

## Perceptions of Prospective Biology Teachers on Importance and Difficulty of Organs as a School Subject

<sup>1</sup>Mustafa Serdar Koksall and <sup>2</sup>Osman Cimen

<sup>1</sup>Department of Elementary Education, Eregli Education Faculty, 67300, Karaelmas University, Zonguldak, Turkey

<sup>2</sup>Department of Secondary Education, Gazi Education Faculty, 06500, Gazi University, Ankara, Turkey

**Abstract:** Biology classes are the most important contexts for learning biology. In these contexts, teachers' affective perceptions are the most important factors for quality of learning due to their effects on choice of activities and assessment and on planning. In biology, systems and their organs are the important steps to understand biological organization. By considering importance and difficulty as the effective factors on components of "task value" as a motivational construct, this study aimed at examining the perceptions of prospective biology teachers on importance and difficulty of organs as a school subject and their criteria for ranking the organs in terms of importance and difficulty. The sample of the study included 65 participants in third, fourth and fifth grades of biology education department in Gazi University of Turkey. To collect the data, one ranking questionnaire prepared by researchers was used. The results of the study showed that the participants explained the heart, kidney, brain, spinal cord, cerebellum and liver as the most important and difficult whereas they determined nose, tongue, esophagus, large intestine and gallbladder as the least important and difficult subjects.

**Key words:** Prospective Biology Teacher • Task Value • Organs

### INTRODUCTION

Biology as a science has been providing many important innovations for our lives by studies in its basic disciplines; genetics, biotechnology, molecular biology, microbiology and biochemistry. With their famous studies such as cloning, gene transfer, prevention of microbial diseases and proteomics, these areas became popular and then entered into our daily life with some discussions on some issues such as ethical issues and side effects of genetic engineering products. With pros and cons, learning biology for daily life became a need in today's world. Biology learning includes understanding biological organization from molecules to ecosystems. To understand systems and their organs are one of the most important steps of learning the organization of life. So, to learn and teach organs as a school subject are important task for biology teachers.. Although learning and teaching biology begin at elementary grades, under the title of biology, they begin to occur in high school

years. Biology learning and teaching in high school includes many factors which are determinants of learning quality. These can be classified as affective and cognitive factors. For the cognitive domain, reasoning ability, information processing and academic achievement are among the most studied constructs [1-5]. Under the affective title, some well-defined constructs are included. Those among the most frequently emphasized factors of the affective domain in the science and biology education literature are attitude, self-efficacy, anxiety and motivation [4,6-11]. As an affective factor, giving more importance of motivation for science education over the other affective factors in science education was suggested by some researchers [6]. Motivational preparedness of prospective teachers as mediators of curriculum to teach and learn any subject matter of a curriculum and related perceptions on the subject matter are important to reach aims of a curriculum [12], because every curriculum is needed to be considered in instructional level and teachers are important actors in this level due to their decisions on

planning, developing principles and selecting materials [28].

There are many models for explaining motivational preparedness. But, one of the most studied model; expectancy-value model that accepts one individual as an active and rational decision maker might be a good reflective model for explaining the motivational situations of individuals who have been gaining, using and constructing knowledge for their daily lives by themselves [14]. The model states that individuals' choice, persistence and performance can be explained by their beliefs about how well they do task and how much they value task. The model claims that expectancies and values influence directly achievement choices, performance, effort and persistence [15]. In many studies, task value component of the model was showed to be positively correlated with the other important motivational constructs such as self-efficacy, intrinsic motivation, extrinsic motivation and control of learning beliefs [4, 16-19]. The correlational evidence gathered by these studies has been supporting the importance and predictive power of "task value" component of the model on motivational forces which can initiate and provide action on task. Wigfield and Eccles explained that the subcomponents of the "task value" were "importance", "utility" and "interest" (intrinsic value or attainment value) and "cost" [15]. The most studied factors are "importance", "utility" and "interest". They described the "importance" as the importance of doing well on a given task, "utility" as a degree of how a given task fit into an individual's future plans and "interest" as the enjoyment one gets from doing a given task. Some studies showed that utility and attainment value components can not be separated as different factors and it is more appropriate to consider them under the importance factor [19]. Similarly, the recently explained factor; difficulty of a task is also emphasized frequently in the literature of task value and to be effective on utility and attainment value components [21, 22]. Therefore, importance and difficulty were considered as powerful components of the task value in this study.

