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Are Pre-Service Science Teachers Qualified Enough to Teach Human Reproductive System?*

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Abstract

This study aims to reveal pre-service science teachers' (PSTs) levels of knowledge about the human reproductive system and their professional competence perceptions. The study was conducted using the case method. A form consisting of 6 open-ended questions was developed and applied to PSTs. The sample was composed of 62 PSTs , who were 3rd and 4th-year students in the Science Teaching Department of a university. It was found that the majority of the participants had a superficial understanding of the human reproductive system and they had various alternative concepts about the subject. The students attributed their incomplete understanding of the subject to the fact that they did not learn the subject effectively because they did not make a regular revision of their lessons, because the subject was taught superficially, and they felt embarrassed while the subject was being taught to them. It can be said that social life and the way individuals look at the subject play an essential part in obtaining such results. Based on the results, it can be said that offering teachers training on the subject by experts can yield positive results in teaching the subject.

Keywords: Human Reproductive System, Pre-Service Science Teachers, Professional Competence, Knowledge

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INTRODUCTION

The reproductive system and the health of the system are important for living creatures in terms of the continuity and sustainability of life. Adolescence can be regarded as a period that should be considered primarily in subjects related to the reproductive system and the health of the system since it is the period when sexual behaviours begin to be shaped in the transition from childhood to adulthood. It is the period when the reproduction-related problems of women increase more rapidly than those of men, and various problems which emerge during this period take an important place in the life of young people who take a step towards adolescence. Furthermore, some problems experienced during the period originate from the youth's lack of knowledge about the reproductive system and its health (Gölbaşı, 2002; Tosun, 1999; Sezgin, 2000).

Informing the youth about the reproductive system and the health of the system, offering them training, and their participation in the training can contribute to the solution of problems (Özcebe, 2000). Informing or training can be performed by integrating the relevant subjects into the courses at school, or it can be in the form of seminars held at certain intervals. Tosun (1999) argues that educational and consultancy services that respond to the problems of all segments of society will help to solve problems by identifying the priorities since the needs for reproductive health are diverse. A study conducted by Hadjichambis et al. (2015) with the participation of 7th graders (N: 946) suggested that students' conceptual understanding and their motivation in biology classes would increase when taking into consideration the pre-test and post-test results of an application, which was conducted based on an inquiry about the subject of reproduction.

An examination of the curricula for physical sciences and science courses demonstrated that the gains related to the human reproductive system were available in the unit of "reproduction, growing up, and development in humans" in the 7th-grade coursebook and in the unit of "reproductive system and embryonic development" in the 11th-grade coursebook and that the adequate content was available in the coursebooks prepared according to those gains. However, the literature suggests that there are some problems in teaching the subject (see literature review).

It is important that students learn subjects related to the human reproductive system, which form the basis of sexual education, efficiently in formal education. Therefore, especially individuals who will provide education should be well equipped on the subject (Sungur, 1997). In other words, teachers, the most important components of formal education, should have adequate domain knowledge and professional skills to teach the subject. Otherwise, teachers who have inadequate content knowledge and/or have alternative concepts can transfer their misconceptions unconsciously to their students, and thus they can cause students to form concepts far from scientific truths (Yağbasan & Gülçiçek, 2003; Kabapınar, 2007; Erdoğmuş, 2009; Kruger, et al., 1992; Kaptan & Korkmaz, 2000; Kapucu & Yıldırım, 2012; Kapucu & Çılgın, 2016; Görecek Baybars, 2018).

