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Models By Science Teacher Candidates for The Teaching the Reutilization of Wastes[1]

Fen Bilgisi Öğretmen Adaylarının Atıkların Geri Kazanımının Öğretimine Yönelik Modelleri

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Öz

Bu çalışma ile geri dönüşüm ve yeniden kullanım konularının öğretiminde kullanılmak üzere fen bilgisi öğretmen adayları tarafından modeller oluşturulması amaçlanmıştır. Çalışmaya Fen Bilgisi Öğretmenliği 3. sınıfta ve 4. sınıfta öğrenim gören toplam 30 öğrenci katılmıştır. Çalışma sonucunda fen bilgisi öğretmen adayları tarafından geliştirilen 8 modelin tamamında geri kazanım vurgulanırken, dört modelde geri dönüşüm, dört modelde ise yeniden kullanımın vurgulandığı belirlenmiştir. Fen bilgisi öğretmen adaylarının tamamının katı atıkları kullanarak modeller geliştirdikleri görülmektedir. Çalışmanın sonucunda oluşturulan modellerde en çok plastik ve kâğıt-karton atıkların kullanıldığı, metal ve kompozit atık türlerinin ise hiç kullanılmadığı tespit edilmiştir. Hazırlanan tüm modellerde atıkların farklı bir amaç için yeniden kullanımı mesajının öne çıktığı belirlenmiştir.

Abstract

The aim of this study was to have science teacher candidates develop models for teaching the subjects of recycling and reutilization of wastes. The study was performed with a total of 30 third-year and fourth-year students attending the Science Education Department of a Turkish University. The study results indicated that all eight models developed by the teachers candidates within the scope of this study emphasized recovery, while four of them also highlighted recycling, and four of them also focused on reutilization. It was observed that all science teacher candidates developed models by using solid wastes. Plastic and paper-cardboard were the most frequently used wastes in models developed within the scope of this study, while metal and composites wastes were not used in any of the teacher candidate models. It was observed that all of the models emphasized the reutilization of wastes for different purposes.

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1. This study is a part of the first author's doctorate thesis.

1. Introduction

The problem of solid wastes – which is a product of increasing urbanization and population growth – represents one of the most important environmental challenges of our day (Bilgili, 2006). Solid wastes have significantly detrimental effects on the environment and ecology. The degree to which solid wastes can be taken up and processed by ecosystems depends largely on how much they can decompose. Solid wastes that are not readily decomposed will not be processed by natural cycles, causing these wastes to have harmful effects on nature and disrupt natural cycles (Güler, 2008).

Increasing population and industrialization, and the associated increase in consumption, have led to growing emphasis on the approach known as "3R," which stands for recycling, reutilization and recovery, for reducing the levels of waste whose generation has become a significant problem. Recycling is defined as the utilization of waste as secondary raw materials in production processes after undergoing physical and/or chemical processing, while reutilization is defined as the reuse of wastes without undergoing any additional processes other than cleaning, until they complete their economic lifespan (Güler, 2008). Recovery, on the other hand, refers to the reuse, the extraction of primary or secondary raw materials, or the conversion into energy of solid wastes through physical, chemical and biological methods. Recovery is a broad concept that encompasses recycling and reutilization (Yaman, 2007).

Separately sorting recyclable materials at their source is important not only for ensuring that recycling activities are economically viable, but also for facilitating the design and operation of recycling facilities. For this reason, it is imperative for recycling activities to include the sorting of wastes at their source (Bayer, 2008).

The environmental aspect of sustainable growth requires countries to make conscious and well-planned utilization of their natural wealth in order to ensure the prosperity of their societies and future generations. Environmentally-conscious societies are comprised of individuals who are knowledgeable about their country's environmental and natural wealth, who are aware of the need for sustaining these sources of wealth, and who act accordingly by assuming an active role in implementing environmental measures (Hungerford and Volk, 1990; Sander, Jelemenska and Kattmann, 2006). Raising individuals who are conscious about the environment, the utilization of natural wealth and sustainability is only possible through an environmental education which begins in elementary school, and enables students to become environmentally-aware and to develop a sense of responsibility towards nature; such an education need to be provided by teachers possessing the necessary skills and awareness to transform sustainability into a life-style (Lord, 1999; Moseley, Reinke and Bootout, 2002; Slingsby and Baker, 2003).

