there were similar opinions between learning difficulties and recommended solutions in terms of "classroom settings", percentages of learning difficulties were more than recommended solutions. Difficulties and solutions about "classroom settings" occurred from same three factors. These factors were classrooms' quantity, physical environment and materials. When crowded classrooms were perceived 26.2% as difficulty, dividing overcrowded classrooms were perceived 14.3% as solution. When unsuitable physical environment were perceived 11.9% as difficulty, improving the physical environment were perceived 11.9% as solution. When lack of materials were perceived 47.6% as difficulty, supply of materials were perceived 23.8% as solution. As the most common difficulties for classroom settings were lack of materials (47.6%), crowded classrooms generally second (26.2%). Another problem was "insufficient physical environments", which was also related to lack of equipment (11.9%).

Previous studies show that teachers' perceived problems include lack of materials and crowded classes and teacher opinions suggest that crowded classes are still a reason why activities cannot be carried out effectively (Sozbilir, 2004; Yeşilyurt and Gül, 2009). Teachers state that they are faced with problems such as financial difficulties, crowded classrooms, lack of time, unstable (frequently changing) education programs, lack of function of Institution Responsible for Education Materials, insufficient materials and tools, lack of necessary laboratories and equipment etc. (Yildirim, 2008).

One of the main elements which will ensure efficiency in learning is the use of materials (Yalın, 2003). Use of materials in teaching might be identified best as the use of supporting elements which enrich the education and teaching setting, facilitate learning and concretize addressing the sense organs of the learner. Well-designed and structured teaching materials enrich the teaching process and increase the amount of learning. An answer for these difficulties occured might lie in financial difficulties faced by the school itself. Educational planning in Turkey has always been thought of in terms of quantitative growth which is usually above the financial capacity of the Government. It would be sensible to mention these problems together with financial resources allocated to education and rote learning because the Turkish education system is over-centralized and education in Turkey is financially supported with public resources. Although there are private teaching institutions with relatively low rates at every educational level, public finance is overwhelmingly dominant (Tural, 2002). Thus, it might be seen that the issues of crowded classrooms and lack of materials still remain over the years as primary problems.

In this study, difficulties about "textbooks" occured from incorrect generalizations (2.4%), misconceptions (40.5%), visual deficiency (31.0%) and inappropriate content such as unnecessary and detailed information (57.1%). Solutions about "textbooks" occured from increase the number of image (31.0%), emphasize the important concepts (7.1%), hierarchical presentation of the subjects (28.6%), and removal of detailed and unnecessary information (57.1%) and to be interesting (11.9%). This findings implied that students have difficulty in learning the content of science. A reason for this situation is information source. From studies investigating instruction in science classroom, research found that textbooks played a major role (Lloyd, 1990).

Textbooks as instructional material is a guide for teachers in topic selection and provide ways to teach those topics. Textbooks provide the learner the opportunity to consolidate his/her understanding independently of the teacher (Jones, 1997). The textbook for biology course is the

most consistently visible window on the biologist's profession. The textbook is the most significant tool an instructor has in teaching biology. And the biology textbook is a principal means by which the public learns of the progress, thoughts, and aspirations of the discipline called Biology (Blystone, 1987).

In this study, one of the most common difficulties for textbooks was misconceptions (40.5%). Students frequently demonstrate misconceptions of biological concepts that could be related to textbook design (Blystone, 1987). High school biology textbooks fail to make big ideas comprehensible and meaningful to students (Pozzer and Roth, 2003). Storey (1991) warn readers against believing what they read in science textbooks because of the large number of oversimplifications and outright errors they contains. It was determined that protein synthesis in biology textbooks is insufficient in respect of scientific content and visual presentation (Özay-Köse and Hasenekoğlu 2011).

When one of the most common difficulties for textbooks are visual deficiency (31.0%), one of the most common solutions about "textbooks" occur from increase the number of image (31.0%). It was concluded that biology textbook that was examined was inappropriate in respect to the visual presentations. It was recommended that visual presentations in Biology textbook should be improved, when textbook is analyzed in respect of visual presentations. Connected members were not used in visual presentation. Used members were not balanced and proportioned one another. Lack of harmony in following pictures was shown. These problems might make learning of students difficult (Özay and Hasenekoğlu, 2007). Today's textbooks use many types of visual aids that help teaching difficult scientific concepts. Unfortunately, most textbooks also include decorative color photographs and drawings for selling the book than for educating the students (Holliday, 1990). Similarly, science textbooks are the style of the encyclopedias and they sometimes include more foreign words than foreign language textbooks. It was found that about 2500 new terms were introduced in 6-9th grade science textbooks (Köseoğlu et al., 2003).

