Online Science Education Journal, 2018; 3(2): 15-25.
Online Fen Eğitimi Dergisi, 2018; 3(2): 15-25.

Step by Step Argument Map in Learning Environments: An Example of the Subject of Lenses[1]

Büşra Nur ÇAKAN AKKAŞ, *Graduate School of Natural and Applied Science, Kastamonu University, Turkey, busra.n.c.321@gmail.com*
Elif SÖNMEZ, *Department of Primary Education, Kastamonu University, Turkey, esonmez@kastamonu.edu.tr*
Esra KABATAŞ MEMİŞ, *Department of Mathematics and Science Education, Kastamonu University, Turkey, ekmemis@kastamonu.edu.tr*

To refer to this article

Çakan Akkaş, B. N., Sönmez E., & Kabataş Memiş, E. (2018). Step by step argument map in learning environments: An example of the subject of lenses. *Online Science Education Journal, 3*(2): 15-25.

ABSTRACT
Argument is defined as a whole of claim that have presumptive relationships with each other. Argument map, on the other hand, is used in visually presenting arguments that have a presumptive structure with the help of graphical techniques. Argument maps help individuals to visualize and evaluate reasoning processes. In learning environments, argument mapping helps to establish connections between the data and think at a higher level. The purpose of the study is to enable preservice science teachers to create individual and interactive argument maps using the Rationale™ program within the scope of the subject of lenses. Argument mapping process was realized on the basis of "Rationale™", which is an online computer program. The aforementioned program allows us to examine argument maps that are taught in the subtopic of "Lenses" in the subject of "Optic" at higher education level. Also, discussions were made concerning how to use argument mapping in learning environments and examples of relevant argument maps were presented within the scope of the study.
Keywords: Argumentation, argument mapping, science teaching, lenses

Öğrenme Ortamında Adım Adım Argüman Haritası: Mercekler Konusu Örneği

ÖZET
Argüman, birbirleri ile çıkarıma dayalı ilişkilere sahip iddiaların bütünü olarak tanımlanmaktadır. Argüman haritası ise çıkarımsal bir yapıya sahip argümanların grafiksel teknikleri kullanarak görsel olarak sunulmasına yaramaktadır. Argüman haritaları bireylerin akıl yürütme süreçlerini görselleştirmelerini ve bu süreci değerlendirmelerine yardımcı olmaktadır. Öğrenme ortamlarında argüman haritalama bilgiler arasında bağlantıların kurulmasında ve daha üst düzey düşünmeye yardımcı olmaktadır. Çalışmanın amacı; fen bilgisi öğretmen adaylarının mercekler konusu kapsamında RationaleTM programını kullanarak bireysel ve etkileşimli argüman haritaları oluşturmalarıdır. Argüman haritalama süreci çevrimiçi bir bilgisayar programı olan "RationaleTM" üzerinden gerçekleştirilmiştir. Belirtilen program üzerinden yükseköğretim düzeyinde "Optik" konusunun "Mercekler" alt konusunda gerçekleştirilen argüman haritaları incelenmektedir. Ayrıca çalışma kapsamında argüman haritalamanın öğrenme ortamında nasıl kullanılacağı tartışılarak konuya ilişkin argüman haritası örnekleri sunulmuştur.
Anahtar Kelimeler: Argümantasyon, argüman haritalama, fen öğretimi, mercekler

[1] This study was carried out KÜBAP 01 / 2017-62 project number by supported Kastamonu University Scientific Research Project.

INTRODUCTION

In learning environments, students are required to think more intensely and structure the knowledge actively. Argumentation is used frequently in creating learning environments that are based on inquiry and have the specified properties. Argumentation reflects a discussion process structured together with claim, data and justification (Osborne, Erduran, & Simon, 2004). Toulmin (1958) suggests that argumentation is a means of testing the thoughts and a process of structuring the relationship between claim and data with the help of justification. Argumentation includes making justified claims, mounting counter arguments and rebutal the counter arguments (Garcia-Mila & Andersen, 2008). These processes help students to think and experience the reasoning process.

