New Perspectives in Science Education

International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

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

Gülten ŞENDUR*, Suat TÜRKOGUZ **, Abdullah TOKU***

*Dokuz Eylül University, Buca Education Faculty, Department of Secondary Science and Mathematics Education

**Dokuz Eylül University, Buca Education Faculty, Department of Science Education,

*** Celal Bayar University, Education Faculty, Department of Science Education.

sendurgulten@gmail.com ,suat.turkoguz@gmail.com,***tokuabdullah@gmail.com*

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].

At the same time, 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]; [3]; [4].

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 [5].

- Many studies have indicated that students have difficulties understanding some topics in chemistry. One of these topics is electrochemistry. It was particularly reported that students' conceptual difficulties included holding some common alternative conceptions dealing with electrolysis, electricity flow, voltaic cells and the polarity of electrodes [6].

- 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 1st-, 2nd-, 3rd- and 4th-year 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, the study searched for answers to the following questions:

- Which creative comparisons did the pre-service teachers participating in the study use to explain the concepts pertaining to electrochemistry?
- Which common characteristics did these creative comparisons have?
- How did the pre-service teachers use anthropomorphism and animism in their creative comparisons?
- Did the pre-service teachers have alternative concepts in their minds about the concepts taught to them? If so, what were these alternative concepts?

Method

- This study was to employ the phenomenographic research method. The basis of phenomenographic research is defining, analyzing and understanding how individuals conceptualize phenomena occurring in the world around them [7]; [8].

- 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.

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.

- All of the prospective teachers volunteered to participate in the study. At the same time, the pre-service science teachers had studied the topic of electrochemistry in their chemistry classes in secondary school and in the General Chemistry course they had taken in their first year at the university

Data Collection Instrument

- In the study, a creative comparison questionnaire was used as a data collection instrument. In selecting the concepts in the creative comparison questionnaire, the researchers were particularly focused on the alternative concepts about electrochemistry that most of the learners had..

DATA TOOLS

- At the same time, two experts in the field examined the concepts in terms of the validity of the Creative Comparison questionnaire. Also, a pilot study was conducted with 20 prospective teachers outside of the sample, and as a result of this pilot study, it was seen that 15 minutes would be sufficient for each concept .

- After some explanations about creative comparisons were presented to the pre-service science teachers, 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 like ..... because .....).*

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: “Naming; Eliminating, Developing themes; Establishing validity and reliability; Calculating, and interpreting percentages and frequencies for creative comparisons” [9]; [10], [11], [1].

Data Analysis

- The steps in the process were:
- **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. Then the pre-service teachers' creative comparisons were set up in alphabetical order.

Data Analysis

- **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. In total, 14 prospective teachers' papers were eliminated, and 220 pre-service teachers' papers were accepted into the study.

Data Analysis

- **Developing themes:** In this step, the prospective teachers' creative comparisons were examined according to common characteristics, and themes were defined. With this aim, a focus was placed on the explanations the pre-service teachers provided after the word "because" in the questionnaire.

Data Analysis

- **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 [12] formula.

Data Analysis

- **Calculating and interpreting 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.

Results

- The creative comparisons generated by the pre-service teachers on the concepts of “reduction, oxidation, reducing agent, oxidizing agent, anode, cathode, electrolysis, electrode, salt bridge, corrosion and the order they were offered in are shown in Tables 1, 2 and 3. Creative comparisons with a frequency of 10 and over have been included in the tables.

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
	A person in need	16	7,27		Breath	18	8,18		Platonic love	12	5,45
	Student	12	5,45		Richness of the soul	16	7,27		Demoralizing fan	11	5
	Scale	12	5,45		Factory owner	16	7,27		Bad friend	10	4,54
	Flying balloon	11	5		Doctor	14	6,36		Failure	10	4,54
	Worker	10	4,54		Experience	12	5,45				
	Labor	10	4,54		Teaching	11	5				
					Technology	10	4,54				
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		Interest rate increase	12	5,45
	Experience	16	7,27		Title	14	6,36		Olive oil	11	5
	Raw honey	14	6,36		Success	11	5		Football	11	5
	Negotiation	12	5,45		Airplane	10	4,54		Interest	10	4,54
	Lose weight	11	5		Kite	10	4,54				
	Devotion	10	4,54		Skyscrapers	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 Comparison	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
									Bad friend	10	4,54
Valency change	Wrestler	16	7,27	Change	Old age	14	6,36	Balance	Child	15	6,81
	Title	13	5,9		Body of a Non-athlete	10	4,54		Scale	14	6,36
	Book	13	5,9		Knowledge forgotten	10	4,54		Book	10	4,54
	Psychologist	11	5		Lose weight	10	4,54				
	Battery	10	4,54								