Regarding the factors which caused learning difficulties, the findings obtained in this study indicated that the majority of the prospective teachers stated their teachers didn't practice (54.8%) and teachers were insufficient to establish relations between concepts (54.8%). However, lack of pedagogical and profession (52.4%) and misconceptions (40.5%) were among the most important factors caused by prospective teachers. Inability to provide motivation and interest (38.1%), not associating with daily life (35.7%), not emphasizing the importance of subject (28.6%), and teacher-centered teaching (28.6%) were the other factors preventing prospective teachers from learning protein synthesis effectively. In parallel of these learning difficulties stated by prospective teachers, it was recommended by prospective teachers that the teachers took into account the individual differences (21.4%) and especially student-centered teaching (28.6%). Of course, teachers' teaching styles, teaching methods and techniques might be factors that affect students' learning in protein synthesis. Besides, it was defined that using only traditional methods in teaching causes the teaching process's not reaching the desired level of achievement and not practicing the conceptual learning enough (Öz-Aydın et al., 2014). These findings also indicated that in teaching of protein synthesis, teachers just talk and transfer theoretical or abstract knowledge and do not provide examples from daily life. In other words, the students could not understand why they were learning those topics or concepts in protein synthesis, as they could not relate them with their real lives. A lack of understanding the relationship between what was taught in the class and prospective teachers' daily lives makes

learning biology hard for prospective teachers (Çimer, 2012). On the other hand, misconceptions might originate from certain everyday experiences that were commonly shared by many students. It was also shown that teachers could have played a role in the formation of misconceptions held by their students. Therefore, to promote meaningful learning, appropriate methods must be found to eliminate or prevent misconceptions. Various instructional methods can be used for this purpose (Tekkaya, 2002). In addition, as stated by Dillon (2008), practical work might help students' learning through convincing them what they are being taught really exists or happens in the real world and also practical work can help students to understand concepts; it can also be a powerful motivational tool. Similarly, interest, attitude and motivation was identified as important for learning and academic performance (Prokop, Prokop, and Tunnicliffe, 2007); and also the difficulty made students less motivated to learn the subject (Diki, 2013). Therefore, increasing the students' interest and motivation may help teachers to teach more effectively.

One of the factors which cause learning difficulties was derived from "student". One of the most common difficulties derived from "student" was lack of prior knowledge (45.2%). It was followed by misconceptions (40.5%), lack of motivation (33.3%) and worrying about the usefulness of the subject in the future (28.6%). Solutions of these difficulties were teachers. According to data in this study, providing motivation and interest (9.5%), taking into account individual differences (21.4%), student-centered teaching (28.6%) and emphasizing the importance of subjects (7.1%) were among the solutions often recommended. The teacher should probe for potential misconceptions in the students. Teachers have been related to student outcomes such as achievement and motivation (Ross, 1992). However, protein synthesis is also one of the most difficult topics for both students and their teachers. Relevant prior knowledge and cognitive maturity is required for an adequate understanding of protein synthesis. Students may differ in these respects. In the undergraduate curriculum, human anatomy and physiology courses are traditionally taught using lectures. In these, students usually assume passive roles as listeners while the instructor gives the information. To help students become active, independent learners, instructors need to introduce active learning methods and reduce the use of passive lecture format (Sturges et al., 2009).

In this study, one of the most common difficulties towards "subject" was excess of concepts (%52.4). It was followed by abstract concepts (42.9%), the complexity of the subject content (40.5%), the excess of foreign concepts (31.0%) and conceptual confusion (31.0%) respectively. Examining generally these findings, it seems that prospective teachers focused on the concepts in protein synthesis in terms of learning difficulty. As stated by Anderson, Sheldon and Dubay (1990), biological subjects include many abstract concepts, events, topics and facts that students have to learn and this makes it difficult for students to learn. Similarly to Çimer (2012) emphasized that biology includes that there are a lot of concepts, various biological events that cannot be seen by the naked eye, some concepts are too abstract, and that there are a lot of foreign/Latin words. Moreover, as a discipline, biology encompasses a great deal of topics, concepts and issues that students have to learn.

Regarding the "teaching process", it was found out that the usage of role playing activities (61.9%) predominated within recommended solutions. In teaching of complex and difficult processes, one of the methods to concretize the subject is role playing. Role playing is the animation of characters' properties and feelings in the plays. Role playing provides an opportunity for "acting out" conflicts, collecting information about social issues, learning to take on the roles of others, and

improving students' social skills (Cherif and Somervill, 1995). It is worth mentioning that students in the study group also reported that the role play helped them to visualize the process of protein synthesis supporting a previous study (Stencel and Barkoff, 1993) showing that role play creates a mental picture of molecular or submicroscopic process and helps students link macroscopic with microscopic levels. This can be further enhanced by supplementing the role-play activity with a diagram that students can fill out to help with organization of concepts. Therefore, it is suggested that this method should be often used for teaching protein synthesis. In this study, the usage of materials (54.8%), instructional technology (38.1%), experiment or laboratory application etc. activities (38.1%), concept map (35.7%), analogy (11.9%) and associating with daily life (35.7%) were among the solutions often recommended to use in teaching process. The use of supporting materials, like model, graph, concept map, laboratory activities and, video and other technologies can be used to overcome these difficulties, unfortunately, those supporting materials are not always available in every school in the country (Diki, 2013; Öztaş et al., 2003). The usage of visual materials can helpful for students to understand abstract concepts, to provide channel of communication and strong verbal messages and memorable images in students' minds and materials and therefore they make lessons more interesting for students.