In science education, using tangible teaching materials is both necessary and important for ensuring that scientific knowledge are properly understood by students. Models play an essential and versatile role in support science education (Justi and Gilbert, 2002; Saari and Viiri, 2003; Oh and Oh, 2011). Models, which occupy an important place in education, are simplified representations of physical entities that are too small, too large or too complex to be understood directly, or which lie beyond the human senses. Models can be used for notions, objects, evets, systems or processes (Gilbert, Boulter and Rutherford, 1998a). Models assume the important function of defining, describing and predicting natural events, and allowing scientific concepts to be shared with others (Gilbert, Boulter and Rutherford, 1998b; Oh and Oh, 2011). Models are used to developed simpler versions for objects and concepts, to better visualize events, and to provide explanations to scientific phenomenon (Gilbert, Boulter and Rutherford, 1998a; Coll, 2006).

Considering that models as well as model-support teaching activities occupy an important place in educational programs, a proper understanding of models is important for ensuring effective scientific education. In this context, this study aimed to have science teacher candidates developed models for teaching the subjects of recycling, reutilization and recovery of wastes. This study where science teacher candidates were required to form models for teaching the subjects of recovery, recycling and reutilization will contribute to developing teacher candidates' understanding of models, while also providing further data and depth to the literature on this subject.

2. Methodology

The study was performed using a general screening model, which is defined as a model where an entire population consisting of numerous elements, or a group, specimen or sample obtained from this population, is subject to screening in order to obtain a general opinion about this population (Karasar, 2011). The study group consisted of a total of 30 voluntarily participating third-year and fourth year students attending the Science Education Department of an Education Faculty at a public university in northern Turkey. When forming the study group, the purposeful sampling method was used to ensure that the individuals constituting this group would have similar and matching features (Cristensen, Johnson and Turner, 2015). The participating science teacher candidates were divided into groups of three and four, and

these groups were asked to develop models that would be used for teaching the reutilization of waste materials.

The models developed by the teacher candidates during the study were analyzed using the descriptive analysis method. In the descriptive analysis method, obtained data are summarized and interpreted according to pre-defined themes. The purpose of this analysis is to present data to the readers in an organized and interpreted format (Yıldırım and Şimşek, 2011). In this study, we analyses the types of waste materials the teacher candidates used in their models; the processes they described for these waste materials; and the main message emphasized in these models. We then calculated the frequency of the main and sub-categories within these models.

3. Results

Models developed by the science teacher candidates that emphasized reutilization are shown in Figures 1 to 4.

Teacher candidates in group 1 developed a model based on plastic water bottles. Their model involved shaping small plastic bottles into fruits and a large plastic bottle into a fruit basket, which were then painted. The model illustrated that waste plastic bottles can be reutilized for different purposes. The model developed by the teacher candidates is shown in Figure 1.

Figure 1. Model Prepared by Group 1

Teacher candidates in group 2 developed a model where they used plastic bottle caps to make a vase. The model developed by the teacher candidates is shown in Figure 2.

Figure 2. Model Prepared by Group 2

Teacher candidates in group 3 developed a model where they reused plastic water bottles, pieces of Styrofoam and waste paper to create a night lamp. With this model, the teacher candidates illustrated that many waste materials can be reutilized by, for example, being converted into the shape of a night lamp. The model developed by the teacher candidates is shown in Figure 3.

Figure 3. Model Prepared by Group 3

Teacher candidates in group 4 developed a model where they reused waste batteries, cardboard and paper of different sizes to form chess pieces, by taking into account the different size and feature of each chess piece during this process.

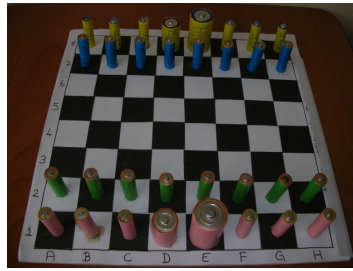The model developed by the teacher candidates is shown in Figure 4.

Figure 4. Model Prepared by Group 4

Models developed by the science teacher candidates that emphasized recycling are shown in Figures 5 to 8.

