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Simulation in the elimination of conceptual problems related to the issue of nerve conduction

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Abstract

The issue of nervous system, one of the subjects of biology, is difficult and abstract to understand, and is inherently capable of causing misconceptions. Conducting a class allocated to the subject matter by employing effective teaching methods and techniques is, therefore, very important for fully understanding the subject and for eliminating such conceptual mistakes. Information and communication technologies are frequently used in biology education in order to form effective learning environments. In this way, problems which cannot be resolved through traditional methods of teaching can be overcome. This research aims at determining the effects of teaching through simulation- which has been performed in relation to the topic of nerve conduction- on concept teaching and on eliminating the misconceptions. The study group for the research was composed of 25 third year students attending the Biology Education Department of Hacettepe University Faculty of Education. In consequence, it was observed that the misconceptions carried by the students were removed thanks to classes taught through the simulation.

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1. Introduction

The role played by qualified teachers is extremely important in creating the manpower necessitated by the epoch and in raising the quality in education. For a developed society, teachers need to have adequate technological,

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pedagogical and field knowledge, and to follow technological developments. In terms of teachers' efficacy, Shulman (1987) divided the knowledge that teachers should carry into seven categories; namely, (a) field knowledge, (b) pedagogical field knowledge, (c) knowledge of curriculum including materials and the programme, (d) pedagogical knowledge including knowledge of classroom management and organisation, (e) knowledge of learners and their characteristics, (f) knowledge of the educational environment and the circumstance of it, (g) knowledge of educational objectives, targets and values and of the philosophical and historical foundations of them. The first two of the categories are evaluated as the efficacies of the special field. According to Shulman, field knowledge is composed of teachers' knowledge of the concepts and phenomena in their field; and pedagogical field knowledge consists of the ways of representing and formulating to make a subject comprehensible to others. For effective teaching, teachers must have sufficient field knowledge and be able to transfer the knowledge into learners efficiently. Hence, in order to be able to perform an effective biology teaching, firm knowledge of biology and skills to effectively present the topics of biology are necessary.

Information technologies are expected to be integrated into the process by both teachers and learners in the teaching and learning of biology. Students cannot learn the topics deeply and meaningfully without technological devices, especially in the case of complex science topics. Besides, technological devices can help learners by establishing the models in their minds with animations (Ainsworth and VanLabeke, 2004; Boucheix and Schneider, 2009; Mayer and Moreno, 2002). Multimedia animations as a technological device bring the microscopic concepts and topics into the macroscopic level, and can provide learners with better learning environments; and thus they can raise the quality of learning (Dalacosta, Kamariotaki-Paparrigopoulou, Palyvos and Spyrellis, 2009; Özmen, 2011).

Due to the general content of the topics, terms of Latin origin, and the complex associations between topics; many topics in the high school biology curriculum are considered to be difficult by students. The topic of Nervous System is also one of the topics difficult to comprehend, and by its nature, it causes misconceptions because of the abstract concepts available (Lazarowits and Penso, 1992; Bahar, Johnstone and Hansell, 1999; Tekkaya, Çapa and Yılmaz, 2000; Tekkaya, Özkan and Sungur, 2001). For this reason, researching into whether or not prospective teachers have any misconceptions in the topics of nervous system difficult for students to understand, and eliminating them if they have any are very important in raising the quality of biology education conducted in schools.

This research aims at determining the effects of teaching through simulations- which has been performed in relation to the topic of nervous system- on concept teaching and on eliminating the misconceptions.

2. Method

2.1. Study group

The study group was composed of 25 third year students attending the Biology Education Department of Hacettepe University Faculty of Education.

2.2. Research model

This research was designed in the single group pre-test – post-test model, an experimental research model.

2.3. Data collection tool

Nervous system

- The test on Nervous System contained questions requiring written answers and drawings for the purposes of uncovering the prospective teachers' knowledge in relation to the target behaviours specified in the curriculum for high school 3rd grade biology course.

Audio-visual Simulation

- Original animation was produced by Physio Viva Educational Animations Company. Having the permissions necessary, the audio-visual simulation was adapted by the researchers and in this adaptation process the Adobe After Effects software was used.
- The content of the simulation was prepared in accordance with the target behaviours specified in the curriculum for high school 3rd grade biology course.
- In the part about impulse transfer, such topics as the structure of pre-synaptic and post-synaptic neurons and the procedure of impulse transfer between two neurons were included.

