Araştırma Temelli Etkinlik Dergisi (ATED) / Journal of Inquiry Based Activities (JIBA)
Vol 14, No 1, 15-28, 2024

A Journey of Discovery Where Repairing Household Appliances Meets Teaching Science

Hasan Özyıldırım[1] & Pelin Yaman[2]

ABSTRACT

In the study, repair activities were planned with prospective science teachers (f=24) using broken household appliances and it was aimed to establish a relationship between such practices and science teaching during the activities. The activities, which were carried out as a single group, were carried out in collaborative groups of four. Case study, one of the qualitative research models, was used as a method. The applications were planned within the scope of the 5E learning cycle, one of the inquiry-based learning approaches. After the activities, it was observed that the prospective teachers obtained important gains such as seeing the application areas of the science principles they learned in the lessons and transferring them to daily life, acquiring manual skills, and gaining experience. In addition, with such activities, sensitivity to issues such as recycling, sustainability, and recycling can be created instead of the disposable philosophy of our age.

Keywords: home appliance, science education, prospective science teacher, repair activity, science principles.

Ev Aletlerinin Tamiriyle Fen Bilimleri Öğretiminin Buluştuğu Bir Keşif Yolculuğu

ÖZ

Araştırmada, Fen Bilgisi Öğretmen Adayları (f=24) ile bozuk ev aletleri kullanılarak tamir etkinlikleri planlanmış ve etkinlikler sürecinde bu tür uygulamalar ile fen öğretimi arasında ilişkilendirmeler kurulması amaçlanmıştır. Tek grup olarak gerçekleştirilen uygulamalar, dörder kişilik işbirlikli grup çalışmaları ile yürütülmüştür Yöntem olarak nitel araştırma modellerinden durum çalışması kullanılmıştır. Uygulamalar, sorgulama temelli öğrenme yaklaşımlarından 5E öğrenme döngüsü kapsamında planlanmıştır. Uygulama sonrasında öğretmen adaylarının, derslerde öğrendikleri fen prensiplerinin uygulama alanlarını görme ve günlük yaşama transfer edebilme, el becerisi kazanma, deneyim, sahibi olma gibi önemli kazanımlar elde ettikleri görülmüştür. Ayrıca bu tür etkinlikler ile geri dönüşüm, sürdürülebilirlik, çağımızın kullan at felsefesi yerine yeniden kazanım gibi konulara duyarlılık oluşabilir.

Anahtar Kelimeler: ev aleti, fen eğitimi, fen bilgisi öğretmen adayı, tamir aktivitesi, fen prensipleri.

Article Information:
Submitted: 02.09.2023 Revised: 23.02.2024 Accepted: 27.03.2024

[1] PhD. Lecturer, Trakya University, Faculty of Education, Department of Mathematics and Science Education, E-mail: hozyildirim@trakya.edu.tr, ORCID: 0000-0002-8513-7713
[2]Science Education Teacher, Ministry of National Education, E-mail: pyaman25@gmail.com, ORCID: 0000-0003-4935-2261

INTRODUCTION

Repair practices are becoming increasingly widespread thanks to various initiatives such as scientific understandings in everyday life (Hielscher & Jaeger-Erben, 2021), common technology meeting points, and repair cafés (Charter & Keiller, 2014; Houston et al., 2016; Hielscher & Jaeger-Erben, 2021; Meissner, 2021). In addition, these practices can be easily associated with science, technology, engineering, and mathematics (STEM) activities, which is an interdisciplinary teaching approach; also, they can support learners' interest in STEM subjects (Bybee, 2010; Xie, Fang, & Shauman, 2015; Corlu & Çallı, 2017). Teachers gain skills to understand engineering practices through repair experiences (Dym, Littlen & Orwin, 2013; Katehi, Pearson, & Feder, 2009). Lucas et al. (2014) point to teachers' significant lack of understanding and confidence in thinking like engineers.

Similarly, Brand (2020) argues in the Next Generation Science Standards that teachers do not sufficiently understand the scope and content of engineering practices and do not adequately grasp the working logic and practices underlying these designs. This may lead to problems such as teachers' inability to associate science principles and engineering practices with the working principles of technological tools and equipment, which may be reflected in their teaching processes. Making repair applications using simple household appliances can solve the aforementioned problems. Using these practices, teachers/pre-service teachers can become technologically literate, improve their knowledge and skills, and gain the ability to relate science principles to current life/engineering practices. Based on this goal, this study focused on pre-service teachers' broader understanding of the basic concepts of science from an interdisciplinary perspective through tinkering activities and their thoughts on learning/reinforcing these concepts effectively. These applications were carried out within the scope of the thesis titled *The Effects of Applications of Household Appliances on Technology Literacy of Preservice Science Teachers and Their Association Between Science and Technology* (Yaman, & Özyıldırım, 2021).

