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Teacher narration when using pictures to depict everyday life physical science contexts: A novel classification

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ABSTRACT
This paper describes a study in which five physical science teachers were requested to take photographs and describe the science concepts embedded in these. Particularly, the science had to be relevant to the grade 10 – grade 12 curriculum they were teaching. This study was an exploratory case study employing qualitative methods. To analyze data from the study, the four-field method for analyzing photographs was used (Käpylä, 2014). The analysis reveals that in all the narratives accompanying the captured photographs, the Indirect Observation – Cognitive Domain dominated. The overall findings of the study demonstrate that the corresponding narrations reflect the cognitive role of photographs. However, this paper argues that phenomenological thinking about human experience connects emotions and personal and social meanings to factual knowledge and knowledge structures, therefore these purposes of pictures in teaching and learning of physical science could be divided into cognitive, affective and psychomotor domains.

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Introduction

Since the learning speed and style of everyone differ, the education required also differs (Bayar & Çepni, p.1 2022). In everyday life, science is always there, and teachers could use this as a teaching resource. It is pointed out that such teaching resources can provide "… meaningful learning of science concepts and the use of this knowledge in situations or problems where they are encountered in life" (Çepni, Ülger & Ormanci, 2017, p. 2). Furthermore, it is argued that the basic feature of scientifically literate persons is understanding and recognizing science concepts from everyday life (Çepni, et al., 2017). This article aims to showcase the conceptualization and understanding of science from a real-world perspective (Tal & Dierking, 2014). The teaching and learning of science can be enhanced in several ways. For instance, this could be through (i) practical work, (ii) science shows, (iii) technology simulations, and (iv) interpreting the real world. Practical work involves improving understanding of science concepts by linking theory to practice using science laboratory apparatus. In addition, science shows are useful because they excite, engage, and teach students science concepts. Furthermore, there are technology simulations about science concepts that can be presented using computer-integrated technology. Moreover, interpreting the real world could involve taking photographs and interpreting these. Here, this would involve narrating science concepts embedded in a photograph. With the advent of smart mobile telephones, taking photographs has become easier with respect to pastimes. An extra advantage is possible if teachers and their students may use such photographs in the teaching and learning context. In fact, instructional materials such as pictures, photographs, and charts are not only necessary in the instructional process but also useful in drawing students' attention (Okanlawon, 2017, p.275). In this connection (Ortiz, 2023, p2) opines that posters can be something more than visual supports through which detailed, synthetic and graphic information is shown, but at the same time, they can be a didactic tool with which to bring knowledge to students.

This suggests that meaning making devices used in the teaching and learning context may be extremely beneficial to rural and disadvantaged schools that could not afford the other approaches identified here. In addition to this, Rankhumise (2018, p.3) argues that many students have only one side of acquisition (school). Parents may be illiterate and therefore unable to assist students with their schoolwork. There may be fewer resources such as reading books, the internet, and encyclopedias to assist learning. Unlikely, student needs to have infrastructure such as study desk or electricity at home to do their homework.

When a science textbook is opened, there can be usually found text, written in an academic language including illustrative diagrams and pictures. Therefore, utilizing photographs in teaching becomes even more important in situations where textbooks are not readily available. This is because diagrams and pictures provide a different perspective through visualization. The cognitive process of visualisation involves three stages named as the internalization, conceptualisation, and externalisation of visual models (Mnguni, 2014, p.3). Internalization is about the eye, for instance seeing an object and the brain processing this. Conceptualization relates to meaning-making which is a reconstruction of prior knowledge in working memory based on new knowledge from where it is stored as cognitive visual models (Mnguni, 2014, p.3). On the other hand, externalization involves "… the production of external visual models by way of expressing cognitive mental schema" (Mnguni, 2014, p.3). Essentially, students see a picture and commit this to the working memory wherein Visio-spatial thinking takes place (Mayer 2003). Visio-spatial thinking is "… the process of using the eyes to identify, locate, and think about objects and orient ourselves … the formation, inspection, transformation, and maintenance of images in the 'mind's eye' …" (Mathewson, 1999, p.34).