It is important for students to visualize their thoughts and reasoning in the argumentation process and reconsider and evaluate them. Argument map is a tool used in realizing all these points being specified. Argument map is used in visually presenting arguments that have a presumptive structure with the help of graphical techniques. Argument mapping resembles other mapping activities such as mind mapping and concept mapping, but it focuses on logical, evidentiary or presumptive relationships between hypotheses (Pashler, 2011). An argument map is a diagram that consists of "boxes and arrows" and indicates claim and claim-evidence relationship (van Gelder, 2002). In argument maps which are created using "boxes and arrows", while boxes indicate statuses of basic claim, reasons, objections and exceptions; arrows are used for revealing evidence-based relationships of these statuses (van Gelder, 2002). Argument maps are usually created by arranging arguments within a text hierarchically as a pyramid. By this way, the disclosure of the argument structure will enable reasoning.

It is important to know the elements that constitute the structure of an argument in the process of creating an argument map. Because the relationships between elements of an argument such as claim, evidence, justification and objection are visualized in an argument map. While a single claim and a single justification related to that claim constitute a simple argument; multiple claims and multiple justifications or objections represent a complex argument (Davies, 2009). In other words, it is possible to state that a complex argument consists of multiple simple arguments. Individuals may understand a simple argument more easily than a complex argument. In this context, argument maps considerably help individuals to understand, analyze and evaluate their own and other people's arguments (Harrel, 2007). Individuals create multiple complex arguments by combining many simple arguments in the argumentation process and the process occurs in their mind abstractly. However, it is possible to transform the abstract structure of reasoning (ter Berg & van der Brugge, 2013) and the multidimensional structure of complex arguments into a concrete conceptual structure by means of argument maps. Taking all these into consideration; some points to be regarded in creating argument maps are speficied by Sampson and Gleim (2009) as follows:

- Each box should contain a whole meaningful and research-based sentence.
- Boxes should not contain any question sentence. The arguments being presented should consist of either correct or wrong statements.
- If statuses or data contain multiple claims, the claims should be written individually and a claim-evidence relationship should be established for each claim.
- If a claim is supported or confuted by multiple evidences, the reasons specifying evidences aimed at supporting or confuting the claim should be offered.
- If a claim is supported by multiple evidences, abstract and general evidences should be indicated as the hierarchical and primary reason; whereas concrete and particular evidences should be indicated as the secondary reason.
- Arguments consist of claims. Thus, claims should be supported by evidences. Reasons should summarize the claim-evidence relationship at the end of each map.

In the first section of the study, the definition and intended purposes of argument maps are introduced in general. In the second section, information about how to utilize the Rationale™ program used in creating argument maps are presented. In the third section, an example of argument map application is embraced in detail within the scope of the subject of "Lenses". In the fourth section, on the other hand, an evaluation concerning the study results is included.

1. How to Use the Argument Mapping Program Rationale™?

The argument mapping program Rationale™ is accessed via the internet. In order to do that, it is required to open an account in the program with a user name and a password via an e-mail address and start to use the program with these data. Figure 1 shows the screen that opens in the program once the user name and password are entered. The link "Create a new map" which is indicated with a red arrow directs to the page where the argument map will be created.