Teacher candidates in group 5 designed waste containers for glass, paper and plastic. With this model, the teacher candidates emphasized the need to sort glass, plastic and paper wastes at their source. In this model; paper, pieces of glass and plastic water bottles were placed in waste containers for paper, glass and plastic, respectively, and it was also emphasized that, after sorting and collection, the paper, glass and plastic wastes are processed in recycling facilities to provide a new product. The teacher candidates symbolized the new products obtained through recycling by using glasses, paper and uniforms in their model. The model developed by the teacher candidates is shown in Figure 5.
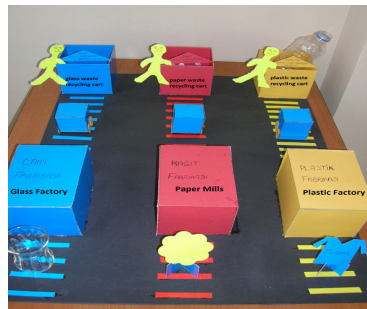

Figure 5. Model Prepared by Group 5

Teacher candidates in group 6 developed a model that highlighted recyclable wastes and the recycling symbol. The teacher candidates drew a recycling symbol on a cardboard plate, and formed the arrows of the recycling symbol by using and attaching glass, plastic and paper. The model developed by the teacher candidates is shown in Figure 6.

Figure 6. Model Prepared by Group 6

Teacher candidates in group 7 developed a model with two different recycling facilities. The teacher candidates used pieces of waste paper, glass and plastic to represent the materials undergoing recycling, and to also symbolize the new paper and bottle products obtained through recycling. The model developed by the teacher candidates is shown in Figure 7.
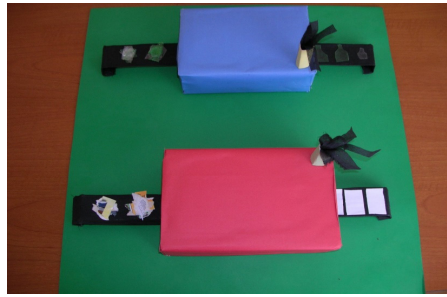
Figure 7. Model Prepared by Group 7

Teacher candidates in group 8 developed a model that represented how wastes are thrown into recycling containers by consumers following use, then collected by a waste collection vehicle, sorted according to the type of waste, processed in the recycling facility, and finally converted into a new product and sold. The teacher candidates explicitly illustrated in their model that sorting is performed at the source by the consumers, before the wastes are taken to the recycling facility by waste collection vehicles. The model also showed a recycling logo with a picture of the earth at its center, thus underscoring the importance of recycling for the earth. The model developed by the teacher candidates is shown in Figure 8.
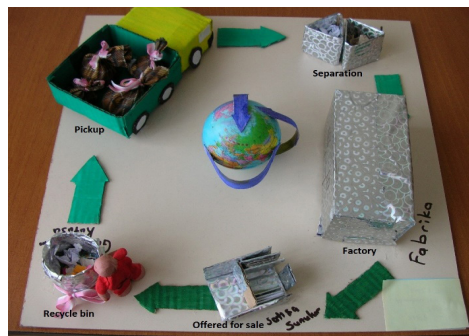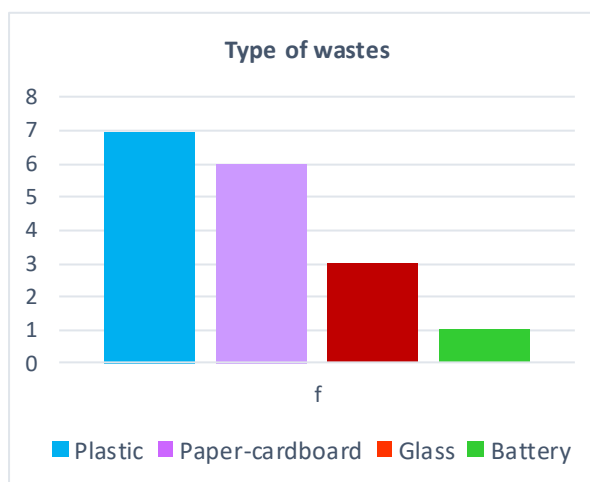


Figure 8. Model Prepared by Group 8

The types of wastes used by the participating teacher candidates in their models is shown in Graph 1.

Graph 1. Types of waste materials used in the models

An evaluation of Graph 1 reveals that all of the science teacher candidates used solid waste materials in their models. The most frequently used materials in the teacher candidates' models were plastic and paper-cardboard. In addition, one of the models also made use of waste batteries.