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		Girl/Boy friend	13	5,9		Farewell	12	5,45		Light	15	6,81
	Sickness	11	5		Psycholo-gist	11	5		Friendship	11	5		Cable	14	6,36
									Sieve	10	4,54		Tube	12	5,45
									Fishermen	10	4,54		Teacher	12	5,45
Reaction	Sun	15	6,81	Reaction	Sun	19	8,63	Electric Current	Book	15	6,81	Balance	Scale	17	7,72
	Betraying friend	14	6,36		Chocolate	15	6,81		Love	12	5,45		Sickness	14	6,36
	Depression	12	5,45		Insolence	12	5,45		Trade	11	5				
	Generosity	11	5		Stingy	10	4,54								
	Student	10	4,54												

- 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 person in need because a person in need tends to get help because he needs to. In reduction, too, there is a need for electrons so electrons are taken."* PT-58
- *"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 that revealed these alternative concepts were as follows :

- *“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*

As can be understood from Table 2, that two themes appeared regarding the concept of corrosion. Some of the creative comparisons in these themes and the explanations given are as follows :

- *“Corrosion is like a grinding wheel because it causes surfaces to corrode . In corrosion too, surfaces get corroded because of chemical reactions.” PT-90*
- *”Corrosion is like old age because our capacity to do things change when we are old, our level of using our functions decreases . In corrosion too, many properties break down.” PT-4*

- 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 in these themes 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.

- 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*

As can be understood from Table 3, the pre-service teachers' creative comparisons were more related to the decomposition category. One of the explanations in this context was:

- *Electrolysis is like an operation because in an operation, a procedure is carried out to break down the patient's sick part. Electrolysis too is a process where chemical components are separated from each other." PT-56*

- 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.

Conclusion and Discussion

- In this study, which examined the creative comparisons pre-service science teachers generated regarding the basic concepts of electrochemistry and the anthropomorphic and animistic characteristics they attributed to the concepts, it was found that in general, the pre-service teachers built their creative comparisons around the galvanic battery.

Conclusion and Discussion

- 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

- Şendur, G. (2014). Are creative comparisons developed by prospective chemistry teachers evidence of their conceptual understanding? The case of inter- and intramolecular forces. *Chemistry Education Research and Practice*, 15 (4),689-719.
- Treagust, D. F., Chittleborough, G., & Mamiala, L. T. (2003). The role of submicroscopic and symbolicrepresentations in chemical explanations. International Journal of Science Education,25 (11),1353-1368.
- Kallery, M., & Psillos, D. (2004). Anthropomorphism and Animism in Early Years Science: Why Teachers Use Them, How Conceptualise Them and What Are Their Views on Their Use". *Research in Science Education* (34), 291-311.
- Nakiboğlu, C., & Poyraz, H. E. (2006). Investıgatıon of "Anthropomorphısm" and "Anımısm" ın Unıversıty Chemıstry Students' Explanatıons Related to Atom and Chemıcal Bondıng. Kastamonu Educatıon Journal*, 14*, 83-90.

References

- Lancor R. A., (2014), Using student-generated analogies to investigate conceptions of energy: a multidisciplinary study, International Journal Science Education., 36(1), 1–23.
- Rahayu, S., Treagust, D. F., Chandrasegaran, A. L., Kita, M., & Ibnu, S. (2011). Assessment of electrochemical concepts: A comparative study involving senior high school students in Indonesia and Japan. *Research in Science and Technological Education, 29*(2), 169–188.
- Marton F. M., (1994), Phenomenography, in Husen T. And Postlethwaite T. N. (ed.), The international encyclopedia of education, Oxford: Pergamon, 2nd edn, vol. 8, pp. 4424–4429.
- Vanderstoep C. W. & Johnston D. D., (2009), Research Methods for Everyday Life: Blending Qualitative and Quantitative Approaches, San Francisco: Wiley.

References

- Saban A., Kocbeker B. N. & Saban A., (2006), An investigation of the concept of teacher among prospective teachers through metaphor analysis, Education Science: Theory Pract., 6(2),461–522.
- Saban A., (2008), Primary school teachers' and their students mental images about the concept of knowledge, Elementary Education Online, 7(2), 421–455.
- Ozder A., (2013), How do high-school students perceive the concept of 'map': A case study from Istanbul, Education Research Review,8(16), 1392–1398.
- Miles M. B. & Huberman A. M., (1994), Qualitative data analysis, Thousand Oaks: Sage.

Thanks for listening !