The repair applications made using different household appliances were not included in the scope of any course in an integrative approach as a science practice. However, they were planned as a science learning activity that pre-service teachers worked on in their free time. While evaluating the activity, the answers to the following questions were sought:

- What are the experience and readiness statuses of pre-service teachers before repair applications?
- What are the strategies and approaches that pre-service teachers employ in repair processes?
- What are the experiences of pre-service teachers after repair practices?

In this context, the present study aimed to seek answers to all three research questions using content analysis approaches for qualitative results.

IMPLEMENTATION PROCESS OF THE ACTIVITY

The repair practice was planned within the scope of the 5E learning cycle, one of the inquiry-based learning approaches. This teaching model includes skills and activities to increase the research curiosity of the students involved in the practices and focus them on research. The 5E learning model consists of an introduction, exploration, explanation, deepening, and evaluation stages (Bybee 1997; Martin, 2000; Carin & Bass, 2005). This approach also suggests more than one way for students to interact with practice materials and understand why they need to learn what they learn (Morin, 2014; as cited in Kızılaslan et al., 2022). Therefore, this model was preferred because it would be an effective model for associating the principles of science with the repair of household appliances.

Within the framework of this plan, volunteer study groups of six students each were formed from students studying in the Science Teaching Department, Faculty of Education, The study was conducted with 24 pre-service teachers (19 female and 5 male). The laboratories of the same faculty were used for the study.

Structural arrangements, including the equipment that might be needed for repair activities in laboratories, the technology infrastructure required for research and presentations, and the information on safety precautions to be considered during the repair process, were created. Within the scope of the study, *Activity Worksheets* (Appendices 4, 5, 6, and 7), *researcher observation notes,* and an *evaluation form* were used as data sources. Activity Worksheets 1–4 included questions about revealing the knowledge of the pre-service teachers about the working principles of the household appliances that they would apply before, during, and after the study, the relationship of these household appliances with science, the relationship of their historical development with the nature of science and technology, and their awareness of transferring the working principles of household appliances to science course outcomes. Worksheets were developed in line with the opinions of researchers who are experts in science education. For the *researcher observation notes*, a researcher took notes of the interactions within the group, discussions, main perspectives, and general orientations toward the repair process. The researchers used these notes to confirm and verify the data obtained from the activity worksheet. The *evaluation form* was used to reveal the pre-service teachers' scientific knowledge about the working principles of household appliances and their views on the applications of household appliances. While developing the form, the opinions of field education experts were obtained, and the content and face validity of the questions were confirmed.

The analysis of the activity worksheets aimed to obtain results from the questions *"What are the experience and readiness statuses of pre-service teachers before repair applications?", "What are the strategies and approaches that pre-service teachers employ in repair processes?," and "What are the experiences of pre-service teachers after repair practices?"* Accordingly, the qualitative data obtained from all three data sources were analyzed using content analysis. Then, one researcher, an expert in the field, grouped the data under each of the three questions and brought them together to form categories within themselves. The second researcher recoded the data based on the categorizations defined by the first researcher to confirm and verify the qualitative findings.

The basic steps of the activity and the visuals related to this process were as follows.

Introduction stage (40 min). Activity Worksheet 1 was used to draw the attention of the pre-service teachers to the idea of repair. In this stage, motivating questions such as *"Have you repaired a household appliance before?," "What kind of a method did you follow during the repair?," "Would you like to learn how to repair a household appliance?," "What kind of an appliance would you like to repair?,"* and *"Which science principles are used when repairing a household appliance?"* were asked. The students answered *"No, I have not repaired it," "I would first take safety precautions," "I would try to understand the working principle/method," and "I look for the necessary tools for repair."* The students chose basic household appliances as those they wanted to repair. Another striking situation was that the pre-service teachers desired to experience the repair activity (Appendix 1).