Therefore, visual models such as diagrams and pictures lead to learning which involves different mental processes (Mayer, 2002). Mayer argues that if the goal of instruction is to promote transfer, the teaching objectives should "… include the cognitive processes associated with understand, apply, analyze, evaluate, and create" (Mayer, 2002, p 323). Further, Mayer points out that transfer is about finding ways that foster meaningful learning, which involves emphasizing cognitive processes "… that go beyond remembering" Mayer (2002, p.228).

Researchers have investigated the effects of the use of diagrams and pictures in different learning and teaching contexts. For instance, Triacca (2017) focussed on teaching and learning with pictures, using photography in primary schools. While on the other hand, Calvani (2011) and Paoletti (2011) investigated the efficacy of digital images and text. Images have also been used in teaching as diverse learning areas as medicine. A typical example here is a literature review study that investigated the constructive use of images in medical teaching (Norris, 2012). Käpylä (2014) underlined the teaching potential of pictures. Meantime, Hutchings and Ojalvo (2009) outlined how photographs help to convey complex scientific concepts and ideas in the classroom.

In this study, the aim was to establish teacher narration when using pictures to depict everyday life science in physics. To establish teacher narration about teaching physical science concepts using photographs, the four-field method which was developed by Käpylä (2014) was used to analyze pictures. In the four-field method to analyze photographs, there are direct and indirect observations that are influenced by cognitive as well as affective domains. The four-field method is associated with the notion of "Interpretative Phenomenological Analysis (IPA)". The IPA is used to understand participants' subjective realities through personal interpretations of their lived experiences and the meanings that they attach to such experiences (Smith, Flowers & Larkin, 2011). In IPA, participants describe what a phenomenon looks like for them within a specific context. However, the

IPA extends simple descriptions and develops an interpretative analysis of the description in relation to social, cultural, and theoretical contexts. Insights and lessons learned about the processes involved in IPA by a researcher exploring photographs as pedagogical resources may help to advance this methodology within science education research. Table 1 shows the relationships within the four-field method. It can be observed from the table that analyses could involve Direct observations within a Cognitive or Affective domain.

Table 1

The Four-Field Method for Analyzing Photographs

Observations	Domain	
	Cognitive	Affective
Direct	Directly observed objects and details	Immediate feelings and attitudes aroused by a picture
Indirect	Interpretations based on knowledge structures	Socially mediated attitudes, symbols and meanings'

Note. Adapted from Käpylä (2014)

In describing direct and indirect observations, Wilson (n.d.) opines "Observation may be direct, i.e., the researcher is the observer, recording what he or she is watching or … may be indirect, i.e., the researcher must rely on the reported observations (including self-observations) of others". What this means for instance is: if one has a photograph showing a snail eating a leaf (see Figure 1) then they may say, I see a snail eating a leaf or even describe the features of the snail and the leaf. In effect, this person can describe directly what he/she observes (Direct Observation). Since the person will be observing and describing the snail in detail this would be from a cognitive perspective. In this case, this would be classified as Direct – Cognitive. The other three combinations would be interpreted in a similar manner depending on the descriptions of the observer.

Figure 1

A Photograph of a Snail Eating a Leaf

Note. UWL Website – BioWeb Home, 2011

Challenges to learning and teaching science from a rural perspective are not unique to South Africa. For instance, in Nigeria, in an analysis of poor performance among high school chemistry students, the recommendation was that effective and academically qualified teachers should teach the subject (Nbina, 2012). In Kenya on the other hand, researchers report that high achievers in chemistry had positive attitudes and good study skills and they prepared better for examinations (Ngila &

Makewa, 2014). Meanwhile, in Tanzania, researchers identified shortages of learning materials and a lack of guidance on the importance of science in students' future as leading to poor performance (Nyamba & Mwajombe, 2012). The examples illustrated here from an African context show the need to use different initiatives meant to improve the teaching and learning of science at school.

