Pre-service teachers’ perceptions and preferences about visualization

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Abstract

The aim of this study is to determine the preferences of teacher candidates studying at Elementary Science Education Program related to texts diagrams and their perception about visualization in their comprehension of the human body systems. The study was conducted with third year teacher candidates in the fall semester in 2009-2010 academic year and within the context "Human Anatomy and Physiology" course. The research results revealed that teacher candidates prefer the form of written expression to drawing and that their prior knowledge is important in visualization. The teacher candidates involved in the research stated they had difficulty in visualizing the topics about which they did not have sufficient prior knowledge.

Keywords: visualization; human body systems; visual materials; teacher education; science teachers.

1. Introduction

Concepts can be described as information structures that represent the common characteristics of different objects and phenomena and get a meaning in human mind. As can be understood from this definition, the word concept is discrete and does not refer to pieces of information that can be learned just through definitions. Discrete nature of concepts makes it difficult for learners to visualize concepts in their mind. In this case, a concrete presentation of concepts by visualizing them as much as possible grows in importance. Visualization plays a key role in making sense of concepts and changing them from the discrete to the concrete. Visualization has become an important way for human beings to learn and perceive concepts (Dastani, 2002). Visual materials are used to help the learner both develop the concepts in a field in the process of learning and analyze and schematize them in a coherence by taking the interaction of the concepts in that field into account. Pictures, drawings, diagrams and observation of examples activate cognitive processes such as intuitive understanding of complex processes and building discrete relationships. Visual materials like concept networks, mind maps, concept maps, flow diagrams, schemes and graphics are used for individuals’ cognitive or internal reflections. As well emphasizing meaning, visuals also improves and strengthens expression. Studies revealed that visualization of written texts contributed to an efficient construction of cognitive models (Anderson, 1971; Schnotz, 2002). Complex systems have two levels of organization. Mechanical and other complex systems have a structural organization, consisting of parts in a
particular arrangement and a functional organization consisting of a sequence of actions and events, usually dynamic operations of parts, and their consequences (Heiser & Tversky, 2006).

It is through understanding of the relationships between structures and functions that how the human body systems work can be understood in science. The structures and functions in the systems making up the human body are not directly visible. The fact that structures are stable while functions are dynamic by nature might require the use of visual materials to ensure that functional understanding takes place. While visual materials are not automatically interpreted in the human mind, learners have to be educated to become visually literate in order to equip themselves with skills to interpret content of visual messages as well as text (Glasgow, 1994).

The functional diagrams used in learning makes it easy to combine structures with functions. The first purposeful attempts of individuals in understanding how human body systems work occur at around ten years of age. Students in this age group are directed to the use of diagrams in understanding the human body for the first time in science classes. The use the diagrams drawn by students themselves in conjunction with the text makes it possible for them to understand the relationship between the internal structure of human body with its tasks (Ramadas & Nair, 1999; Reis & Tunnicliffe, 2001). According to Mayer (2001), visuals are good if they are facilitators for learning and appropriately designed to help people construct knowledge through the cognitive process of selection, organization, and integration.

Teachers play an important role in selecting or creating instructional visual materials to help students learn. Teachers have to be visual interpreters, and sometimes they have to be visual designers too. In the teacher preparation process, it is therefore important to help teacher candidates develop knowledge and skills of visual literacy to gain the ability of understanding visual materials appropriately. Therefore, learning about teacher candidates’ visualization preferences and competence has vital importance. The purpose of this study is to identify the preferences of teacher candidates studying at Elementary Science Education Program related to texts diagrams and their perceptions about visualization in their comprehension of the human body systems The study searched for answers to the following questions: "How do the teacher candidates explain the digestive system using texts and diagrams?", "What are the teacher candidates' preferences about explanation through the text or drawing?" and "What are the difficulties experienced by the teacher candidates in understanding the human body systems?".

2. Method

The research was conducted with the descriptive method. The qualitative research approach was adopted in data collection and data analysis. Qualitative research can be described as a research approach, in which qualitative data collection techniques such as observation, interviews and document analysis are used and which follows a qualitative process to present perceptions and events in a natural environment in a realistic and holistic manner (Yıldırım & Şimşek, 2005). Research data were collected with semi-structured interviews and written documents and analyzed descriptively.

2.1. Participants

A total of 47 third-year teacher candidates studying Elementary Science Education major at Eskişehir Osmangazi University Faculty of Education in the fall semester of the academic year 2009-2010 were involved in the research. Seven of the teacher candidates surveyed are male, while the remaining 40 are female.

2.2. Collecting and analyzing data

Research data were collected through semi-structured interviews and written documents. The documents obtained by one of the researchers from a total of 47 science teacher candidates who participated in “Human Anatomy and Physiology” course. Descriptive analysis method was employed in the data analysis stage. Descriptive analysis is a method used in researches in which the conceptual and theoretical framework is determined clearly beforehand. The research questions, the questions utilized in interview and observation processes or the dimensions in these processes are considered during the presentation of the data (Yıldırım & Şimşek, 2005). At the beginning of the process for analyzing the interview data, sound recordings were put in writing and transferred into the interview form prepared in computer. Then common statements in the responses given by the teacher candidates during the semi-structured interviews were determined. Teacher candidates' responses to the questions were paired under the same themes. As the next step, the views of teacher candidates were classified. The data were given the final form
and organized then. The views, coded under certain themes in the previous phase, were associated with each other and analyzed. It was at this stage that the associations were established between the opinions stated by teacher candidates.