Discovery stage (40 min). In this stage, Activity Worksheets 2 and 3 were used, focusing on recognizing the appliances to be repaired and understanding their basic problems. In this framework, pre-service teachers were given broken household appliances (an iron, a toaster, an electric juicer, a kitchen rondo, a blender, and a curling iron) and the tools and materials required for repair (a multimeter, a screwdriver, needlenose pliers, a test light, conductive cables, a plug, a socket, a cordless drill, a resistance wire, etc.). The pre-service teachers aimed to understand their experiences with the tools in question or the purposes of use of the relevant tools. In this context, they were asked to make in-group discussions and participate in decision-making processes. The tools that the pre-service teachers needed the most during repair in order of importance were noted as a screwdriver, a test light, pliers, a drill, and a wrench. Regarding the purpose for which these tools could be used, the participants made explanations such as *"Screwdrivers are used to remove and instal screws," "Test lights are used to understand whether there is an electric current or not," and "Pliers, are used to tighten operations"* (Appendix 2).

Figure 1. *Stage of discovering repair practices.*

Explanation stage (40 min). The pre-service teachers explained to the class the basic opinions formed in the group in the previous stage. They emphasized the working principle of the appliance to be repaired and the misconceptions or incomplete understandings of the associated scientific principles. For example, pre-service teachers were given the opportunity to establish associations with the relevant science topics and concepts by asking questions such as "*Could using test light during the repair have something to do with electrical conductivity?"* and *"Did you notice that the expansion mechanism in the thermostat was broken while repairing the iron?"* It was observed that the pre-service teachers were excited during this application and impatient to start the application. During the application process, the students expressed their thoughts about this stage of the application with their own statements such as *"It was exciting to try to find the broken circuit with a multimeter," "We checked it with a test light," "I enjoyed being able to associate science subjects with repairing broken instruments,"* and *"I did not think that I needed to use a way to repair it."*

Deepening stage (120 min). The information on repair processes was obtained through a skill-oriented process. In this stage, pre-service teachers were given broken household appliances and supported to disassemble the appliance, understand their equipment more closely, use repair tools, comprehend the functions and intended use of the basic parts in the appliance through internet research, and discuss them in groups. The pre-service teachers expressed their opinions about this process of the application with statements such as *"I had never opened a household appliance before," "I knew that I had to use science principles to repair it, but I had never tried it," "I always saw the appliances as a whole, and I was excited to handle and disassemble each part separately,"* and *"We discussed as a group what each part of the iron we opened for repair was for. This was a nice experience."*

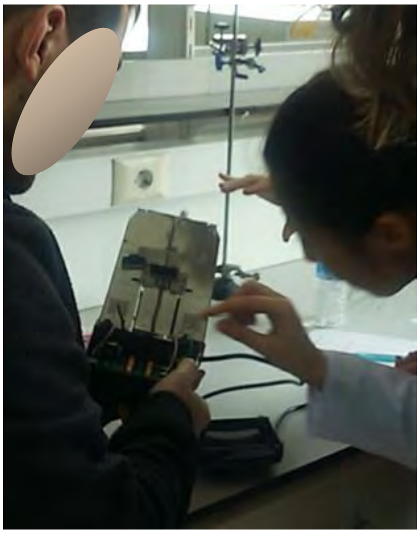


Figure 2. *Deepening stage in repair practices.*

Evaluation stage (60 min). Activity Worksheet 4 was used in this stage to measure the extent to which pre-service teachers' experiences could be directly evaluated through success and failure and how much they learned new concepts and skills. Pre-service teachers' statements such as *"I gained the ability to transfer the information I learned to daily life," "I will make an effort to repair even if I cannot repair," "I learned the way I should follow while repairing," "I gained the ability to use repair tools," "I got to know repair tools closely,"* and *"I wish I could have done such applications earlier. Thus, I could have reinforced my knowledge more easily"* showed that the students gained application skills and were satisfied with their experience.

Figure 3. *Deepening stage in repair practices.*

CONCLUSION AND RECOMMENDATIONS

This study aimed to introduce the repair activity to the literature by associating it with the teaching of science, and to develop a deep understanding in light of the findings obtained. Pre-service science teachers (*n*=24) participated in the study. During the implementation process, the experience and readiness of the teachers in this field, the strategies and approaches they used, and the experiences they gained were examined. The feedback received from the students during the implementation process, and the researcher's observations showed that a significant proportion of the students was willing to experience the repair of home appliances, which they were familiar with but had not experienced earlier, and take part in the application voluntarily (Appendix 1). The strategies and approaches of the pre-service teachers in the repair processes presented in Appendix 2 were examined. The pre-service teachers who experienced repair practices could emphasize that scientific knowledge changed and developed over time and they could associate it with the dimensions of the nature of science. In addition, the participants' statement that *"technology changes as science develops"* showed that they could establish interdisciplinary associations with technological literacy and engineering sciences.