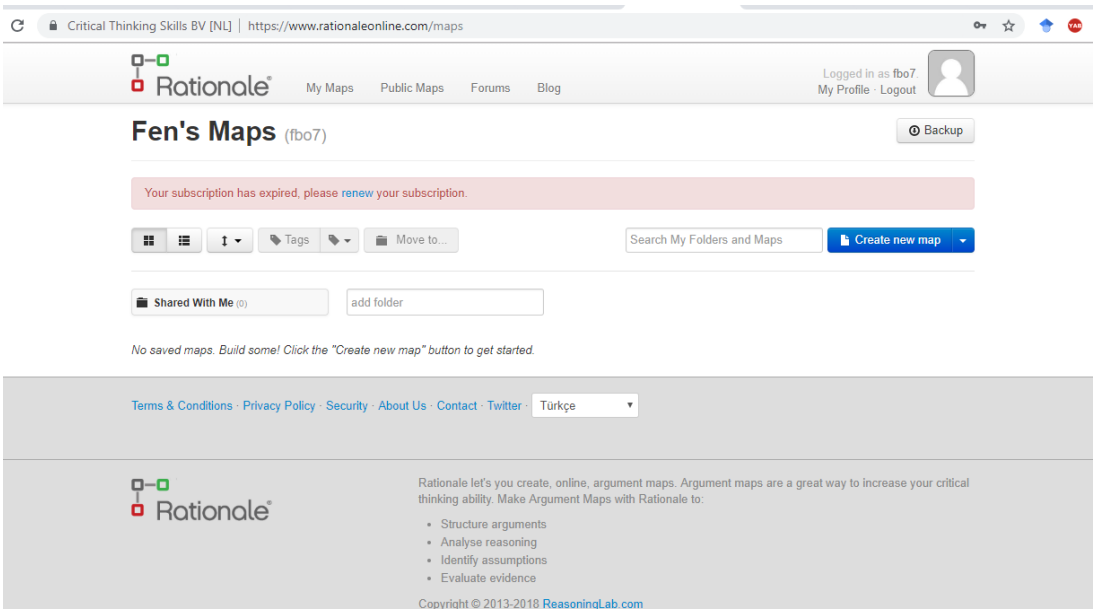

Figure 1. *Login Screen*

The aforementioned link directs to the page where the map will be created. Figure 2 shows the image related to that page. On the left side of the figure are boxes concerning the elements of "Contention, Reason and Objection" which represent the structure of an argument. The contention box is colored in black, the reason box in green and the objection box in red. These boxes can be moved to the white page in the middle of the figure with the help of the drag-and-drop command. It is possible to write sentences related to contentions, reasons and objections within the boxes copied to the white page.