The functions of the structures and organs making up the digestive system were given to the teacher candidates in written texts. They were asked to answer the questions prepared based on these texts by drawing. As a second material, they were given diagrams showing the organs of the digestive system and were asked to write the names of the organs indicated by arrows. The data collected in writing were analyzed using documents analysis technique. Documents analysis is a method that involves the analysis of printed materials containing information about the phenomena and events (Yıldırım & Şimşek, 2005). The analysis of research data were carried out in the following phases: 1. The documents collected from the teacher candidates were examined separately by each of the two researchers. 2. The researchers coded the suitable themes by independently reading the forms where the data within the scope of the study was written. In situations where there were not any themes to mark, they formed another theme under “other” title for this data and performed the markings under that theme. 3. After coding the themes independently, the researchers compared the reliability of the coding keys. During the comparison, themes which included each question item and were marked by the researchers were controlled and the “agreement” and “disagreement” among the researchers were determined. If the three researchers marked the same theme or did not mark a specific one at the same time, this situation was considered to be an “agreement among experts;” whereas the situations where they marked different themes were considered as “Disagreement.” The conciliation percentages were determined based on Miles and Huberman’s (1994) formula. The result gained through this formula showed that there’s 85% reliability. The 15% data on which the three researchers could not reach an agreement was placed into the existing themes with the consensus reached through the joint study by the researchers.

3. Findings

3.1. Comprehension of structures and functions through texts and shapes

The text given to the teacher candidates gave information about the structure of the teeth and tooth types. In parallel with the information given in the text, they were asked to tabulate the information related to the number of teeth, tooth form, tooth position and functions in infancy and adulthood. 10 out of 46 teacher candidates who were present in the lesson that day did not respond to the question. Almost all of the teacher candidates who provided an answer for the question gave incorrect information about the number of the number of teeth in infancy. They were also confused about the number of premolar teeth and that of molar teeth in adulthood. In explaining the position and function of teeth, on the other hand, the teacher candidates were turned out to be more competent.

In the text of functions given to teacher candidates were explained digestion steps of proteins, carbohydrates and fats and the enzymes involved in the meantime. The teacher candidates were asked to illustrate the steps of the process. 11 teacher candidates did not answer the question. Six of the candidates preferred drawing, but three of them managed to give full illustrations. 16 teacher candidates, on the other hand, presented the topic with texts or equations but they failed to provide adequate explanation about comprehension of enzymes in particular. The teacher candidates were given texts and diagrams which describe the structures and functions of the digestive system so that the comprehension level related to this topic can be determined. The teacher candidates were asked to write the names of the digestive system organs indicated by arrows in structure diagrams. It was determined that the teacher candidates felt most confused about the locations of the stomach, gallbladder, liver and pancreas. It was also found that almost all of the teacher candidates were incompetent to locate the places of hard palate, tongue, uvula and soft palate in the mouth.

In function diagrams, the teacher candidates were asked to express in writing the stages from the food intake in the mouth till its arrival to mouth. It was determined that the teacher candidates were inadequate for reading function diagrams. The greatest trouble experienced was about expressing the stages of the process of swallowing. Especially the stage in which the uvula stops respiratory process during swallowing could be properly expressed by almost none of the teacher candidates. It could be concluded in light of these findings that the teacher candidates are inadequate in visualization.

In visualization of the digestive system, the criteria preferred by Mathai and Ramadas (2009) were adopted. In teacher candidates’ visualization of the digestive system, forming of an image, accuracy of the image produced and manipulation of the produced image and accuracy of this manipulation criteria were adopted. The teacher candidates...
were asked "What would it be like if the location of the salivary glands were different or if they did not exist?"
Some of the responses to this question are given below:
If it weren’t for the salivary glands,
• foods couldn’t get wet and the mouth wall couldn’t be dampened
• food residues would harm teeth
• amylase enzyme initiating digestion of carbohydrates in the mouth would not take place
• we wouldn’t be able to get a taste with taste buds
• we wouldn’t be able to chew and swallow foods comfortably
If the salivary glands were somewhere different,
• they wouldn’t be able to perform their functions fully because each of them have different tasks
• it would take long for the secreted saliva to reach foods and the mouth so digestion would be more difficult
• if the sublingual salivary gland were under the chin, lubrication of foods would not be possible and the mouth wall would not always be moistened.
When answering this question, students who could describe the system effectively could also articulate what would happen if structure of the system were different or it was viewed in a different way. But they preferred to express their knowledge with text instead of drawing diagrams.