In Turkey, elementary science education curriculum was structured by focusing on constructivist approach and nowadays biology education curriculum has also been established by considering elementary education curriculum. Although every curriculum is prepared by focusing on content, philosophic approach, general framework and activities, teacher preparedness and perceptions are also needed to be considered as much as

content and other components of a curriculum. In fact, the first step to decide on the subjects of any curriculum is to ask teachers and to determine their situations for the subjects [13]. Moreover, every curriculum needs to be considered in instruction level to be successful. When considered at the beginning phase of the biology curriculum study in Turkey, to determine prospective teachers' motivational preparedness as main mediator of the curriculum is very important step to go further. The curriculum content studies and prospective teachers' perceptions on the content are always focus of the international science education community and data coming from different countries provide opportunity to synthesize knowledge structure of biology curriculums in the world and might provide a way for new reform studies in the other countries. Again, Turkish cultural context is very different from other countries due to its geographic importance as linking two continents and cultural regions as western and eastern. The data about importance and difficulty of organs subject might provide a baseline to the studies to be conducted in the other countries to find a cultural relatedness on science and biology education in Turkish context. Again, Turkey is a country which aimed at entering European Union and the country has been conducting many reforms in its educational system. In parallel, the main approaches used for curriculums are based on western models such as constructivist approach in spite of existence of eastern cultural structure in some parts of Turkey. The developments in Turkey are seriously followed by European countries. The aspect studied in this study is a partial reflection of previous curriculums, because the participants experienced the old content-dominated curriculums during their whole education processes. The study might also give a baseline for the comparisons in terms of changes to be made by authorities.

As the main point considered in this study, appropriate perception on subject matter knowledge for teaching is a clear requirement for teachers as mediators of curriculum [23]. Only measuring subject matter knowledge is not enough to conclude about the situations of prospective teachers to teach them, value given by the prospective teachers on subject matter should also be considered to examine teaching on any subject matter of curriculum [23]. High school biology lessons are unique contexts for application of curriculum. The organs as subject of biology curriculum have quality problems to learn such as lack of interest and understanding about the subject among high school and

undergraduate level students [25, 26]. In the contexts of biology lessons, teachers out of cognitive and affective factors are the most important factors for quality of learning due to their responsibilities on choice of activities and assessment and on planning. The value given to the subject by teachers will reflect his or her classroom practice and so, will be effective in learning of the students. Some of researchers also stated that ideas, beliefs on and values about the subject should be considered as an aspect like subject matter knowledge level for teachers [24]. Again, Turner-Bisset by citing Turner-Bisset' old study stated how prospective teachers' beliefs about the subject matter had an effect on their teaching [24]. Again, Wandersee et. al. stated that values and attitudes coming from our background affect our perceptions on what is possible, what is likely and what is impossible [12]. By considering importance of values on subject matter, it was thought that the most appropriate theoretical frame was expectancy-value theory to study on the subject, so, the theory was chosen for the purpose of the study.

In addition, international literature does not have enough study on the issue by considering expectancy-value theory. In parallel, Turkish literature does not also have any study on the subjects. Studies in both international and national literature focused on general science titles rather than considering narrower subject matter such as organs [26, 27]. By taking into account the current curriculum change, importance of values of teachers and lack of studies, the main research question for this study is "What are the prospective biology teachers' perceptions related to importance and difficulty of organs as a subject matter and their criteria for the different perceptions on organs?".

## MATERIAL AND METHODS

In this study, quantitative research approach and survey technique as data collection way were used.

**Participants:** The study was conducted with prospective biology teachers. It included 65 participants in third, fourth and fifth grades of biology education department in Gazi University of Turkey. These three grades were selected due to their experience with all of topics studied. The first and second graders were partially experienced about the topics. Distribution of the students across grades is about evenly with small difference in third grade as additional two individuals. The focus of the department is to provide education on teaching competencies for

secondary school biology and basic understandings and affective characteristics about biology education. Participants' age range is from 19 to 22. Fifteen of the participants were male whereas the others were female. The participation of the study was based on willingness. For the purpose of the study, all of 150 of the students enrolled in the program were asked to determine whether they were willing to participate to the study.