Considering that the university environment brings together the youth with different lifestyles and experiences, it can be said that the interaction between them will also be reflected in their attitudes and behaviors. The youth's lack of knowledge about the reproductive system and the health of the system makes us think that the group in question can be at risk (Gölbaşı, 2002; Tosun, 1999). Furthermore, teachers' and pre-service teachers' perceptions of professional self-efficacy can also directly influence the learning of the subject. Therefore, whether teachers and pre-service teachers have concerns similar to those of students in teaching the subject should be revealed. Thus, the results to be obtained by this study concerning pre-service science teachers' perceptions of professional self-efficacy and their levels of knowledge about the human reproductive system will fill the gap in the literature. It is also thought that identifying the problems of pre-service science teachers in learning the human reproductive system and professional self-efficacy will have stimulating effects on academicians so that they can take the necessary precautions. Thus, this study's goal is to reveal pre-service science teachers' levels of knowledge about the human reproductive system and their professional competence perceptions. Within this framework, the study seeks answers to the following questions:

1. What is pre-service science teachers' level of knowledge about the human reproductive system?

2. What perceptions do they have of their professional competence in the human reproductive system?

Literature Review

A literature review indicates that students at differing levels of learning do not have adequate knowledge of the human reproductive system and have misconceptions in this respect (Yan Yip, 1998; Donati et al., 2000; Sydsjö et al., 2006). In a study conducted in Taiwan with the participation of primary school, secondary school, and high school students, it was found that only 12.9% of primary school students, 38.7% of secondary school students, and 54.4% of high school students could understand the meaning of reproduction exactly (Hsiung & Hsiung, 2003). A similar result was obtained in a study carried out with pre-service biology teachers. Kurt, et al. (2013) revealed that pre-service teachers' cognitive structures about the reproductive system were not adequate, their understanding was incomplete, and they had alternative concepts.

Moreover, it was demonstrated that the human reproductive system was one of the subjects, which was difficult for student understanding (Aşçı & Demircioğlu, 2004; Kurt & Temelli, 2011; Çimer, 2012). In a study classifying the subjects of biology according to difficulty index analysis, Özatlı (2006) found that the subject of reproduction was difficult to understand by 26.18% (20%<difficult). Likewise, in a study aiming to find subjects that 11th graders had difficulty while learning the biology course, Çimer revealed that reproduction in general and reproduction in humans were among the difficult subjects.

Another problem encountered in teaching the human reproductive system is the social effects in the subject's nature. Koluaçık et al., (2010) claim that it is a taboo to talk about subjects such as reproduction, sexuality, and family planning in Turkey because it is a shame, a sin, and privacy. Therefore, individuals cannot state their problems in such matters explicitly. Another study confirming the finding was conducted by Haşıloğlu & Yağcıoğlu (2017). The researchers performed the study to find what 6th graders felt, what problems they experienced, and what they thought while listening to their teachers who taught the subjects of reproduction, growing up, and development in humans. As a result, they found that most of the boys and girls wanted to listen to teachers of their sex teaching subjects related to reproduction and that students felt embarrassed, did not understand, or could not ask questions for the parts they did not understand when they listened to the subject from a teacher of the opposite sex because they were shameful subjects. Sydsjö et al. (2006) reported that most of the young people who joined the survey had learned subjects related to reproduction at school, from their friends, or the media. It has been stated in the literature that studies on this subject in Turkey are limited due to social impact (Kömürcü vd., 2014).

METHODOLOGY

In the current research, a case study was employed, which is a method that allows researchers to conduct an in-depth investigation of an event in a short time. The case to be examined may sometimes be a school, a person, or a group, and there is no concern about generalizing the results (Denscombe, 1998; Wellington, 2000; Çepni, 2010).

Study Group

The study sample was taken through criterion sampling, one of the purposeful sampling methods. In the criterion sampling method, the sample comprises individuals who meet the criteria set for sampling (Patton, 2014). The criterion set for pre-service science teachers in the study was having taken a course related to the human reproductive system during undergraduate education. Therefore, 3rd and 4th-year students who had taken the courses of General Biology 2 and Human Anatomy and

Physiology were determined to be appropriate for inclusion in the study. The study sample was composed of 62 pre-service science teachers (45 females and 7 males) who were 3rd and 4th-year students in the Science Teaching Department of a university in the Central Anatolian Region of Turkey.

