



Creative Comparisons Developed by Pre-service Science Teachers and the Use of Anthropomorphism and Animism Towards Electrochemistry Concepts

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Abstract

The aim of this study was to determine the creative comparisons pre-service science teachers made relevant to the topic of electrochemistry and to uncover how they used anthropomorphism and animism in formulating these creative comparisons. In the context of this aim, the study was conducted in line with the phenomenographic research method. The study group consisted of 220 pre-service teachers enrolled in the Department of Science Education at a State University in Turkey in the 2015-2016 academic year. A creative comparison form was used in the study as a data collection instrument. The creative comparison form referred to the concepts of "reduction, oxidation, reducing agent, oxidizing agent, anode, cathode, electrolysis, electrode, salt bridge, corrosion" and required the students to complete the sentences presented to them by filling in the blanks (e.g., reduction is like because). Content analysis was used in the analysis of the data derived from the creative comparisons. The statements and words that reflected the use of anthropomorphism and animism in these creative comparisons were individually recorded and encoded as data. The results of the analysis showed that the students were confused with the concepts of "reducing agent," "oxidizing agent" and "corrosion" and had alternative concepts for these notions. At the same time, it was discovered that the pre-service teachers considered the concepts of "anode" and "cathode" only in the context of the galvanic battery and disregarded the electrolytic cell. It was seen that the pre-service teachers used anthropomorphic references in the statements they used in their creative comparisons.

1. Introduction

When students are asked to make comparisons about science concepts, creative comparisons give them the opportunity to freely express themselves and be more productive in learning science [1]. Also, while explaining scientific concepts, students may also make use of anthropomorphism and animism. Anthropomorphism involves attributing human emotions and desires to inanimate objects; animism is the belief in the existence of a force that makes inanimate objects come alive [2]. In this context, student-generated creative comparisons and the use of anthropomorphism-animism in these creative comparisons may provide a tool that teachers can use to evaluate how students understand concepts [3]. Many studies have indicated that students have difficulties understanding some topics in electrochemistry. In this context, it is important to determine how learners explain concepts in electrochemistry. One of the ways to do this is to become aware of learners' understanding of these concepts through their creative comparisons.

This study determined the creative comparisons that pre-service science teachers made relevant to the topic of electrochemistry and sought to uncover how they used anthropomorphism and animism in formulating these creative comparisons. Based on these goals, following questions were examined:

- 1) Which creative comparisons did the pre-service teachers participating in the study use to explain the concepts pertaining to electrochemistry?
- 2) Which common characteristics did these creative comparisons have?
- 3) How did the pre-service teachers use anthropomorphism and animism in their creative comparisons?

2. Method

This study was to employ the phenomenographic research method. In this study, the phenomenographic research method was accepted as a suitable method because determining the creative comparisons the pre-service teachers generated about concepts of electrochemistry and how



they used anthropomorphism and animism in these creative comparisons comprised the basic aim of the study.

2. 1. The study group

The study group for the research was selected according to the method of typical case sampling. The study group consisted of 220 pre-service science teachers (1st, 2nd, 3rd and 4th year students) who were studying in the Science Education Department of a state university in Turkey during the 2015–2016 academic year.

2.2. Data Collection Instrument

In the study, a creative comparison questionnaire was used as a data collection instrument. The pre-service teachers were asked to generate creative comparisons for the concepts of “reduction, oxidation, reducing agent, oxidizing agent, anode, cathode, electrolysis, electrode, salt bridge, corrosion.” Also, the pre-service teachers were asked to explain how they generated these creative comparisons by completing the sentences in the questionnaire (e.g., *Reduction is likebecause*).

3. Data Analysis

The data acquired from the creative comparisons questionnaire in the study were analyzed according to content analysis. In the analysis, five steps were followed [4]. The steps were:

1. **Naming:** In this step, each of the creative comparisons composed by the pre-service teachers for each concept were individually examined. Also, some of these creative comparisons that were not meaningful were determined.
2. **Eliminating:** In the eliminating stage, some creative comparisons that had been determined in some pre-service teachers' papers in the naming stage were dropped from the study. 220 pre-service teachers' papers were accepted into the study.
3. **Developing themes:** In this step, the prospective teachers' creative comparisons were examined according to common characteristics, and themes were defined.
4. **Establishing validity and reliability:** To establish reliability, two researchers independently paired the prospective teachers' creative comparisons with the themes. The percentage of concordance between the researchers' pairing of the themes was calculated as 0.87 by using [5] formula.
5. **Calculating percentages and frequencies for the creative comparisons:** In this stage, frequencies and percentages were calculated for the creative comparisons.

In addition, the use of anthropomorphism and animism was examined in the creative comparisons.

4. Results

The creative comparisons generated by the pre-service are shown in Tables 1, 2 and 3. Creative comparisons with a frequency of 10 and over have been included in the tables.