The science principles and science concepts such as "electrical circuits," "heat conduction," "energy conversion," and "expansion" they used during the applications indicated that the pre-service teachers had concrete repair experiences and could successfully associate them with science principles (Appendix 2). Testing repair equipment with appropriate methods helped develop a deeper understanding of how to develop a future repair habit attitude and many related perceived outcomes (Appendices 2 and 3). For example, a good example of strategy development was when the students first tested only with a test light, tried to identify broken parts with a multimeter, and then focused on how to find and remove or replace the broken part with their group mates. Haury and Rillero (1994) stated that, as part of applied science programs, the students learned better by remembering the material they had experienced, felt a sense of accomplishment on completing the task, and could also transfer this experience to new learning situations. According to Maker et al. (2015), students with an aptitude for physical science could easily understand and manage technical materials. Also, they could build and repair machines to help with human tasks and establish relationships between parts. Within engineering design processes, the repair, assembly, and understanding of various parts, components, and subsystems are important components for both production and subsequent repair and maintenance (Dym, Little & Orwin, 2013).

Appendix 3 presents the experiences of the pre-service teachers after the practices. The statements in the Appendix show that the teachers gained the experience of relating theoretical knowledge to contemporary life, realized the need to develop strategies for repair, and grasped the relationship between the principles of science and engineering practices. As a result of these practices, the feedback *"I would consider repairing"* in their future plans could be considered as a positive attitude toward the practices of engineering and technology applications. Holstermann, Grube, and Bögeholz (2010) reported that the components that made up an effective learning activity included practices attributed as fun, pleasant, stimulating, and important, which could be considered as qualities increasing interest and willingness.

The present study was conducted with student volunteers, and therefore no significant problems were encountered during the study. The results obtained during the implementation process revealed that the pre-service teachers could not decide how to start the applications and how and where to use the repair kits due to their lack of experience, leading to some in-group discussions. Sometimes, different ideas about the approach emerged within the group, in which case the teachers decided according to the tendency of the majority of the group members. Researchers who wanted to experience such applications could make comparisons by forming separate groups of students with no previous repair experience and experienced students, or similar applications could be tried using different teaching methods. In addition, using such applications with groups of different profiles and age ranges could provide the opportunity to see different perspectives. Outcomes such as an increase in the lifespan of damaged materials through repair, economy, resource efficiency, waste reduction, low carbon consumption, and sustainability strategies that were not among the objectives of this study are also important in terms of the environmental cycle (Hielscher & Jaeger-Erben, 2021; Svensson, Russell, & Richter, 2023). Therefore, these outcomes or activities can provide teachers with the skills to make broken appliances reusable with simple repairs instead of the "use and throw" philosophy. Also, awareness can be raised on issues such as recycling, sustainability, and environmental protection.

Limitations of the study and recommendations

The results of this study, designed within the framework of qualitative research approaches, defined the experiences and approaches of pre-service teachers in repair processes to a large extent. However, the research design had various limitations. First, the study was conducted with a group of pre-service teachers who willingly agreed to participate. Hence, studying repair activities with different research groups and samples could provide a better understanding of repair activities. Second, the appliances to be repaired were limited to household appliances and based on specific scientific principles. Repeating repair activities with different appliances, tools, and processors in the field of information technology can offer an innovative perspective on repair activities. Third, the present study aimed to introduce and discuss a good example of repair effectiveness in light of the results obtained. Therefore, the authors could not provide a broad conceptual framework for repair activities. Bullock and Sator (2015) stated that the maker movement gained immense attention internationally. They emphasized that the effort to reuse and repair should come to the fore in educational practices, especially as an opposing view to consumer culture. Accordingly, discussing repair activities within different conceptual frameworks such as maker movement, engineering design, and design thinking, and proving their effectiveness can substantially contribute to the existing literature.

Engaging students and pre-service teachers in training in this field of repair helps them relate science concepts, skills, and application areas of science principles to life. It also develops essential 21st-century skills such as creativity, critical thinking, problem-solving, collaboration, and communication. Such activities can arouse students' curiosity and encourage them to repair an out-of-order or broken appliance around them. While repairing, they monitor and follow steps such as understanding how the appliance works, defining the problem, researching solutions, making a plan, implementing the plan, and evaluating the result. These steps are similar to the scientific method and the design process used in science and engineering applications, respectively. In this case, the example of home appliances as an application is varied, and they can explore concepts such as motion, force, and energy while repairing a broken toy. They can also learn about the application areas of energy conversions and series/parallel connections while repairing a broken flashlight.