Data Collection

A survey form consisting of open-ended questions was developed by the researcher in line with the purpose of the study. For the content validity of the survey questions, the opinions of two researchers who have doctorate in science education were taken. The survey contained six open-ended questions aiming to identify the participants' levels of knowledge about the structure of the reproductive system and the anatomic location and tasks of its organs, how reproduction occurs, and how reproductive cells are formed. Moreover, there were also questions that aimed to identify whether the participants considered their knowledge of the subject adequate and whether they would find the process of teaching the subject disturbing, to identify their perceptions of self-efficacy. Pre-application with a similar small group, which is critical in identifying the problems in the draft form of open-ended questionnaires, is an important step in obtaining valid and reliable results (ASA, 1997; Mertens, 1998). For this reason, a preliminary trial was conducted on a small group of open-ended questions in sufficient time. As a result, minor corrections were made to make the questions more clear and understandable.

Data Analysis

Descriptive and content analysis were used together as an analysis method, since some of the survey questions were aimed at measuring the knowledge of pre-service teachers about the human reproductive system and some of them were aimed at determining their views on teaching the subject. While the 1st, 2nd, and 5th questions in the questionnaire were analyzed descriptively, the 3rd, 4th, and 6th questions were subjected to content analysis. While the answers given by the pre-service teachers in the descriptive analysis questions were directly frequencyd; In the questions for which content analysis was made, the answers of the students were examined beforehand and categories were created. It is seen that the answers given to the questions asked to measure knowledge or understanding are examined in advance and the answer categories are formed according to the quality of the answers given as a result of this examination. (Karataş et al, 2003, Kurt, 2010). In the content analysis process, the researchers, after evaluating and classifying the answers given by 6 students, corresponding to 10% of the participants, for each question in the questionnaire separately, came together and compared their categories, and after reaching a consensus, the first researcher continued to evaluate the remaining questionnaires. Below, as an example, the analysis process for Question 3 is explained.

In the third question, pre-service teachers were asked how reproductive cells are formed. Valid answers of the students including scientifically correct statements are "Sufficient"; Answers that include scientifically correct statements as well as misconceptions "contain a misconception", answers that contain partially scientifically correct statements are "Insufficient"; Finally, those who did not make any explanation were categorized as "No Explanation".

Besides in the analysis process, examples of quotations from the data expressed by the students in writing were also presented (for example see Table 6). The researcher spent a long time with the participants as they had their own class and students. Considering that the researcher is a part of the process, it can be said that there is no negative situation on the collected data in terms of validity. It is of great importance for the researcher to stay in the environment where he/she observes for a long time, for the data collected to be healthier and more realistic (Yıldırım ve Şimşek, 2013:300 p).

The real identities of the pre-service teachers participating in the study were kept confidential. The responses given by 15 participants to the survey questions were analyzed by the researcher and an

expert in science education independently. The codes and categories distinguished by the two researchers were compared, and the rate of agreement between them was found to be 78% (Miles & Huberman, 1994).

FINDINGS

This section presents the findings obtained within the framework of the study questions under the following sub-headings.

Findings for Research Question One

As seen from Table 1, which is about showing the human reproductive organs and their structures on a chart, there were no pre-service teachers who could show the locations of all male and female reproductive organs correctly. Accordingly, only 10% of the pre-service teachers could show the location of most of the organs correctly. According to Table 1, the rate of those who could show some of the male and female reproductive organs correctly was 34% and 44%, respectively. However, 13% could not show any of the organs on the chart.

Table 1. Pre-service Science Teachers' Levels of Knowledge About the Anatomic Locations of the Human Reproductive Organs and Their Structures

Demonstrating the anatomic locations of the organs	n	(%)
i. He/she can show all the male and female reproductive organs	-	-
ii. He/she can show most of the male and female reproductive organs (8-10)	6	9.7
iii. He/she can show some of the male and female reproductive organs (4-7)	21	33.9
iv. He/she can show only a few of the male and female reproductive organs (1-3)	27	43.5
v. He/she can show none of the male and female reproductive organs (0)	8	12.9

It is seen from Table 2, which is about the tasks of the human reproductive organs, that there were no pre-service teachers who could show all the reproductive organs correctly and that only 19% of them could explain the tasks of some of the organs. Of the pre-service teachers participating in the study, 47% could explain the tasks of only a few of the organs, whereas 31% could not explain any of the tasks of the organs.