When the creative comparisons generated by the pre-service teachers on “Reduction, Oxidation and Reducing Agent” are examined in Tables 1 and 2, it can be seen that these creative comparisons can be collected in the two themes of formation and valence change. Some of the pre-service teachers' creative comparisons and explanations are as follows:

“Reduction is like a diabetic because diabetics bring their glucose levels down by taking insulin. In reduction too, valence is brought down by taking in electrons.” PT-37

“Oxidation is like teaching because knowledge is given out when teaching. In oxidation too, this is achieved by giving out electrons.” PT-60

It was also seen from the explanations the pre-service teachers gave that they had alternative concepts regarding the concepts. It was especially found that the pre-service teachers had alternative concepts about oxidizing agents and that they confused the concepts of reduction and oxidation. Some of the explanations were as follows:



Table 1 Creative comparisons generated by pre-service teachers on concepts of Reduction, Oxidation and Oxidizing Agent and their frequencies and percentages

Reduction				Oxidation				Oxidizing Agent			
Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%
Formation	Friend	26	11,18	Formation	Motherly love	25	11,36	Formation	Thief	18	8,18
	Shopping	20	9,09		Unrequited love	19	8,63		Virus	15	6,81
	Student	12	5,45		Breath	18	8,18		Platonic love	12	5,45
	Scale	12	5,45		Doctor	14	6,36		Bad friend	10	4,54
	Worker	10	4,54		Experience	12	5,45		Failure	10	4,54
	Labor	10	4,54		Teaching	11	5				
Valence Change	Overeater	22	10	Valence Change	Thermometer	18	8,18	Valence Change	Boxer	16	7,27
	Diabetic	18	8,18		Blessing	14	6,36		Olive oil	11	5
	Experience	16	7,27		Title	14	6,36		Football	11	5
	Negotiation	12	5,45		Success	11	5		Interest	10	4,54
	Lose weight	11	5		Airplane	10	4,54				

Table 2 Creative comparisons generated by pre-service teachers on concepts of Reducing Agent, Corrosion and Salt-bridge and their frequencies and percentages

Reducing Agent				Corrosion				Salt-bridge			
Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%	Theme	Creative	f	%
Formation	Our loved ones	17	7,72	Decomposition	Iron	14	6,36	Connection	Matchmaker	18	8,18
	False friend	15	6,81		Broken heart	14	6,36		As-Sirat	15	6,81
	Fuel	14	6,36		Natural disaster	13	5,9		Bosphorus Bridge	12	5,45
	Avid fan	11	5		Grinding wheel	11	5		Setter	10	4,54
Valency change	Wrestler	16	7,27	Change	Old age	14	6,36	Balance	Child	15	6,81
	Book	13	5,9		Knowledge forgotten	10	4,54		Scale	14	6,36
	Psychologist	11	5		Lose weight	10	4,54		Book	10	4,54
	Battery	10	4,54								

"A reducing agent is like a wrestler because when a wrestler loses, he loses his value. When a reducing agent is reduced, its value is reduced as well." PT-84

"Reduction is like losing weight because when people lose weight they lose kilos. In reduction too, electrons are lost." PT-198

A review of Table 2 and 3 show that the concepts of connection and balance have emerged with regard to the concepts of salt bridge and electrode. Some of the explanations of the pre-service teachers are the following:

"A salt bridge is like the Bosphorus Bridge because it connects two banks. A salt bridge connects two half-cells. The current running from one to the other is similar." PT-65

"An electrode is like a teacher because there can be no education without a teacher; the teacher is an important link and is needed in the educational system. Electrodes too make a connection and are needed." PT-47



Table 3 Creative comparison generated by pre-service teachers on concepts of Anode, Cathode, Electrolysis and Electrode their frequencies and percentages

Anode				Cathode				Electrolysis				Electrode			
Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%	Theme	Creative Comparison	f	%
Load	Negative person	16	7,27	Load	Happiness	22	10	Decomposition	Operation	15	6,81	Connection	Train	19	8,63
	Sadness	13	5,9		Positive person	17	7,72		School principal	12	5,45		Orchestra	15	6,81
	Nervous person	12	5,45		Psychologist	11	5		Farewell	12	5,45		Light	15	6,81
	Sickness	11	5						Friendship	11	5		Cable	14	6,36
Reaction	Sun	15	6,81	Reaction	Sun	19	8,63	Electric Current	Sieve	10	4,54	Balance	Teacher	12	5,45
	Depression	12	5,45		Chocolate	15	6,81		Book	15	6,81		Scale	17	7,72
	Generosity	11	5		Insolence	12	5,45		Love	12	5,45		Sickness	14	6,36
	Student	10	4,54		Stingy	10	4,54		Trade	11	5				

The creative comparisons and explanations of the pre-service teachers on the concepts of anode and cathode showed that they focused more on the loads of Galvanic batteries and did not take account of the electrolysis cell. Some of the explanations follow:

"An anode is like a negative person because it radiates negativity. The load valency of an anode is also negative." PT-23

"A cathode is like a psychologist because it is positive. The cathode's load is positive too." PT-81

When the creative comparisons of the pre-service teachers were examined for characteristics of anthropomorphism and animism, it could be seen that statements such as "need," "feeling relief," "feeling bad," "wishing to be happy," and "getting all tired out" that reflected the language of human behavior were frequently used.

5. Conclusion and Discussion

In this study, it was found that in general, the pre-service teachers built their creative comparisons around the galvanic battery. It was also observed that the pre-service teachers had alternative concepts about "reduction," "oxidation," "oxidizing agent" and "reducing agent" and that their creative comparisons were by and large formulated using the language of anthropomorphism and animism.

References

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