**Instruments:** To collect the data, one ranking questionnaire prepared by researchers was used. The organs stated in common secondary school biology books were used in the questionnaire. In Turkey, one curriculum and one book type with the same content are used for secondary biology education. Therefore, the content of this book to decide on selecting organs was used. The questionnaire included 21 organs' name as the topics of biology to be taught and learned. In the questionnaire, the students were asked to rank them by using "21" for the most important and the least difficult and 1 for the least important and for the most difficult topics. The numbers from 1 to 21 were used for only one time to rank organs. For instance; if you choose 1 for importance of one organ, you can not use the same number for importance of other organs. Then, they were asked to explain the criteria they used for ranking by giving them a blank place under the ranking table. In this situation, it was taught that more than one criterion might have been considered, so to ask about their criteria used during the ranking is more appropriate. All of the criteria used by prospective teacher are presented in Table 4. Therefore, they used the criteria to show their thinking about "importance" and "difficulty" of the topics.

**Analysis of the Data:** Data analysis was conducted by tallying the observations for each ranking unit (1, 2,... 20, 21). Then all of the frequencies for each unit of ranking were determined and 21 units were combined into three different categories as "Of little" for 1-7, "Moderately" for 8-14 and "Very" for 15-21 to each organ. Then, these categories were examined to conclude about the actual category of any organ in continuum beginning from 1 to 21. The combined frequencies were used to compare the perceptions of the prospective biology teachers on organs in terms of difficulty and importance. The organs with the highest frequency on the categories of both rankings were labeled and frequencies of the organs were underlined in the Table 1 and 2. The process of analysis can be illustrated by the following figure;

## Data Analysis Procedure

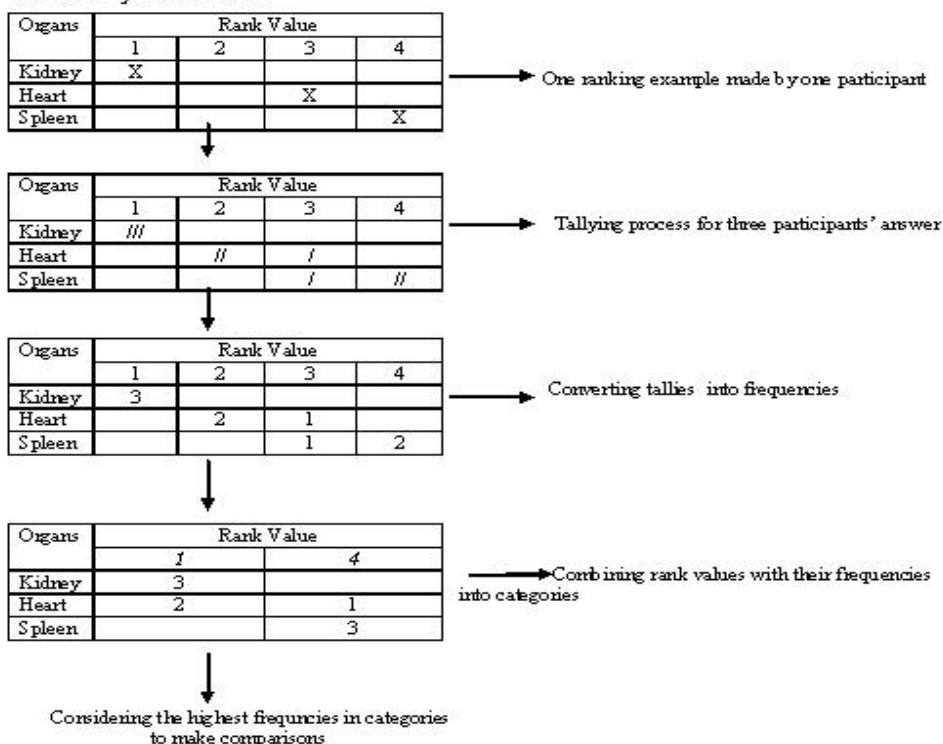


Fig. 1: Data analysis procedure

## RESULTS

Under this title, the results of the data analysis and criteria proposed by the participants will be presented.