3.2. Teacher candidates’ text-drawing preferences

A total of 39 teacher candidates, present in class on the day the topic was taught, were given the following task: “On a drawing, indicate the functions that are performed till the food arrives the stomach.” 17 teacher candidates preferred not to respond while the remaining 22 teacher candidates tried to perform the task; 9 of them preferred writing and 13 of them chose drawing to present the topic. Considering these responses, it could be argued that only 1/3 of 39 teacher candidates preferred to express the images already in their mind in drawing. Interviews with teacher candidates revealed similar results as well. The teacher candidates mentioned their preferences of texts or drawing with the following: “if there is a visual aid I understand better, but when I read on my own and get brief notes I can learn better,” “actually when I both read the relevant texts and see them in drawing, I learn where things are and what tasks they perform at least; it works better for me when both of them are together,” and “in fact, it all depends on the situation or the lessons. Visuals are more useful for some lessons but for some other lessons it doesn’t make any difference for me at all. But in general, I can say that I make use of visuals more than texts. These statements support the idea that teacher candidates prefer visuals to written texts in learning terms.

Teacher candidates participating in the research stated that their prior knowledge played an important role in the illustrative transfer of the visualization occurring in the mind. The following statements of the teacher candidates reveal that prior knowledge is an essential part visual animation: “I need to have a preliminary study for this. If did not design or see any drawing related to the digestive system, it is really difficult for me to describe it after reading the text. But when I have a preparation, if I studied previously about that, drawing is the easiest way for me because sometimes people can not express themselves in writing. Sentences can be long and boring but you can show anything with arrows in drawing; you can literally describe,” “Actually I could not make a complete drawing of what I had not seen before, so I just wrote their names instead of drawing” and “I managed to do some of them based on my prior knowledge, but I couldn’t do the complicated ones so I just left them incomplete and explained only verbally.”

3.3. The problems experienced by teacher candidates about visualization

Teacher candidates pointed out with the following statements that they had problems in visually expressing the images created in the mind: “Receiving the texts and performing the drawing was too much of a challenge for me and I couldn’t make that. Converting into drawing shows how much we comprehend the text. We couldn’t convert the ones we didn’t understand because there were too many foreign terms in the texts,” “I could just show things like mouth and teeth, generally things I can see, but I couldn’t make it for the internal organs,” “I couldn’t make any drawing nor could I draw any visuals. I actually knew the ones I had read before and perhaps I could have visualized them in my mind but I just couldn’t express those things in drawing,” “we hadn’t had much visualization experience in the previous years, I mean we had not been asked to do something like that. So our knowledge was limited to what the professors presented or to our own effort. I think this had an effect on the fact that I had difficulty” and “in
this practice, I had some difficulties in drawings and I could not understand some of the theoretical information. For example I could not identify the liver there; I couldn’t figure out its exact location.” The teacher candidates attributed the problems they had in visualization to the inadequacy of the previous practices. They also came up with some suggestions to increase their proficiency in visualization stated in the following expressions: “I think this practice would have been better if the text were presented with illustrations rather than a long text, if I had been able to picture something in my mind and if we had been asked to place them in those drawings. I mean we didn’t know the drawings so I couldn’t visualize anything in my mind to draw,” “if there had been a discussion atmosphere in the classroom contributed by everyone’s ideas, if each student had told what he or she knew about the structure of the tongue for example, maybe our learning would have been more permanent and therefore we could have performed the drawing task better” and “we use concept maps or other visual methods to achieve concrete and permanent learning. We could practice visualization better if we had more of such applications.”

4. Discussion

Research findings revealed that Turkish teacher candidates have high dependence on verbal mode. The teacher candidates expressed both structure and their functions significantly better with texts rather than diagrams. The teacher candidates also stated that their prior knowledge strongly influenced their visualization. Similar results from Mathai & Ramadas (2009) research support our findings. They also found that Indian students have high dependence on verbal mode. It could be suggested that the similar cultural backgrounds of Turkish and Indian educational systems might have led to these results.

The teacher candidates recommended that being exposed to more instructional practice about visualization may increase their competence in visualization. Yeh & Chen’s (2010) research findings implied that the instruction of visual design principles could possibly improve pre-service teachers’ visual literacy. Also Ainsworth & Loizou (2003) found that learners could overcome the text disadvantage if they drew self-explanations.

Research results also point out that teacher candidates have problems with text’s structural organizations. The teacher candidates themselves claimed if they had better explanations on text they would give better answers. Pettersson (1993) indicates that poor design can inadvertently confuse learners, and learners may end up less competent than before. It is important to design visuals that do not mislead or confuse people. Researchers also suggest that learning visual design principles could help both designers and learners to gain ability to compose, analyze, and interpret visual materials (Carter, 2003; Graham, Hannigan, & Curran, 2005).

5. Conclusion and recommendation

- Teacher candidates prefer learning through texts.
- Prior knowledge affects visualization.
- Teacher candidates have difficulties in the field of mental visualization.
- Increasing the number of studies related to visualization would certainly add to increasing teacher candidates’ competency.

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