Table 2.Pre-service Science Teachers' Levels of Knowledge About the Tasks of the Human Reproductive Organs/the Structures of the Organs

The tasks of the reproductive organs	n	(%)
i. He/she can explain the tasks of all reproductive organs	-	-
ii. He/she can explain the tasks of most of the reproductive organs	1	1.6
iii. He/she can explain the tasks of some of the reproductive organs	12	19.4
iv. He/she can explain the tasks of only a few of the reproductive organs	29	46.8
v. He/she cannot explain the tasks of the reproductive organs	19	30.6

According to Table 3, which is about how reproductive cells are formed, the rate of the pre-service teachers who could adequately explain the formation of reproductive cells was 15%, while the rate of those who could explain it inadequately was 42%. The rate of the pre-service teachers who gave answers containing misconceptions was 24%. On the other hand, 16% could not explain the formation of reproductive cells.

Table 3. Pre-service Science Teachers' Levels of Knowledge about the Formation of Reproductive Cells

The formation of reproductive cells	n	(%)
i. Explanation about the formation of reproductive cells is adequate.	9	14.5
ii. Explanation about the formation of reproductive cells is inadequate.	26	41.9
iii. Explanation about the formation of reproductive cells contains misconceptions.	15	24.2
iv. No explanation on the formation of reproductive cells is provided.	10	16.1

According to Table 4 about how reproduction occurs in humans, 5% of the pre-service teachers could make an adequate explanation, whereas 63%, a high percentage of them, could not provide an adequate explanation. The rate of answers containing misconceptions about how reproduction occurs was 29%. On the other hand, 3% provided no explanation about the subject.

Table 4. Pre-service Science Teachers' Levels of Knowledge about Reproduction

How reproduction occurs	n	(%)
I. Explanation of how reproduction occurs is adequate	3	4.8
ii. Explanation of how reproduction occurs contains misconceptions	18	29
iii. Explanation of how reproduction occurs is inadequate	39	62.9
iv. No explanation about how reproduction occurs is provided	2	3.2

Findings for Research Question Two

Upon examining whether the pre-service teachers had adequate knowledge of the reproductive system, it was observed that the majority of them (62.9%) thought that they had inadequate knowledge of the subject, as can be seen from Table 5. They described the reasons for feeling inadequate in the subject as having difficulty in answering questions, the lack of the detailed knowledge of the subject, not revising what they had learned, superficial teaching of the subject, hesitating to ask questions about what they did not understand due to feeling embarrassed, the failure to learn the subject effectively, and the lack of interest in the subject.

It is observed from Table 5 that only a small number of the pre-service teachers thought that they had adequate knowledge of the subject. They explained the reasons for their adequate knowledge of the subject as making a revision, being curious about the subject, and listening to the teacher carefully while he/she was teaching the subject.

Although there were pre-service who thought that they had partially adequate knowledge of the subject, they did not make any explanations about the reasons for this.

Table 5. Pre-service Science Teachers' Perceptions of Their Levels of Content Knowledge About the Human Reproductive System

Having adequate knowledge of the reproductive system	n	%	Reasons
Those who think that they have adequate knowledge of the reproductive system	7	11.3	Revising
			Listening to the teacher carefully
			Being curious
Those who do not think that they have adequate knowledge of the reproductive system	39	62.9	The failure to answer questions/having difficulty in answering questions
			The lack of detailed knowledge
			Not revising
			Superficial teaching of the subject
			Feeling embarrassed while the subject is being taught
			Hesitating to ask questions about what is not understood
			Not having an interest in the subject
			The failure to learn the subject effectively
Those who think that they have partially adequate knowledge of the reproductive system	11	17.7	No explanation
Those who give no answers	5	8.1	-

As is seen from Table 6, the rate of the pre-service teachers who thought that they could teach the subject to their students without hesitation was 65%. They explained the reasons for this as the fact that it was an important subject that students needed to know, that no problems would arise if they were knowledgeable about the subject, that students were younger than them, that they needed to teach the subject as teachers, and that it was an ordinary and natural event. However, the rate of those who thought that they could not teach the subject so easily was 35%. They explained the reasons for this as the fact that students would joke about the subject, that students would consider the subject shameful, and that they would feel embarrassed.