As seen in Table 1, rankings of the participants showed a clear pattern about the importance of the organs. The organs of *Nose, Tongue, Esophagus, Large intestine, Spleen, Sex organs and Gallbladder* were ordered as the organs that had little importance whereas *Brain, Spinal Cord, Cerebellum, Heart, Liver, Eye, Lung and Kidney* were indicated as the most important organs. *Gastric, Pancreas, Small intestine, Duodenum, Ear and Trachea* were the organs having moderate importance. When asked them about their criteria to rank the organs, the participants provided the criteria as providing homeostasis, providing functions required being alive, their usage frequency, complexity of their functions, anatomies and physiologies of them, the number of their tasks in organisms, complexity of their structure and the rate of their relation to other issues in biology.

Table 2 presented another important response pattern on difficulty rankings of the organs. *Nose, Tongue, Esophagus, Large intestine and Gallbladder* were ranked as the organs possessing little difficulty while

*Ear, Trachea, Brain, Spinal Cord, Cerebellum, Heart, Liver and Kidney* were perceived as the very difficult issues in biology. *Spleen, Sex organs, Eye, Lung, Gastric, Pancreas, Small intestine and Duodenum* were the organs with moderate difficulty. With similar approach to importance ranking, the participants were asked to tell their criteria for the rankings on difficulty of organs. They stated more comprehensive and various criteria. The criteria were difficulties in understanding, process of learning of the organs, structural complexity of the organs, physiological complexity of the organs, the time required to learn the organs, functions of the organs, tasks completed by the organs, details of the organs as an issue, interest degree on the organs, number of concepts and lecturer effect.

After their individual presentations, both of the factors of the study together are presented in the Table 3. When looked at the Table 3, two extreme categories can easily be seen that *Nose, Tongue, Esophagus, Large intestine and Gallbladder* are under the category of organs possessing little importance and difficulty whereas *Brain, Spinal Cord, Cerebellum, Heart, Liver and Kidney* are categorized as the organs that are both very important and difficult. The other organs are included in the other intermediate categories.

Table 1: Combined frequencies of rankings conducted by the participants about importance of organs as a school topic

	Degree of Importance			
	<i>Of little importance</i>	<i>Moderately important</i>	<i>Very important</i>	<i>Total</i>
	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>
<i>Brain</i>	10	3	<u>52</u>	65
<i>Spinal Cord</i>	12	8	<u>45</u>	65
<i>Cerebellum</i>	11	13	<u>41</u>	65
<i>Eye</i>	18	<u>27</u>	20	65
<i>Nose</i>	<u>37</u>	20	8	65
<i>Ear</i>	27	<u>28</u>	10	65
<i>Tongue</i>	<u>41</u>	17	7	65
<i>Trachea</i>	<u>27</u>	25	13	65
<i>Esophagus</i>	<u>34</u>	19	12	65
<i>Lung</i>	12	20	<u>33</u>	65
<i>Heart</i>	11	7	<u>47</u>	65
<i>Liver</i>	10	19	<u>36</u>	65
<i>Gastric</i>	11	<u>35</u>	19	65
<i>Pancreas</i>	13	<u>39</u>	13	65
<i>Spleen</i>	<u>35</u>	18	12	65
<i>Small intestine</i>	16	<u>39</u>	10	65
<i>Large intestine</i>	<u>33</u>	24	8	65
<i>Sex organs</i>	<u>28</u>	23	14	65
<i>Duodenum</i>	21	<u>25</u>	19	65
<i>Kidney</i>	10	26	<u>29</u>	65
<i>Gallbladder</i>	<u>36</u>	17	12	65

Table 2: Combined frequencies of rankings conducted by the participants about difficulty of organs as a school topic