The types of processes for waste materials emphasized by the teacher candidates in their models is shown in Graph 2.
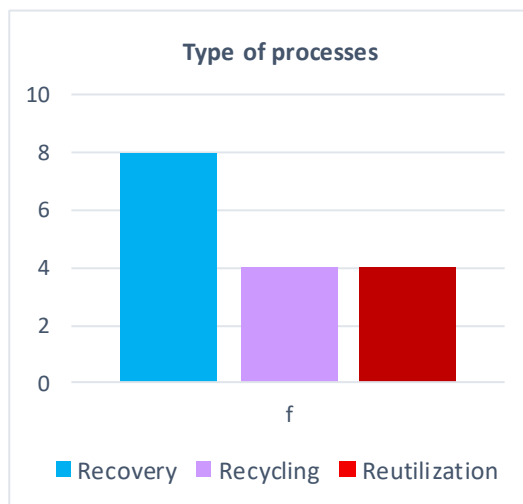
Type of processes

Graph 2. Types of processes for waste materials emphasized in the models

An evaluation of Graph 2 reveals that all of the science teacher candidates highlighted recovery in their models. In addition, four of the teacher candidates' models also highlighted recycling, while the four other also highlighted reutilization.

The messages emphasized in the models of the participating science teacher candidates are shown in Graph 3.

Massage emphasized in the models
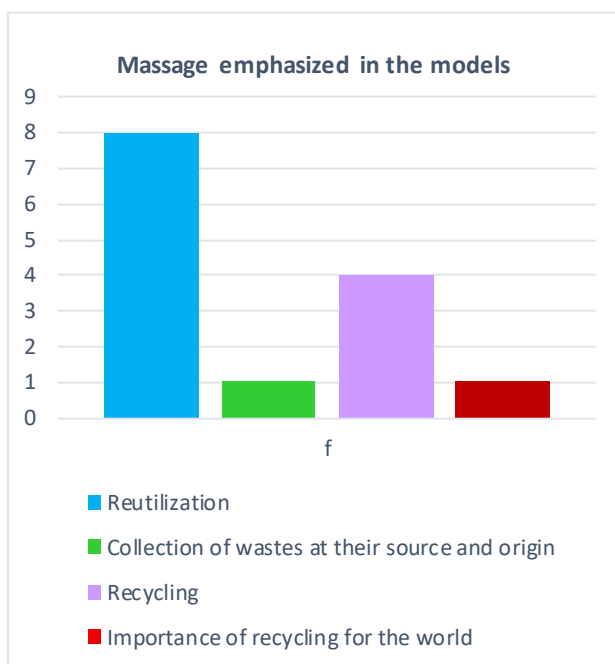
Graph 3. Message emphasized in the models

An evaluation of Graph 3 indicates that, in their models, the science teacher candidates mainly emphasized the reuse of waste materials for different purposes and the recycling of wastes. In addition, there was also a single model emphasizing the collection of wastes at their source and origin, and the importance of recycling for the world.

4. Conclusions

In this study, teacher candidates developed models that highlighted the reuse of wastes as teaching materials for describing the subject of recovery and recycling. In the models developed by the teacher candidates on reutilization; plastic and paper-cardboard wastes were used along with waste batteries to form fruit baskets, chess pieces, night lamps and flower pots.

Two of the models developed by the science teacher candidates represented, or symbolized, the entire recycling

process beginning with the collection of waste materials in recycling containers, followed by processing in recycling facilities, and ending with the formation of a new product through recycling. In only two of the models was the recycling symbol used, while one of the model highlighted the need for consumers to sort wastes before disposing them. These three models thus made mention of recyclable wastes.

In their models, the science teacher candidates used solid wastes such as paper-cardboard, plastic, glass and batteries, with plastic and paper-cardboard wastes being the mainly used materials. It was noteworthy that none of the teacher candidates used metal or composite wastes in their models. In addition, all of the teach candidates' models expressed the message that waste materials can be reused for different purposes.

The importance of recycling and reutilization can be better understood in light of the fact that the amount of waste generated by human activities is rapidly growing and posing a increasing threat to the environment, and the fact that all natural resources are ultimately finite. Ensuring sustainable growth is of vital importance, and to leave a livable world for future generations, it is crucial that we provide education on such essential matters starting from an early age. Previous studies have demonstrated that the use of models in education is an effective mean for ensuring meaningful and lasting learning (Frederiksen, White and Gutwill, 1998; Barab, et al., 2000; Gobert and Pallant, 2004). For this reason, we believe that using educational models on the subjects recovery, reutilization and recycling at every level of education is important for raising environmentally-conscious individuals.