It is opined that well-written science textbooks assist in improving the competencies of students who study concepts at school (Sinaga, Kaniawati, & Setiawan, 2017). This is because textbooks contain the curriculum content, exercises, and examples meant to assist students in grasping the subject content (Stein, 2017). In this regard, science textbooks are an essential component in teaching subjects such as biology, physical science, and mathematics. This is more so in rural schools where the textbook is relied upon even much more than fully equipped laboratories. The textbooks are relied upon because invariably in South Africa, rural schools generally do not have laboratories, electricity, and the necessary digital technology to support teaching and learning (Khumalo, 2014). Students from rural schools also find it difficult to obtain textbooks. This may be due to issues of accessibility of schools. What has been revealed by studies though is that the unavailability of textbooks in such schools has resulted in difficulties in teaching (Kiggundu & Nayimuli, 2009). Thus, it is decided to consider exploring the use of photographs as teaching resources. Here it was contemplated that photographs depicting everyday life would be used to teach curriculum-based physical science concepts. This was based on the view that when "… using photography … we can better connect and show our students how math surrounds us" (Furner & Marinas, 2015, p. 146). The question that this study sought to answer was "What were teachers' narrations about teaching physical science concepts using photographs depicting everyday life experiences?" This was important from a rural perspective where supporting teaching resources are not available because there are limited studies investigating this.

METHODS

This study used a qualitative method. Qualitative research is a form of social inquiry where meaning arises out of social situations.

Research Design

This study is the case study approach. A case study "… is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 18). In fact, case studies are effective in investigations that seek to understand complex real-world issues (Harrison, Birks, Franklin, & Mills, 2017). In the present study, five Grade 12 Physical Science teachers were participants in the case study.

Participants

A convenient sample of five teachers working in five different high schools in the North-West province of South Africa participated in the study. Convenient sample is quick, inexpensive, and convenient (Elfil & Negida, 2017). There were two females and three males whose ages ranged between 25 years and 45 years (M = 35.6 years; SD = 7.54). All were suitably qualified because they had completed a Bachelor of Science degree including a diploma in education. Regarding teaching experience, this ranged between 5 years and 15 years (M = 9.2 years; SD = 3.77).

The teachers were from rural schools in the province. The teachers taught Grade 10 to Grade 12 Physical Science. Their choice was because their schools had not performed well in the 2017 Physical Science examination. The selection of the five was cognisant of the argument that "… there are no easy rules for determining size. It depends on what you want to know, the purpose of the inquiry, what is at stake, what will be credible, and the available time and resources" (McMillan &

Schumacher, 2006, p. 322). In addition, researchers argue that a case study whose intention is to describe the participants' views does not need many respondents (McMillan & Schumacher, 2006). For the purposes of this study and to maintain the anonymity of the teachers, their given names are Teacher 1, Teacher 2, – Teacher 5.

Data Collection Procedure

Participants had to take photographs depicting any area of science within the syllabus. Specifically, the teachers were to capture pictures from everyday life experiences. Following this, they had to write a narration about the photographs. That is a standard explanation of the science they identified in each photograph. The narration had to identify and explain the science in the captured photograph.

Data Analysis

In analysing the five photographs and accompanying narrations, Käpylä's (2014) four-field method was used (see Table 1). Initially, each photograph presented by the participants is described. This is followed by the classification with respect to each narration. In classifying the narrations, codes were used instead of the full names. For example, Direct Observation is depicted by (DO), and Indirect Observation by (IO). On the other hand, the Cognitive Domain is depicted by (CD) while the Affective Domain is depicted by (AD). For clarity of classification, the codes are included within the narrations. In order to validate each classification, the narratives were given to two senior scholars to independently classify. In all instances, the classifications of the researchers and the senior scholars were the same. This suggests that the classifications could be deemed to be valid.

RESULTS

The first photograph presented by Fatima (all the teachers' names are pseudonyms) showed a room light from a bulb (see Figure 2). The light bulb emitted white light.