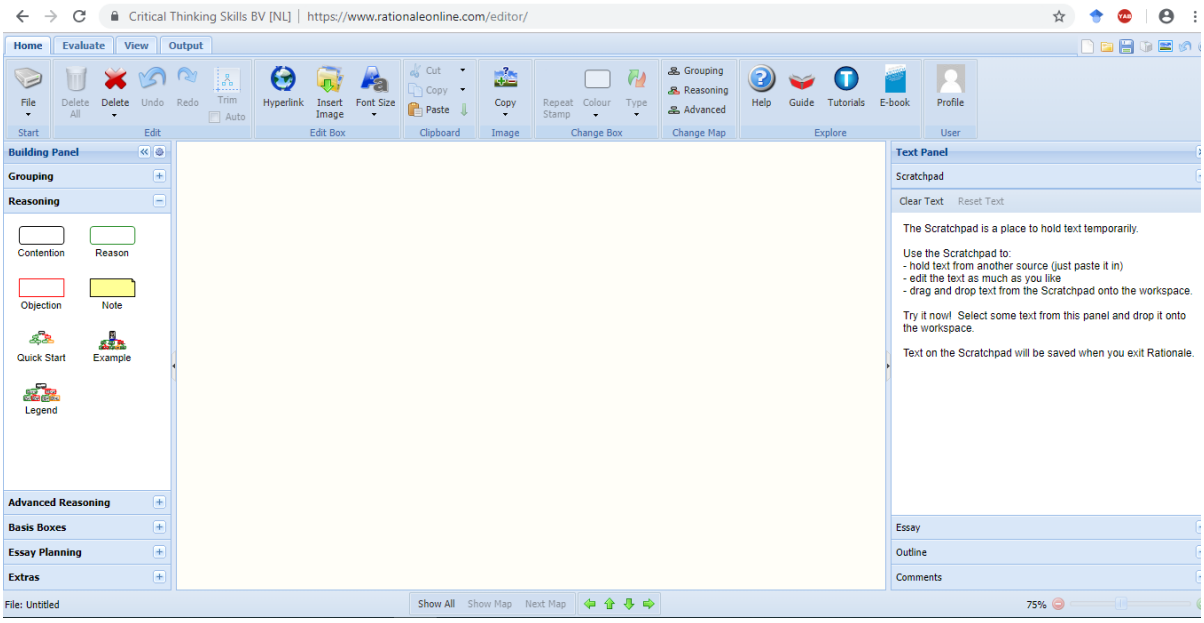

Figure 2. *Argument Mapping Screen*

Above it is indicated that an argument structure can be visualized using the boxes on the left of the page. Figure 3 shows how the elements constituting the argument structure will establish a relationship with each other representatively. The figure includes a contention and reasons, objections and confutations related to that contention. Two simple arguments were created using Reason 1 and Reason 2 related to the contention. In addition, there are an objection and a confutation related to the contention. The map created by these elements reflects a complex argument structure. As is seen, the argument mapping program Rationale™ consists of boxes indicating an argument structure and arrows indicating the evidentiary relationships between them. The map can be printed in various forms (PDF, PNG AND RTNL) after being completed in the program.

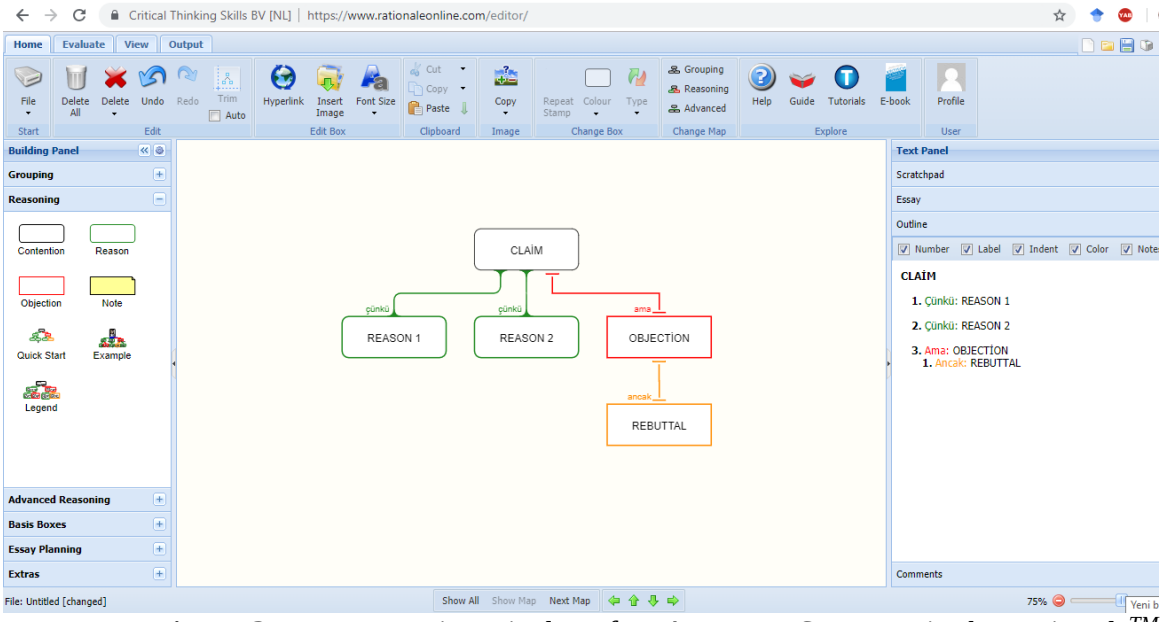

Figure 3. *Representative Display of an Argument Structure in the Rationale™ Program*

In the program, it is possible to create not only argument maps individually, but also interactive argument maps where many people can work on the same map. At this stage, people who participate in the argument mapping process can also connect to the program online. Reasons, objections and confutations related to a contention can be evaluated by other people. Arguments created by a person are evaluated by another person.