	Degree of <i>difficult</i>			
	<i>Of little difficult</i>	<i>Moderately difficult</i>	<i>Very difficult</i>	<i>Total</i>
	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>
<i>Brain</i>	12	2	<u>52</u>	65
<i>Spinal Cord</i>	10	9	<u>46</u>	65
<i>Cerebellum</i>	8	16	<u>41</u>	65
<i>Eye</i>	16	15	<u>34</u>	65
<i>Nose</i>	<u>35</u>	22	8	65
<i>Ear</i>	<u>27</u>	18	20	65
<i>Tongue</i>	<u>47</u>	12	6	65
<i>Trachea</i>	<u>46</u>	7	12	65
<i>Esophagus</i>	<u>43</u>	13	9	65
<i>Lung</i>	16	<u>33</u>	16	65
<i>Heart</i>	16	15	<u>34</u>	65
<i>Liver</i>	12	21	<u>32</u>	65
<i>Gastric</i>	13	<u>37</u>	15	65
<i>Pancreas</i>	14	<u>33</u>	18	65
<i>Spleen</i>	25	<u>27</u>	13	65
<i>Small intestine</i>	12	<u>41</u>	12	65
<i>Large intestine</i>	<u>32</u>	26	7	65
<i>Sex organs</i>	11	<u>37</u>	17	65
<i>Duodenum</i>	18	<u>32</u>	15	65
<i>Kidney</i>	11	24	<u>30</u>	65
<i>Gallbladder</i>	<u>34</u>	20	11	65

Table 3: Categorization of the organs in terms of their importance and difficulty

<i>Degree of Importance</i>			
Degree of Difficulty	<i>Of little importance</i>	<i>Moderately important</i>	<i>Very important</i>
<i>Of little difficulty</i>	Nose, Tongue, Esophagus, Large intestine, Gallbladder		
<i>Moderately difficult</i>	Spleen, Sex organs	Gastric, Pancreas, Small intestine, Duodenum	Eye, Lung
<i>Very Difficult</i>		Ear, Trachea	Brain, Spinal Cord, Cerebellum, Heart, Liver, Kidney

Table 4: Ranking criteria that are used for organs in terms of difficulty and importance.

Criteria of ranking organs for the importance	Criteria of ranking organs for the difficulty
Role in providing homeostasis	Difficulties in understanding
Providing functions required being alive	Process of learning of the organs
Their usage frequency	Structural complexity of the organs
Complexity of their functions	Physiological complexity of the organs
Anatomies and physiologies of them	The time required to learn the organs
The number of their tasks in organisms	Functions of the organs, tasks completed by the organs
Complexity of their structure	Details of the organs as an issue
The rate of their relation to other issues in biology	Interest degree on the organs
	Number of concepts
	Lecturer effect

Table 4 shows ranking criteria used by prospective teachers. The most frequently emphasized criteria for "importance" were homeostasis, functions and complexity of functions whereas they explained understanding, learning process, structural and physiological complexity and time as the most frequently stated situations for "difficulty" criteria.

## DISCUSSION

The results of the study showed that the heart, kidney and liver among the organs prospective biology teachers indicated were determined as the most important and difficult. They are main functional organs of important systems to maintain homeostasis. In fact, all of the organs play a role for homeostasis. But, the most certain organs contributing homeostasis are heart, kidney and liver by regulating blood content, speed and water, mineral level in tissues. In line with this result, homeostasis factor is also frequently explained among the criteria to rank organs for importance. All of the nervous system organs are included in the category of the very important and difficult to learn. In their study with different group from prospective teachers, Tekkaya, Özkan and Sungur found the nervous system to be perceived as the very difficult to learn by high school students (%33.7, n=368) [24]. Their results showed that high school students also presented similar pattern for difficulty with perceptions of