Figure 2

A Light from a Bulb

In her narration, Fatima wrote:

Light is an electromagnetic wave that travels at a constant speed [IO – CD]. It can only pass through transparent objects and is absorbed by opaque objects [IO – CD]. As we can see with the window and the wall it only moves through the glass window and it is absorbed by the wall [IO – CD]. Light rays also refract (bend) when they move through materials of different optical densities. It is also well capable of laminating (light up) rooms when is dark. So, if we have a closed room which is without an opening or window, it will stay dark [IO – CD].

The second photograph presented by Makhwenkwe showed sachets of Epson salt (see Figure 3).

Figure 3

Sachets of Epson Salt

In his narration, Makhwenkwe wrote:

Epsom salts as an "old wives' tale" have been deemed useful for prolonging the life of cut flowers, known to be good muscle relaxants and good for detoxification [DO – CD]. I would explore the science within the usefulness of Epsom salts [IO-AD]. Physical science concepts: Epsom salt is also known as the chemical compound magnesium sulfate [IO – CD]. Epsom salts are related to atoms and compounds learned in grade 10 physical science [IO – CD]. Epsom salt contains magnesium, a mineral important to plant life hence adding it to the water of a flower arrangement provides the flowers with a source of magnesium even after they are cut, hence prolonging their life [IO – CD].

The third photograph presented by Mfundo showed rusted iron bars some were painted white and blue while others were not (see figure 4). In his narration, Mfundo wrote:

Figure 4

Rusted Iron Bars

Rusting, also known as corrosion is a spontaneous redox reaction in which a metal (Fe) is attacked by some substances (water and oxygen) in its environment (in air) and is converted to an unwanted compound (Iron III oxide). Iron (Fe) undergoes oxidation by losing electrons [IO – CD]. Corrosion occurs when iron is not protected by paint, it will start to react with water and oxygen in the atmosphere [IO – CD]. Galvanizing/electroplating the metal prevents it from corroding. The photograph shows the difference between painted and un-painted iron bars [DO – CD]. You can see that the unpainted bars have rusted [DO – CD].

The fourth photograph presented by Piet showed books packed on wooden shelves (see Figure 5). In his narration, Piet wrote:

Figure 5

Books Packed on Wooden Shelve

Newton's first law States that an object at rest or moving at a constant speed will continue in that position unless a non-zero resultant force acts on it [IO – CD]. The books on the shelves have a certain force (weight) which they apply on the shelves now the shelves do not break. Also, the books are not lifted upwards. This means that the forces exerted by both objects are exerting are equal but opposite [IO – CD]. There is also a force of gravity on the books which is balanced by the normal force acting upwards from the bookshelves [IO – CD].

The fifth photograph, presented by Bubele showed a car tyre being pumped (see Figure 6). In his narration, Bubele wrote:

Figure 6

A Car Tire Being Pumped

Tyre pressure is important to be maintained and checked at all times especially before a long journey [IO – CD]. At low temperatures, the average kinetic energy of the molecules decrease. The volume is regarded as being the dimensions of the container and the volume of the molecules is neglible [IO – CD]. Also, the car tyre has to be full (the right pressure) before any journey for safety's sake [IO – CD].