2. Example of Argument Map Application: Subject of Lenses

The purpose of the study is to enable preservice science teachers to create individual and interactive argument maps using the Rationale™ program within the scope of the subject of lenses. 33 senior students receiving education in the department of science teaching in the fall term of the school year of 2017-2018 participated in the study. Argument maps were created using the program which is introduced under the second topic. The preservice teachers created an individual and an interactive argument map related to the subject of lenses. They were separated into groups of two for the interactive argument map application. In order to evaluate the contentions, reasons and evidences formed by a small group, a discussion environment was created with another small group. The aforementioned program makes it possible to visualize argument structures and understand the more extensive argumentation process which consists of multiple simple arguments.

In the individual argument map, the students were asked to form a contention using the program, present reasons using evidences related to the contention, raise objections related to the contention and create an argument map that would confute the contention. Examining the argument maps created; it was seen that the maps enabled the preservice teachers to present data within a logical structure and solve complex argument structures. However, it was also seen that the preservice teachers were not able to raise any objection or confutation against their contentions in the individual argument map application. Figure 4 shows an example 1 of argument map which was prepared by a preservice teacher. Examining the example; it is seen that there is a map where the preservice teacher mainly relayed information about the subject of lenses and depicted the relationships between these information. However, argument maps primarily require suggesting a contention and forming reasons and objections related to the contention within the frame of an evidentiary relationship.