5. References

Barab, S. A., Hay, K. E., Barnnet, M., & Keating, T. (2000). Virtual solar system project: Building understanding through model building. Journal of Research in Science Teaching, 37(7), 719-756.

Bayer, Y. (2008). Ayrı toplamanın kompostlaştırma üzerindeki etkisi (The effect of source seperated on composting). MS Thesis, Yıldız Technical University, Graduate School of Natural and Applied Sciences, İstanbul.

Bilgili, M. S. (2006). Katı atık düzenli depo sahalarında atıkların aerobik ve anaerobik ayrışması üzerine sızıntı suyu geri devrinin etkileri (The Effect of leachate recirculation on aerobic and anaaerobic degradation of municipal solid waste in landfills). PhD Thesis, Yıldız Technical University, Graduate School of Natural and Applied Sciences, İstanbul.

Christensen, L. B., Johnson, R. B., & Turner, L. A. (2015). Araştırma yöntemleri desen ve analiz (Research methods, design, and analysis). In Ahmet Alpay (Translation Ed.). Ankara: Anı.

Coll, R. K. (2006). The role of models, mental models and analogies in chemistry teaching. In P. J. Aubusson, A. G. Harrison and S. M. Ritchie (Eds.), Metaphor and analogy in science education (Vol. 30, pp. 65-77). Printed in the Netherlands. Springer.

Frederiksen, J. R., White, B. Y., & Gutwill, J. (1998). Dynamic mental models in learning science: The importance of constructing derivational linkages among models. Journal of Research in Science Teaching, 36(7), 806-836.

Gilbert, J. K., Boulter, C., & Rutherford, M. (1998a). Models in explanations, Part 1: Horses for courses? International Journal of Science Education, 20(1), 83-97. doi: 10.1080/0950069980200106

Gilbert J. K., Boulter, C., & Rutherford, M. (1998b). Models in explanations, Part 2: Whose voice? Whose ears? International Journal of Science Education, 20(2), 187-203. doi: 10.1080/0950069980200205

Gobert, J. D., & Pallant, A. (2004). Fostering students' epistemologies of models via authentic model-based tasks. Journal of Science Education and Technology, 13(1), 7-22.

Güler, N. (2008). Kentleşme sürecinde katı atık yönetimi ve Kocaeli örneği (Solid waste management process of the urbanization and example of Kocaeli). MS Thesis, Kocaeli University, Institute of Social Sciences, Kocaeli.

Hungerford, H. R., & Volk, T. (1990). Changing learner behavior through environmental education. Journal of Environmental Education, 21(3), 8-21.

Justi, R. S., & Gilbert, J. K. (2002). Modelling, teachers' views on the nature of modelling, and implications for the education of modellers. International Journal of Science Education, 24(4), 369-387. doi: 10.1080/09500690110110142

Karasar, N. (2011). Bilimsel Araştırma Yöntemleri. Ankara: Nobel.

Lord, T. R. (1999). A comparison between traditional and constructivist teaching in environmental Science. The Journal of Environmental Education, 30(3), 22-28.

Moseley, C., Reinke, K., & Bootout, V. (2002). The effect of teaching outdoor environmental education on preservice teacher' attitudes toward self-efficacy and outcome expectancy. Journal of Environmental Education, 34(1), 9-15.

Oh, P. S., & Oh, S. J. (2011). What teachers of science need to know about models: An overview. International Journal of Science Education, 33(8), 1109-1130.

Saari, H., & Viiri, J. (2003). A research-based teaching sequence for teaching the concept of modelling to seventh-grade students. International Journal of Science Education, 25(11), 1333-1352. doi: 10.1080/0950069032000052081

Sander, E. O., Jelemenska, P., & Kattmann, U. (2006). Towards a better understanding of ecology. Journal of Biology Education, 40, 119-123.

Slingsby, D., & Baker, S. (2003). Making connection: biology, environmental education and education for sustainable development. Journal of Biology Education, 38(1), 4-6.

Yaman, T. (2007). İstanbul'da Kentsel Katı Atık Yönetimi ve Geri Kazanım Potansiyelinin Belirlenmesi (Determination of municipial solid waste management and recycle potential in İstanbul). MS Thesis, Gebze Technical University, Graduate School of Natural and Applied Sciences, Gebze.

Yıldırım, A., & Şimşek, H. (2011). Sosyal bilimlerde nitel araştırma yöntemleri. Ankara: Seçkin.