Teaching with visual materials can provide more concrete meaning to words, show connections and relationships among ideas explicitly, provide a useful channel of communication and strong verbal messages and memorable images in students' minds, and make lessons more interesting to students (Çimer, 2012). Similarly, analogies can play a central role in this restructuring of students' conceptual frameworks (Pittmann, 1999). In addition to materials, practical works such as laboratory activities may help students learning through convincing them what they are being taught really exists or happens in the real world (Dillon, 2008). Especially, while teaching protein synthesis which are difficult to learn and more molecular, it is quite important to give a place to the activities which help students to conceive events in their minds (Öz-aydın et al., 2014).

4. Conclusion and Suggestions

Possible sources of students' difficulties in learning may be attributed mainly to the biology curriculum, teaching-learning strategies, textbooks, and insufficient laboratory conditions and equipment. In addition, students' motivation and interest must be also taken into consideration (Tekkaya, Özkan, and Sungur, 2001).

This study was investigated the cause of learning difficulties experienced and solutions recommended by prospective biology teachers in protein synthesis subject. Protein synthesis can be thought as an important conceptual handicap for the students, which hinders a meaningful understanding of concepts dependent upon it. Therefore, determining students' perceptions and understandings may help their teachers organize biology courses which will probably better meet students' needs.

The findings from this study indicates that perceived difficulties and solutions quite similarly. Among the learning difficulties, there were classroom setting, textbook, teacher, student and subject, while recommended solutions were classroom setting-related, textbook-related, teacher-related, teaching process. The lack of materials in classroom setting-related difficulties was a common theme, solution of which was perceived as supply of materials. While the majority of the prospective teachers perceived difficulties are inappropriate content such as unnecessary and detailed information in textbook-related, the removal of detailed and unnecessary information

perceived as solution surprisingly. This study also indicated that the majority of the prospective teachers thought their teachers didn't practice and teachers were insufficient to establish relations between concepts in teacher-related difficulties. It was recommended by prospective teachers that the teachers should take into account the individual differences and student-centered teaching especially as solution. One of the most common difficulties towards subject were excess of concepts and it was followed by abstract concepts, the complexity of the subject content, the excess of foreign concepts and conceptual confusion respectively. Ayas, Çepni and Akdeniz (1993) stated that it was not possible to find the exact word giving the original meaning by emphasizing the richness of vocabulary in English language in compared to the Turkish. However, Penick (1995) suggested that students need to learn the concepts of biology, not the words.

Regarding the teaching process, it was found out that the usage of role playing activities predominated within recommended solutions. The usage of materials, instructional technology, experiment or laboratory application etc. activities, concept map, analogy and associating with daily life are among the solutions often recommended to use in teaching process. When the findings from this study are compared to previous studies (Bahar, Johnstone and Hansell, 1999; Prokop et al., 2007; Yeşilyurt and Gül, 2009), which generally account problems in biology courses, there seem the similarities in prospective teachers' perceptions about learning difficulties and solutions. For example, in a study by Tekkaya et al. (2001), it was founded that students had difficulties in learning same subjects and had no interest in the lesson because biology curriculum did not inc1ude subject matter relevant to daily life. Moreover, it was not interesting to the students, and it was hard to learn without a good sequence of the subjects to be learned in the curriculum. According to these findings, biology courses must be supported by qualified textbooks, instructional materials, laboratory sessions and observation and experiments that actively engage students in learning processes.

It is stated that overloaded biology curricula may not contribute to students' achievement and lead them to learn the material through memorization. This, of course, prevents meaningful learning. Designing learning environments while ignoring students' interests and expectations cause several learning problems as well as decreasing their interest in biology. One explanation for these reasoning difficulties may be the inappropriate manner in which the different levels of biological organization are taught to students (Çimer, 2012).

The use of visual and technological materials on the dynamic dimension of protein synthesis may be sufficient to increase the concrete learning. A symbolic means of representation reduce redundant terms in protein synthesis and greater emphasize on the significance.

Biology teachers should carefully screen the textbooks that will be used as reference materials during biology teaching. Teachers should be consult scientists, colleagues about failings and borderline cases. Teachers should then select science textbooks. Identified misconceptions and alternative conceptions should be brought the attention of students and teachers. Teachers, publishers, scientists and text' authors should be in communication.

Teacher education institutions should inform prospective teachers about textbook selection. Finally, biology learning is a fairly complex process and there are numerous factors that influence what we learn about protein synthesis. These factors should be remedied.

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