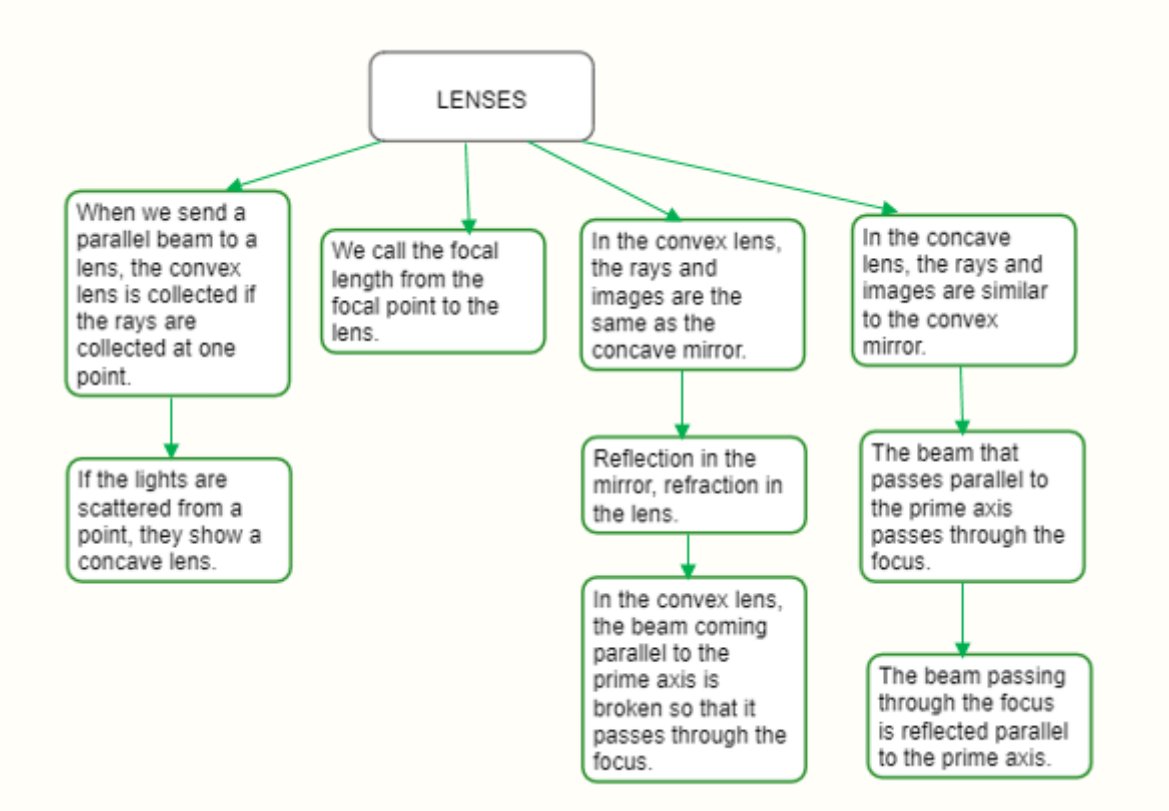

Figure 4. *An Example 1 of Individual Argument Map*

In addition, examining the example 2 of argument map in Figure 5; the preservice teacher formed a contention related to the subject and offered multiple reasons related the contention. However, examining the map; it is seen that only one objection sentence was addressed to the aforementioned contention. In an argument structure, it is important to not only offer multiple reasons related the contention, but also raise objections against the contention. Figure 6 also shows an example 3 of argument map offering a contention related to the subject and reasons and objections related to the contention.