Discussion

There was one predominant issue which is the cognitive function of pictures, our data analysis highlighted that most teachers provided narratives that did not recognize the affective function of the pictures. Interestingly, the most widely used theories of cognitivism in education are based on Bloom's taxonomies of learning objectives (Bloom et al., 1956), which are related to the development of different kinds of learning skills, or ways of learning. Bloom and his colleagues claimed that there are three important domains of learning namely: cognitive (thinking), affective (feeling), and psycho-motor (doing). In this connection, learning styles relate to characteristic cognitive, affective, and psychological behaviours that serve as indicators of how students interact with, respond to, and perceive the learning environment (Felder, 2010). It is argued that students have different learning styles and the manner in which they receive and process information is influenced by their characteristics, strengths, and preferences (Felder, 1996; Warren, 2004). In this regard, Felder (2010) argues that one learning style is neither preferable nor inferior to another, but it is different from others and differs in characteristics, strengths, and weaknesses. Teachers missed the effective role of the photographs because visual interpretation strategies do not form part of the science education curriculum at all levels. Common sense thinking of teachers about pictures is also largely contrary to research findings (Cook, 2006). Teaching from pictures is mostly done in the cognitive framework but affective and cultural domains are avoided. In this study, the data revealed that focal points (direct observation) in the photograph only narrowed down the teachers' interpretation of the cognitive function of photographs. Our study aims to add another piece to the puzzle which can be described as "using photographs to teach physical science". Some studies already reviewed the question of analogies performing a very important role in science teaching in classes and textbooks as the facilitator of learning (Guerra-Ramos, 2011; Vosniadou and Skopeliti, 2019). Some scholars further argue that there are many different methods and techniques which can be used in the learning environment to teach abstract events, phenomena, and concepts (Çelik, Kırındı & Ayçiçek Kotaman, 2020).

This paper is an attempt to develop another way of seeing and using pictures in science education, which starts from the analysis of human experience and puts a strong emphasis on the affective domain and personal and social meanings.

Students must be given the opportunity to learn while using authentic contexts that are rooted in real situations outside the classroom and use a variety of life skills in authentic contexts (DBE, 2010). In this connection, Stears et al., (2003) argue that science learning should be linked with everyday knowledge. So that, it can provide students with science that can be used in their everyday lives and build on their experiences, interests and prior knowledge. In the same manner, fundamental information is essential in creating learning experiences that will allow students to either accommodate or restructure their knowledge frameworks for new learning. It helps to organize students' thoughts and learning. According to Stears et al., (2008) meaningful learning is advocated as non-arbitrary, non-verbatim, deliberate effort, and substantive incorporation of new knowledge to prior knowledge which links new knowledge with higher-order concepts in cognitive structure. Teachers did not describe the contextual aspect of the picture before reasoning with the picture. They started by explaining the physical science concept(s) embedded in the picture. For example, Fatima narrated that with her picture of a light bulb emitting white light. It was expected that she would comment about the curtains, the dark room, and the light bulb, the things that one would directly observe when looking at the picture she captured. Contrary, she started with high concepts and she wrote "Light is an electromagnetic wave which travels at a constant speed". The same trend was observed in Piet. In his rusted iron bars, some were painted white and blue while others were not (see Figure 4). And he wrote that "Rusting, also known as corrosion is a spontaneous redox reaction in which a metal (Fe) is attacked by some substances (water and oxygen) in its environment (in the air) and is converted to an unwanted compound (Iron III oxide)". Mfundo also followed the same pattern when commenting about the physical science concept embedded in his picture of books packed on wooden shelves (see Figure 5). He wrote that "Newton's first law states that an object at rest or moving at a constant speed will continue in that position unless a non-zero resultant force acts on it". The only teacher who presented her case differently is Makhwenkwe with a picture of sachets of Epson salt (see figure 3) He wrote

Epsom salts as an "old wives' tale" have been deemed useful for prolonging the life of cut flowers, known to be good muscle relaxants and good for detoxification". He literally wrote the information that appears on the sachet. This information could be virtually seen in the picture and could serve as a good base to start a discussion. In this study, teachers were unable to present their cases in such a way that they demonstrate photographs can also be employed when introducing a topic. Hence, it is necessary to start from simple to complex and the data in this study did not reveal that.

The foregoing presented a theoretical account of the cognitive process of visualization. In essence, it shows that visualization is inherently complex. In this regard, teachers need to identify the source of a learning difficulty and use appropriate remedial strategies to assist students (Mnguni, 2014). Such strategies among others could involve the use of pictures which are associated with visualization. Therefore, it is important that teachers understand the significance of the classification of the teaching functions of pictures. This is because such understanding will enable them to design relevant instructional strategies to facilitate learning.