Alternative concepts, such as "insemination occurs in the uterus," "it occurs by fertilizing the ovary," "egg cells are produced in the fallow tubes, and they are formed in the mother's womb," "sperm and egg cells are formed through mitotic division, sperm is a male reproductive organ," were the ones that were stated by a higher number of pre-service teachers (25%, 22%, and 20%, respectively). Despite being fewer (6%), the other alternative concepts are shown in Table 7.

Table 6. Pre-service Science Teachers' Perceptions of Their Self-efficacy in Teaching the Human Reproductive System

Being able to teach the reproductive system to students without hesitation	n	%	Reasons (f)
Those who think that they can teach the reproductive system without hesitation	42	65	No explanation (4)
			Because students are younger than me (5)
			Because I will teach the subject superficially/I will not go into details (3)
			Students already know the subject (1)
			I will not have problems if I make preparation beforehand (2)
			It is an ordinary and natural event (4)
			I need to teach it because I am a teacher (4)
			The subject is important, and students need to know it (10)
			Problems will not arise if I am knowledgeable about the subject (7)
			I do not feel embarrassed (2)
			I am knowledgeable enough (3)
Those who do not think that they can teach the reproductive system without hesitation	20	35	I think that students will joke about the subject
			I think that students will find the subject shameful
			I think I will feel embarrassed
			It is not a subject that I can teach so easily
			I do not like the subject
			I have inadequate knowledge
			I think of assigning it as homework
			I am not sure

Table 7. Pre-service Teachers' Alternative Concepts About the Reproductive System

Concepts	Categories	Alternative concepts	%
Reproduction	Way of producing	It occurs with the connection of textures	6
		It occurs through meiosis after insemination	
		It occurs with the combination of egg cells and sperm cells	
Egg cells	Definition	Female reproductive organ	22.4
	Place of production	It occurs in the mother's womb	
		It is produced in the fallow tubes	
	Process of production	It occurs with the differentiation of oogenesis cells	
		It occurs with mitotic division	

Sperm	Definition	Male reproductive organ	19.4
	Place of production	It occurs in the mother's womb	
	Process of production	It occurs with the differentiation of spermatogenesis cells	
		It occurs with meiosis after insemination	
		It occurs with the sequential mitotic division of main sperm cells	
Insemination	How it occurs	Reproduction occurs with the connection of main sperm cells and main egg cells	25.4
		It occurs with the insemination of the ovaries by sperm	
	Where it occurs	It occurs in the uterus	
Others	Vagina	It is basic in structure	6
		It is used for urinating	
		The inseminated eggs are divided, and they form the zygote in the vagina	
	Uterus	It is the place eggs hold on to	
	Ovary	It is the reproductive cell	
	Testicles	It is the reproductive cell	

CONCLUSION, DISCUSSION, AND RECOMMENDATIONS

In this study, it was found that most of the pre-service science teachers could not show the anatomic location of the structures and organs of the human reproductive system correctly. Furthermore, it was determined that they had a superficial understanding of the tasks of those structures and organs and most of them failed to give the expected answers to the questions asked.

Concerning how reproduction occurs and how reproductive cells are formed, most of them made inadequate explanations and gave incorrect answers. Likewise, in a study conducted with pre-service biology teachers, Kurt, et al. (2013) also found that pre-service teachers' cognitive structures about the reproductive system were not at the desired level, that they had an incomplete understanding of the subject and had alternative concepts. Thus, the alternative concepts found in this study and the ones reported in the literature can be compiled, and a Likert-type scale can be developed accordingly. Whether participants have alternative concepts can be determined using such a scale with larger samples.