2.4. Analysis

The answers given by prospective teachers to the questions concerning the nervous system were grouped according to the similarities and differences, and then the frequencies and percentages were calculated.

3. Findings

3.1. The answers given by prospective teachers to the questions concerning impulse transfer

For the questions on nervous system, in relation to impulse transfer, the prospective teachers were asked to draw a picture of a nerve cell and to describe the changes occurring in the nerve cell by using the drawing.

The findings obtained from the prospective teachers before and after teaching through simulations in relation to impulse transfer:

According to the pre-test results, 5 (20%) of the prospective teachers were able to represent the structures of a nerve cell via drawings correctly. 10 (40%) prospective teachers were able to draw the picture of a nerve cell only without demonstrating the structures. It was also found that 10 (40%) of the prospective teachers represented the structures of the nerve cell incorrectly.

The most frequent misconception was the confusion of the terms axone and dendrite. One of the participants (4%) stated axone as synapse.

Another misconception was the direction of the transfer. Only 5 (20%) of the prospective teachers mentioned the direction of the transfer; yet 4 (16%) of them were found to have misconception in this matter (by describing the direction of transfer as from the axone into the dendrite).

Only 2 (8%) talked of the change of electrical load; and none of the participants were able to answer the questions fully.

According to the the post-test results, 14 (56%) of the prospective teachers were able to represent the structures of a nerve cell correctly on a figure.

2 (8%) of the participants drew a picture of a nerve cell without demonstrating the structures.

1 (4%) of them confused the terms axone and dendrite.

12 (48) of them who talked of the direction of transfer were able to state it correctly.

6 (24%) talked of the change of electrical load. Only 6 (24%) of the students were able to answer the question fully.

3.2. The answers given by prospective teachers to the questions concerning the concept of synapse

The prospective teachers were asked to explain the concept of 'synapse'.

Synapse is the area where a neuron transfers the impulse into the axone, dendrite, soma, muscle or soma, muscle or gland of another neuron (Campbell, 2013).

According to the pre-test results:

6 (24%) of the prospective teachers did not give an explanation about the concept. 16 (64%) gave insufficient explanations by saying 'it is the space between the axone and the dendrite; and 2 (8%) were found to have

misconceptions. One of those who had misconceptions described it as “a concept occurring with the passing of an impulse from the axone into the dendrite or from the dendrite into the axone” while the other described it as “the point of junction of the dendrites”.

The number of those who explained the concept correctly was only 1 (4%).

According to the pre-test results;

2 (8%) of the prospective teachers did not give an explanation on the concept. 7 (28%) of them gave insufficient explanations by saying “it is the space between the axone and the dendrite”.

The number of those who explained the concept correctly was 16 (64%).

3.3. *The answers given by prospective teachers to the questions concerning the concept of neurotransmitter substance*

The prospective teachers were asked to explain the concept of ‘neurotransmitter substance’.

Neurotransmitter substances play a role in transferring the impulse. They are chemical substances, and they enable an impulse to pass from a neuron into another or into the effector organ.

According to the pre-test results:

15 (60%) of the prospective teachers did not give an explanation on the concept. 7 (28%) used the statement “chemical substance enabling transfer from the axone into the dendrite”. 1 (4%) used the statement “an intracellular substance”. 2 (8%) were found to have misconceptions. “it is the substance placed in the dendrite side of the neuron cell”, “carrier substance”.

According to the post-test results:

1 (4%) of the prospective teachers did not give an explanation about the concept. The number of those who explained the concept correctly was 24 (96%).

4. Conclusion and recommendations

It was found through this research that insufficiency of knowledge and misconceptions were available with regard to nerve impulse transfer. The misconceptions and insufficiency of knowledge were in parallel to the findings obtained in research conducted by Özsevgeç (2007) with prospective biology teachers for the unit “Controller and Organizer Systems”. The research found that the insufficiencies and misconceptions were reduced to a certain extent with classes taught through simulations.

It is pointed out by both teachers and students that the nervous system is a topic difficult to learn. The fact that the concepts of the topic are abstract and that biological events are at the microscopic level can lead to learning problems. In order for meaningful learning to occur, teaching techniques which do not direct students into memorization and which make them active should be preferred by teachers. Animations will carry the microscopic concepts and topics into the macroscopic level and thus will be able to raise the quality of learning. Curricula and course books must guide teachers in techniques of teaching through animations. Additionally, the topic of systems has concentrated content. The parts related to real life must be emphasised and the content must be made lighter, and re-organised by revising the time, and the teaching techniques.

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