Conclusion and Implications

In terms of the question raised in this article: What were teachers' narrations about teaching physical science concepts using photographs depicting everyday life experiences? It is concluded that teachers associated photographs with only the cognitive domain. It is noticeable here that the affective domain did not feature among the teachers' responses. Using photographs to teach physical science is a skill that teachers can master. Mastering the skill is critical because it will benefit their students and enhance the understanding of science. In the end, this may turn poor performance into good in science and enhance its importance to students' future.

References

Ali, K. & Baig, A. (2012). Problems and issues in implementing innovative curriculum in the developing countries: the Pakistani experience. *BioMed Medical Education, 12(31),* 1-8.

Bayar, V., & Çepni, S. (2022). A thematic content analysis of gifted and talented students in science education in Türkiye. *Journal of Turkish Science Education, 19*(4), 1037-1071.

Bloom, B. S. (Ed.). Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain.* New York: David McKay Co Inc.

Calvani, A. (2011). *Principi dell'istruzione e strategie per insegnare: Criteri per una didattica efficace*. Carocci: Roma, Italy.

Çelik, H, Kırındı, T. & Ayçiçek Kotaman, Y. (2020). The Effect of the Computer-Based Analogy Used in Science Teaching on Learning. *Journal of Turkish Science Education, 17*(1), 73-93.

Çepni, S., Ülger, B. B., & Ormanci, Ü. (2017). Pre-service science teachers' views towards the process of associating science concepts with everyday life. *Journal of Turkish Science Education*, *14*(4), 1 – 15. DOI: 10.12973/tused.10208a

Cook, M. P. (2006). Visual representations in science education: the influence of prior knowledge and cognitive load theory on instructional design principles. *Science Education, 90*(3), 1073-1091.

Department of Basic Education. (2010). *Curriculum Assessment Policy Statement* (CAPS) Pretoria: Department of Education.

Elfil, M., & Negida, A. (2017). Sampling methods in Clinical Research; an Educational Review. *Emergency (Tehran, Iran)*, *5*(1), e52.

Felder, M. (1996). Matters of style. *ASEE, 6*(4), 18–24.

Felder, M. R. (2010). Are learning styles invalid? (Hint: No!). *On-Course Newsletter*. Retrieved from http://www. Oncourseworkshop.com/ learning046.htm

Furner, J. M., & Marinas, C. A. (2015). Teaching math concepts through historical locations using GeoGebra and photography. Paper presented at the 27th International Conference on Technology in Collegiate Mathematics (ICTCM), March 12 - 15, Las Vegas, Nevada.

Guerra-Ramos, M. T. (2011). Analogies as tools for meaning making in elementary science education: How do they work in classroom settings? *Eurasia Journal of Mathematics, Science & Technology Education*, *7*(1), 29–39.

Hutchings, C. & Ojalvo, H. E. (2009). Science (Class) in pictures: Photographing scientific discoveries. The Learning Network: Teaching and Learning with the New York Times. Retrieved from https://learning.blogs.nytimes.com/2009/11/25/science-class-in-pictures-photographing-scientific-discoveries/ [Accessed: 03 August 2020]

Käpylä, M. (2014). A phenomenological view of pictures in teaching and a novel method of analysing them. *NorDiNa*, *10*(2), 231 – 242.

Khumalo, E. B. (2014). *Exploring the perceived impact or poor infrastructure on learners' performance at Umzinyathi rural schools*. (Unpublished doctoral thesis). Tshwane University of Technology, Pretoria.

Kiggundu, E., & Nayimuli, S. (2009). Teaching practice: A make or break phase for student teachers. *South African Journal of Education*, 29, 345 – 358.