undergraduate students, this might be reason of common content, textbook and subject matter of common old curriculum. While nervous system organs are included in the "very" category for two aspects, digestive system organs are included in moderate category for the aspects in a great rate. Again, Tekkaya, Özkan and Sungur found the rating of the digestive system for difficulty in a middle region of the range between 30 subjects of biology by high school students [26]. This result is in line with the result of this study in terms of difficulty. If nervous and digestive systems are compared, it is seen that digestive system has clearer tract and functional compartmentalization. They might be causes to ratings of the participants on digestive system organs as less difficult and important than nervous system organs. The stated criteria such as functional and structural complexity are included in explanations for both of the aspects for organs. So, the criteria explained are also parallel to the rankings of the participants. The other important thing in the results is that some of the sense organs are perceived as the least important and difficult to learn while others are ranked as moderate and very categories for different aspects. The categories for sense organs are different and they are not found only in one category. This indicates a perceptual difference from other organs. Although other organs are partially thought in a system approach, sense organs are considered as different things in terms of difficulty and importance. Lack of consideration on

relationship among them and with the other organs in current instructional contexts might drive the participants to think about them as simple, separate and independent organs. As the different situation, lung as a main functional organ is included in the category of very important, moderate difficult. The respiration and respiratory system are also rated by high school students as the difficult system to learn in the study of Tekkaya, Özkan and Sungur (%35.3, n=368) [26]. The organs of respiratory system are not considered together to learn. As similar to the result for respiratory system, excretory and circulatory system organs are thought as separately to learn. But, learning and teaching biological organization require system perception among organs in terms of both cognitive and affective ways. Similarity in the ranking given by prospective teachers and high school students provides important point to study. High school experiences might play important role in perceptions of undergraduate students for the subjects. What is more, Erten found that high school years were the most important time interval to provide effective experiences in learning human body and organs; he investigated interest and attitude toward the subject with 917 participants including the students from fifth grade to tenth grade and found that ninth grade students had the lowest interest about human body and organs [25]. Ninth grade might be critic period to construct preliminary perceptions and values about subject matter of biology. As stated at beginning, ninth grade is the first time to see biology subject matter under the title of biology. This might be a beginning point to study on development of values of individuals on specific subject matter. As a supportive finding, interest factor are also explained as another important part of the task value model used in this study [15]. Relationship between ninth grade experiences on the subject and its effect on undergraduate learning about the same subject should be investigated.

With the results of this study, it might be suggested that sense organs should be put in a system to consider them together and with other organs in teaching them. This way might difficulty by providing more organized structure. Again, organs of respiratory, excretory and circulatory systems should be connected to each other in each system in which the organ is included. By doing this, importance of the organs and collaboration among them for homeostasis as stated by the participants should be emphasized and taught. Number of pages and concepts for each organs in textbooks used in biology teacher education should be considered again to organize and balance the content for motivational change to

provide easiness and importance perception. Evaluation techniques for the organs should be compared to find question types that refer to individuality and simplicity of and interdependency among organs. In evaluation of organs subject, interconnection, functional dependence and clearer concepts should be emphasized and organs should not be asked as separate functional units. This might be a reason for difficulty perception. The organs which are ranked as very important and difficult should be investigated to find a way to convert them into very easy subjects. Because, these organs are perceived as very important that is a good sign for motivation. As a last suggestion, teaching and presentation ways of nervous system organs might be used as a model for other system organs for providing appropriate motivation and perception.

As the implications of this study, the data showed important compartmentalization in values of the prospective students in terms of organs subject in opposite to system idea among organs. So, the interrelatedness among the organs explained in many international and national books is not reflected into values of the prospective teachers as easiness and importance perceptions. These results might provide important clues for the curriculum authorities at the beginning phase of the biology curriculum.

In Turkey, there is limited number of the universities which has biology education departments and programs used in these departments are the same for all universities. Therefore, the prospective biology teachers in Turkey experience similar content and program and the sample of this study very important to consider due to the limited number of the departments on biology education. This study's result might provide reflection or continuum of the programs in the higher education level into secondary school curriculum via biology teachers who will graduate from these departments.

Future national and international examinations (eg. TIMSS and PISA)' results related to the content of organs might also be examined in the light of the data of this study to compare reflection of the value component into student's knowledge, attitude and understandings on the subjects. Again, organs are common subjects in many curriculums of the biology due to their role in systems and are directly related to diseases which are common in daily life. So, the study has also importance for other curriculums considered systems as higher-order theme and aimed to develop knowledge base for informed decision making. The aspect of informed decision making is explained many international documents as an important aim for science and biology education [28-31].

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