Most of the pre-service teachers did not think that they had adequate knowledge of the human reproductive system. It is seen from Table 5 that the number of the participants who thought that their knowledge of the subject was inadequate was high. According to the pre-service teachers, their inadequate knowledge originated from not revising what they had learned, superficial teaching of the subject, and the failure to learn effectively due to feeling embarrassed while they were taught the subject. The result was significant in that it was consistent with the other data collected using the survey. Alternative concepts, such as "insemination occurs in the uterus," "it occurs with the insemination of the ovaries by sperm," "egg cells are produced in the fallow tubes," "it occurs with the mitotic division of sperm cells and egg cells," and "sperm is the male reproductive organ," created by the pre-service teachers showed that they could not learn the subject effectively due to the reasons they had stated (see Table 7). Considering that the issue is also related to sexual education, it would not be right to expect students to learn the subject only in physical sciences classes at school. The majority of the participants in the studies conducted with the youth stated that they did not have adequate sexual education and that their knowledge of reproduction was inadequate. Moreover, it was found in those studies that the youth had alternative concepts (Duman et al., 2015; Güçlü, Elem & Unutkan, 2015; Sydsjö et al., 2006; Yan Yip, 1998). Koluaçık, et al. (2010) also state that students have incomplete knowledge about the health of reproduction. Thus, it can be said that laying more emphasis on sexual education and offering them education given by experts can yield better results. Supporting this, a study conducted with pre-service teachers who were first-year students in a faculty of education revealed that 89% of the students wished to receive education from doctors and nurses (Kaya, et al., 2007). Such education is thought to facilitate an understanding of the subject of the reproductive system in the physical sciences course. In this context, more space should be devoted to such subjects in student and teacher education programs. Students learn the reproductive system formally for the

first time in the 8th grade. Considering that the process of secondary school education is the period when students enter into adolescence in Turkey, it is the appropriate time for sexual education. A doctoral thesis in the literature argues that the youth under the age of 15 need more guidance and should be directed to become informed (Emodi, 1981). Another study emphasizes the need for repeating education at certain intervals, employing different techniques of education, asking for students' needs and ideas in this respect, offering education by male and female experts, and considering privacy important (Koluaçık, et al., 2010). The study also mentions deficiencies in students' knowledge about the health of reproduction. In a study conducted with the participation of secondary school students, Haşıloğlu & Yağcıoğlu (2017) concluded that most of the students would prefer teachers of their sex to teach such subjects because they felt embarrassed since they were shameful subjects and that they could not ask questions about what they did not understand for the same reason.

It was found that the majority of the pre-service science teachers thought that they could teach the subject of the human reproductive system to their students without hesitation. Furthermore, it would not be wrong to say that the situation will not be as they think during their practice teaching or in their professional life. It was also revealed that some of the pre-service teachers did not think that they could teach the subject to students so easily, and they stated the reasons for this as feeling embarrassed while teaching the subject, being concerned about being ridiculed by students, and the fact that students might consider the subject shameful. Social life and the perspectives of society can be said to play roles in obtaining such a result. It is stated in the literature that subjects such as reproduction, sexuality, and family planning are taboo subjects in Turkey. Therefore, individuals cannot state their demands and problems in such matters openly (Koluaçık, et al., 2010). Based on this result, the main reasons for pre-service teachers' concerns about teaching the subject could be investigated, the necessary support could be received from experts to solve the problem, and the subject could be made more comprehensible by designing activities suggested by experts. Research on the activities in which different methods and techniques are used argues that using different teaching and learning methods is more effective in promoting students' achievement and motivation (Aşçı & Demircioğlu, 2004; Kaya, 2002; Kurt & Temelli, 2011; Türkuzan, 2004; Kurtcuoğlu, 2007; Hadjichambis, 2015). Education on sexual health provides information on individuals' emotional configuration and contributes to the formation of their reactions, which will facilitate their adjustment to different life conditions. Moreover, such education also enables young people to develop positive attitudes towards sexuality and helps them to make rational and responsible choices in the context of sexual behavior (Bulut, 2006; 24-25p). Such education on sexual health is necessary and important for social life. In studies conducted on university students, it was determined that most of the students did not receive any service or training on sexual/reproductive health. For this reason, it is recommended that healthcare professionals organize educational programs for university students (Dağ et al., 2012; Karabulutlu & Kılıç, 2011; Pınar et al., 2009; Aksoy, Ayhan-Başer & Cankurtaran, 2021).

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