Lester, S. (199). An introduction to phenomenological research. Retrieved from https://www.rgs. org/NR/rdonlyres/F50603E0-41AF-4B15-9C84 BA7E4DE8CB4F/0/Seaweedphenomenologyresearch.pdf [Accessed: 03 August 2020]

Mathewson, J. H. (1999). Visual-spatial thinking: An aspect of science overlooked by educators. *Science Education*, 83 (1), 33 – 54. https://doi.org/10.1002/(SICI)1098-237X(199901)83:1<33::AID-SCE2>3.0.CO;2-Z

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory Into Practice*, *41*(4), 226 – 232. DOI: 10.1207/s15430421tip4104_4

Mayer, R. E. (2003). *Learning and instruction*. Prentice-Hall, Upper Saddle River, NJ

Mnguni, L. E. (2014). The theoretical cognitive process of visualization for science education. *SpringerPlus*, *3*(1), 184

Nbina, J. (2012). Analysis of Poor Performance of Senior Secondary Students in Chemistry in Nigeria. *African Research Review, 6(4),* 324 – 334.

Ngila, W. M. & Makewa, L. N. (2014). Learner attitude towards chemistry, study skills and examination preparedness: A case of a public school in Eastern, Kenya. *American Journal of Educational Research*, 2(11A), 8 – 15. doi: 10.12691/education-2-11A-2

Norris, E. M. (2012). The constructive use of images in medical teaching: a literature review. *Journal of the Royal Society of Medicine (JRSM)*, *3*(5), 1 – 8. doi: 10.1258/shorts.2012.011158

Okanlawon E. A. (2017). Teaching Chemistry students with learning difficulties: Exemplary adaptive instructional practices of experienced Teachers. *Ife PsychologIA*, 25(2), 262 – 279.

Paoletti, G. (2011). *Comprendere testi con figure. Immagini, diagrammi e grafici nel design per l'istruzione*. Franco Angeli: Milano, Italy.

Rankhumise MP. (2018). A Comparison of Teachers' and Students' Perceptions of the Factors Contributing to Poor Performance in Physical Sciences: A case of South Africa. *Journal of Turkish Science Education*, 15 (4), 93 – 103. DOI: 10.12973/tused.10208a

Sigit, D. V., Ristanto, R. H., Nurrismawati, A., Komala, R., Prastowo, P., & Katili, A. S. (2023). Ecoliteracy's contribution to creative thinking: a study of senior high school students. *Journal of Turkish Science Education, 20*(2), 356-368.

Sinaga, P., Kaniawati, I., & Setiawan, A. (2017).Improving secondary school students' scientific literacy ability through the design of better science textbooks. *Journal of Turkish Science Education*, *14* (4), 92 – 107. DOI: 10.12973/tused.10215a

Smith, J. A., Flowers, P. & Larkin, M. (2011). *Interpretative Phenomenological Analysis*. Sage.

Stears, M., Malcolm, C. & Kowlas, L. (2003). Making use of everyday knowledge in the science classroom. *African Journal of Research in Mathematics, Science and Technology Education*, 7, 109–118

Stein, N. (2017). Textbooks. In F. Veriava, A. Thom, & T. F. Hodgson (Eds.). *Basic Education Rights Handbook – Education Rights in South Africa*, 27, 264 – 273. Braamfontein, Johannesburg:

Tal, T., & Dierking, L. D. (2014). Learning science in everyday life. *Journal of Research in Science Teaching*, *51*(3), 251 – 259.

Triacca, S. (2017). Teaching and learning with pictures: The use of photography in primary schools. Paper presented at the International and Interdisciplinary Conference IMMAGINI? Image and Imagination between Representation, Communication, Education and Psychology. Brixen, Italy. doi:10.3390/proceedings1090952

UWL Website – BioWeb Home. (2011). Retrieved from http://bioweb.uwlax.edu/bio210/f2011/thoreson_jenn/nutrition.htm/ [Accessed: 02 August 2020]

Vosniadou, S., & Skopeliti, I. (2019). Evaluating the effects of analogy enriched text on the learning of science: The importance of learning indexes. *Journal of Research in Science Teaching, 56*(6), 732-764.

Warren, H. (2004). *Learning styles*. Retrieved from http://www.engsc.ac.ck/ er/ theory/learning.asp/ [Accessed: 5 February 2019]

Wilson, T. (n.d.). Direct and indirect observations. Retrieved from http://www.informationr.net/tdw/publ/ppt/ResMethods/sld007.htm/ [Accessed: 7 February 2019]