REFERENCES

Brand, B. R. (2020). Integrating science and engineering practices: outcomes from a collaborative professional development. *International Journal of STEM Education*, *7*(1), 1-13.

Bullock, S. M., & Sator, A. J. (2015). Maker pedagogy and science teacher education. *Journal of the Canadian Association for Curriculum Studies*, *13*(1), 60–87.

Bybee, R.W. (1997). *Achieving Scientific Literacy*.Portsmouth, N.H.: Heinemann.

Bybee, R. W. (2010). What is STEM education?. *Science*, *329*(5995), 996-996.

Carin, A., J. Bass. (2005). *Teaching Science As Inquiry.* Upper Saddle River, New Jersey: Pearson Prentice Hall.

Corlu, M. S., & Çallı, E. (2017). *Stem Kuram Ve Uygulamaları.* Pusula

Charter, M,. & Keiller, S. (2014) *Grassroots Innovation and the Circular Economy: A Glocal Survey of Repair Cafés and Hackerspaces*. The Centre For Sustainable Design, Guilford, UK.

Dym, C. L., Little, P., & Orwin, E. J. (2013). *Engineering design: a project-based introduction*. John Wiley & Sons.

Haury, D. L., & Rillero, P. (1994). *Perspectives of Hands-On Science Teaching*. The ERIC Clearinghouse for Science, Mathematics, and Environmental Education

Hielscher, S., & Jaeger-Erben, M. (2021). From quick fixes to repair projects: Insights from a citizen science project. *Journal of Cleaner Production*, *278*, 123875.

Holstermann, N., Grube, D., & Bögeholz, S. (2010). Hands-on activities and their influence on students' interest. *Research in Science Education*, *40*, 743-757.

Houston, L., Jackson, S. J., Rosner, D. K., Ahmed, S. I., Young, M., & Kang, L. (2016). *Values in repair.* In Proceedings of the 2016 CHI conference on human factors in computing systems (1403-1414).

Katehi, L., Pearson, G., & Feder, M. (2009). *Engineering in K-12 Education: Understanding the Status and Improving the Prospects*. Washington, DC: National Academies Press.

Kızılaslan, A., Aslan, C., Karakoç, T., & Kapucu, S. (2022). Görme Yetersizliği Olan Öğrencilere Ses Yalıtımının 5E Öğretim Modeliyle Öğretimi. *Journal of Inquiry Based Activities, 12*(2*),* 140-158.

Lucas, B., Claxton, G., & Hanson, J. (2014). *Thinking Like an Engineer: Implications for the education system.* University of Winchester

Maker, C. J., Alhusaini, A. A., Pease, R., Zimmerman, R., & Alamiri, F. Y. (2015). Developing creativity, talents, and interests across the lifespan: Centers for creativity and innovation. *Talent*, *5*(2), 83-109.

Martin, D. J. (2000). *Elementary Science Methods: A Constructivist Approach.* Belmont, CA: Wadsworth/Thomason Learning.

Meissner, M. (2021). Repair is care?-Dimensions of care within collaborative practices in repair cafes. *Journal of Cleaner Production*, *299*, 126913.

Svensson-Hoglund, S., Russell, J. D., & Richter, J. L. (2023). A process approach to product repair from the perspective of the individual. *Circular Economy and Sustainability*, *3*(3), 1327-1359.

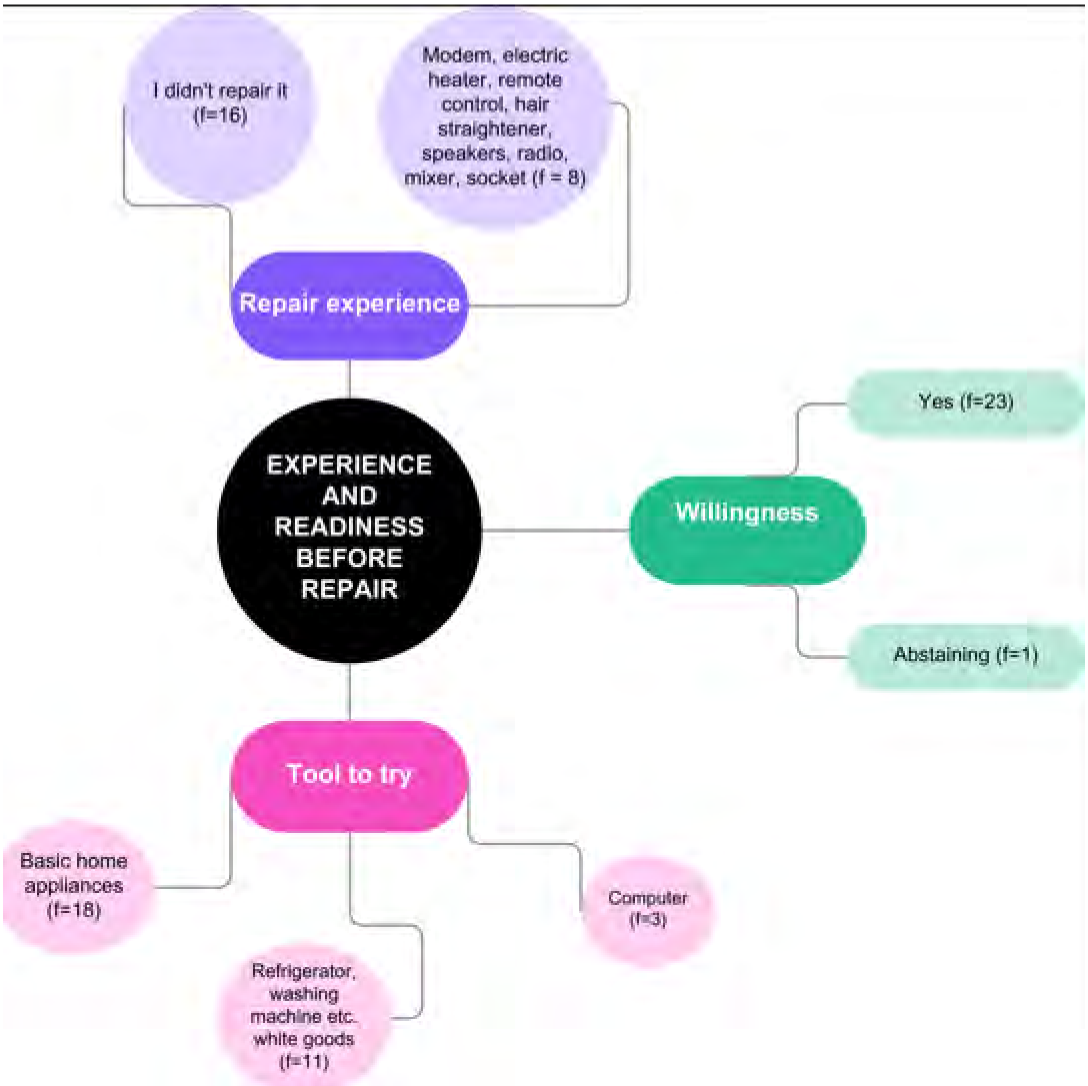
Yaman, P., & Özyıldırım, H. (2021). *Ev aletlerine yönelik uygulamaların fen bilimleri öğretmen adaylarının teknoloji okuryazarlığına ve fen ile teknolojiyi ilişkilendirmelerine etkileri* (Yüksek lisans tezi, Trakya Üniversitesi Fen Bilimleri Enstitüsü).

Xie, Y., Fang, M., & Shauman, K. (2015). STEM education. *Annual Review Of Sociology*, *41*,331-357.

APPENDICES

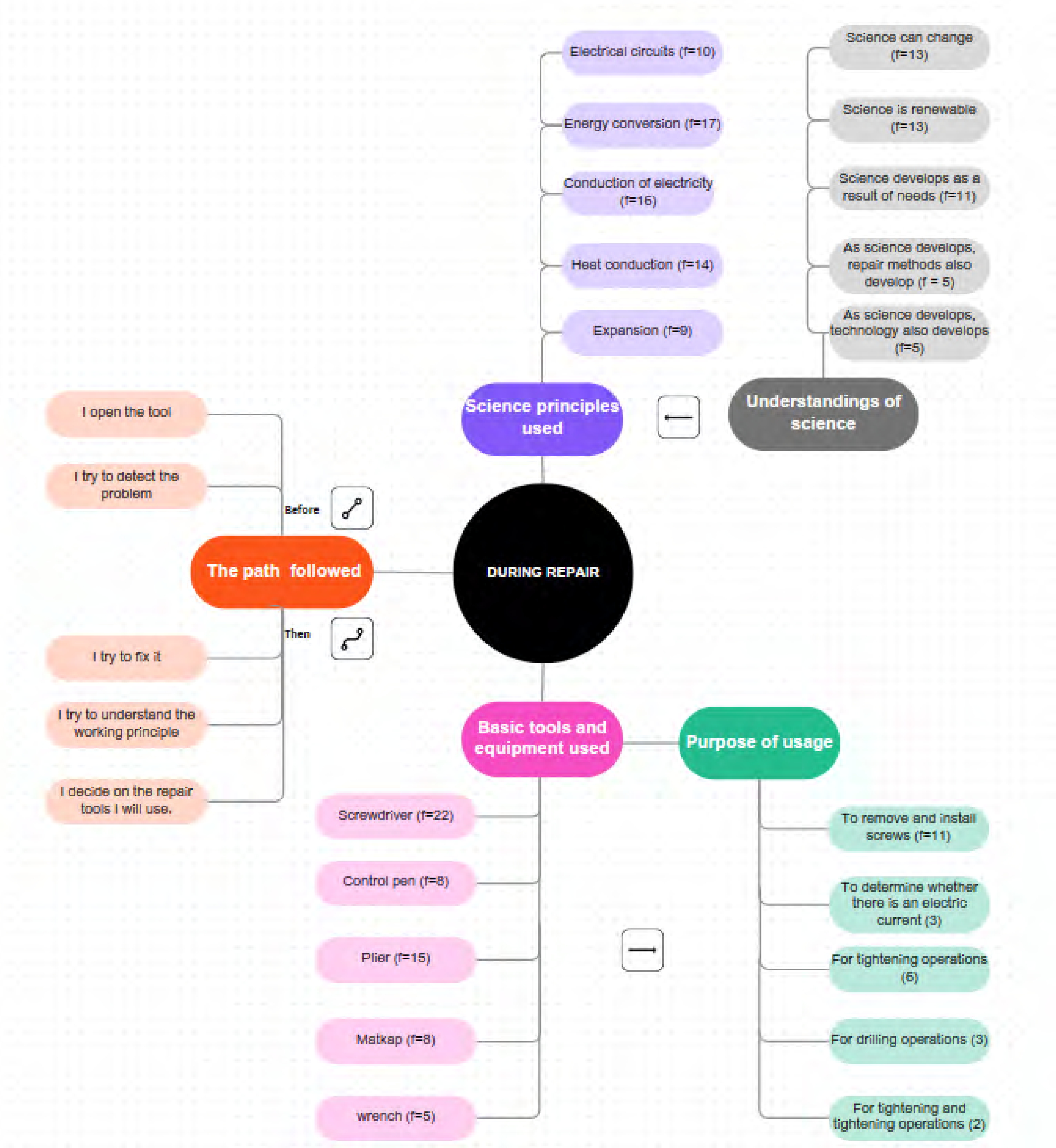
Appendix 1. Experience and readiness statuses of pre-service teachers before the repair applications

Note: *Since one participant provided more than one opinion, the specified frequency values were calculated above the total number of participants.*



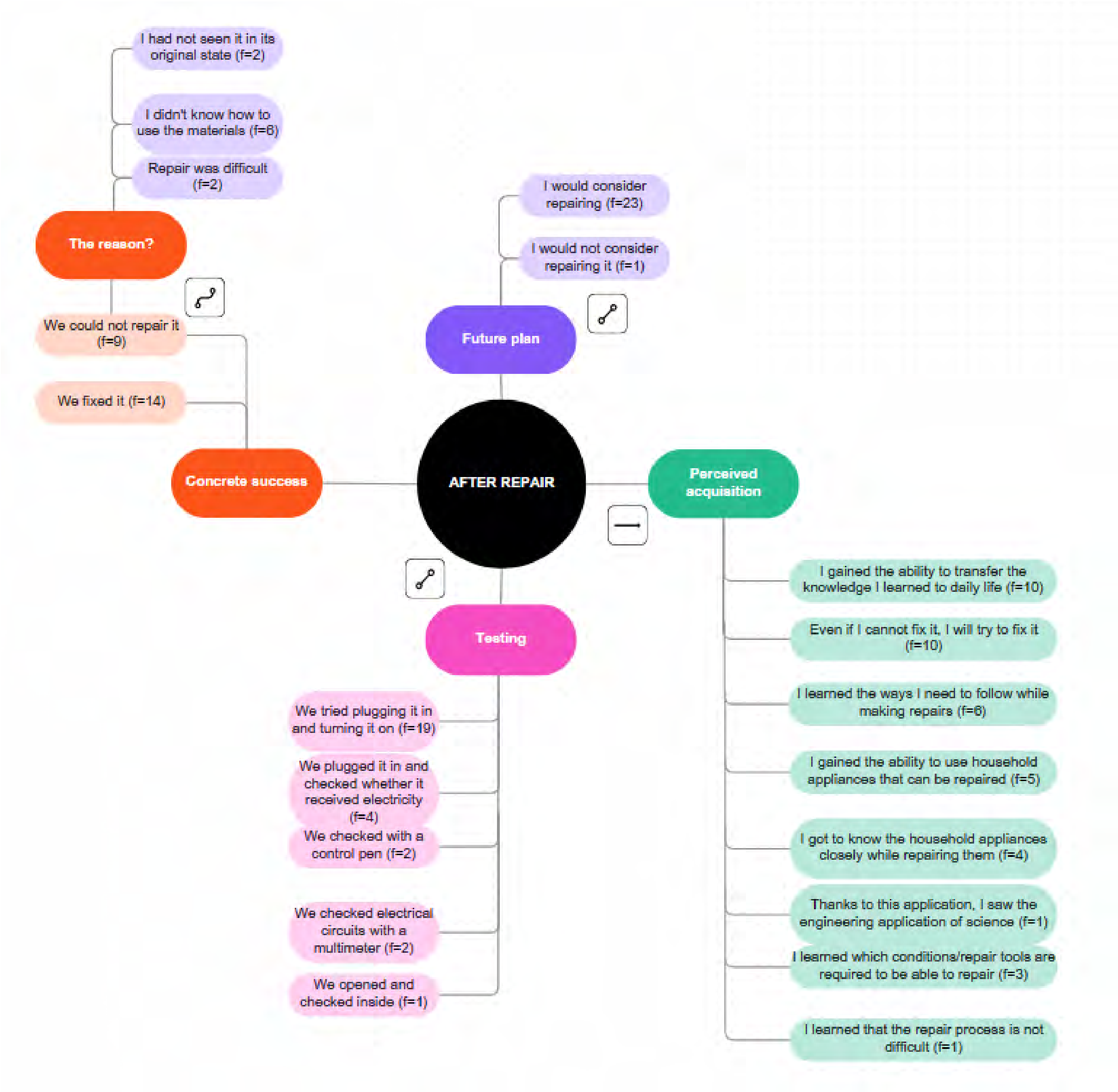
Appendix 2. Pre-service teachers' strategies and approaches in the repair processes

Note: *Since one participant provided more than one opinion, the specified frequency values were calculated above the total number of participants.*



Appendix 3. Pre-service teachers' experiences after the repair practices

Note: *Since one participant provided more than one opinion, the specified frequency values were calculated above the total number of participants.*



Appendix 4. Activity Worksheet 1

BEFORE THE REPAIR APPLICATION

1.(a) Have you repaired a home appliance before? If yes, what kind of appliance did you repair and what method did you follow while repairing it?

(b) If you did repair a home appliance before, would you like to learn how to repair it? What kind of home appliance would you like to repair?

2. How would you proceed when repairing a broken home appliance?

3. What tools do you need to repair a home appliance?
Write down which equipment you can use and for what purpose you can use it.

4. What scientific principles are used when repairing a home appliance?

5. What features of science are used when repairing a home appliance?

Appendix 5. Activity Worksheet 2

DURING THE REPAIR APPLICATION

1. **Mention the home appliance you are repairing.**

2. **Write down the steps you follow when repairing a home appliance.**

3. **Write down the repair tools you use when repairing a home appliance and for what purpose you use them.**

Appendix 6. Activity Worksheet 3

NAMES OF THE FOLLOWING REPAIR TOOLS
WRITE WHAT IT IS USED FOR











Appendix 7. Activity Worksheet 4

AFTER THE REPAIR APPLICATION

1. **Were you able to repair your home appliance? If you were, how did you fix it? If you didn't, what was the reason that you couldn't do it?**

2. **How did you test whether the home appliance you repaired was broken?**

3. **What method did you follow when repairing your home appliance?**

4. **(a) What benefits do you think the repair work you did provided you?**

   (b) If you did not repaire a home appliance before, would you consider repairing it in the future?