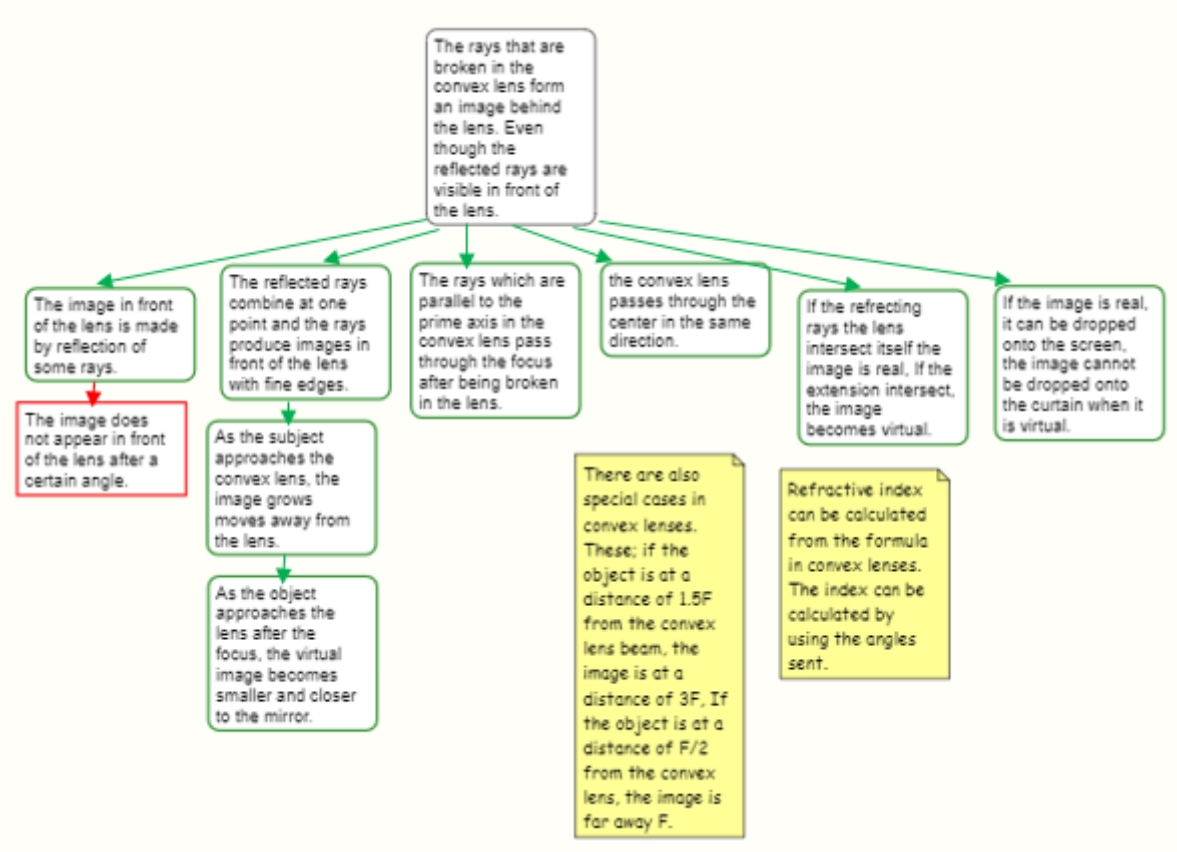

Figure 5. *An Example 2 of Individual Argument Map*

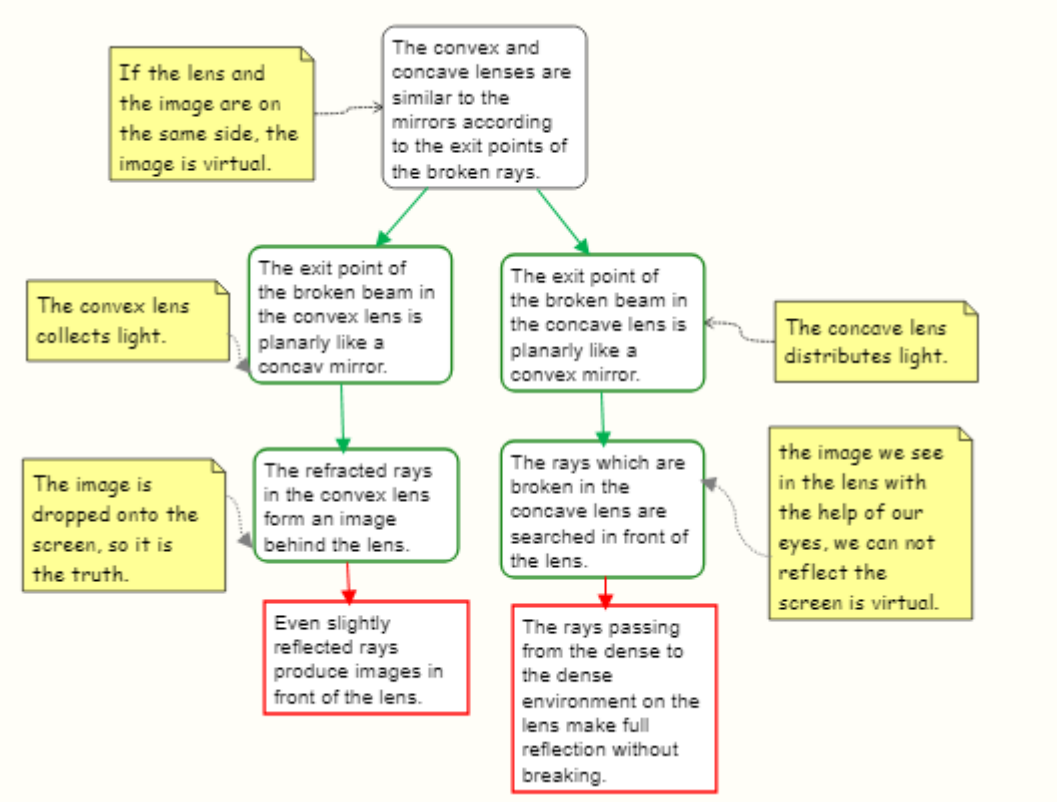

Figure 6. *An Example 3 of Individual Argument Map*

Within the scope of the study, the preservice teachers created interactive argument maps. In this mapping process, researchers can also work on the same map with preservice teachers and ask them questions when necessary. The purpose of these questions is to attract students' attention, make them think more and attach them to the main contention. In the interactive argument map applications, it was seen that the preservice teachers supported their contentions with evidences and frequently used objections and confutations. It was also seen that the preservice teachers offered multiple evidences for each contention in the interactive argument maps and supported these evidences with greater visual elements. Figure 7 and Figure 8 show the examples of interactive argument maps of two different groups working on a map. The statement "No reflection on the lenses." written in the box at the start of the map was suggested as a contention by the researchers. The preservice teachers also wrote their reasons and objections related to the contention within a pattern. Examining the maps; it is seen that the preservice teachers offered multiple reasons and objections related to the contention. In addition, Figure 8 shows that the preservice teachers tried to present their reasons as an evidence and used visual elements for that. These activities gave an opportunity of creating a computer-aided discussion environment in the mapping process.

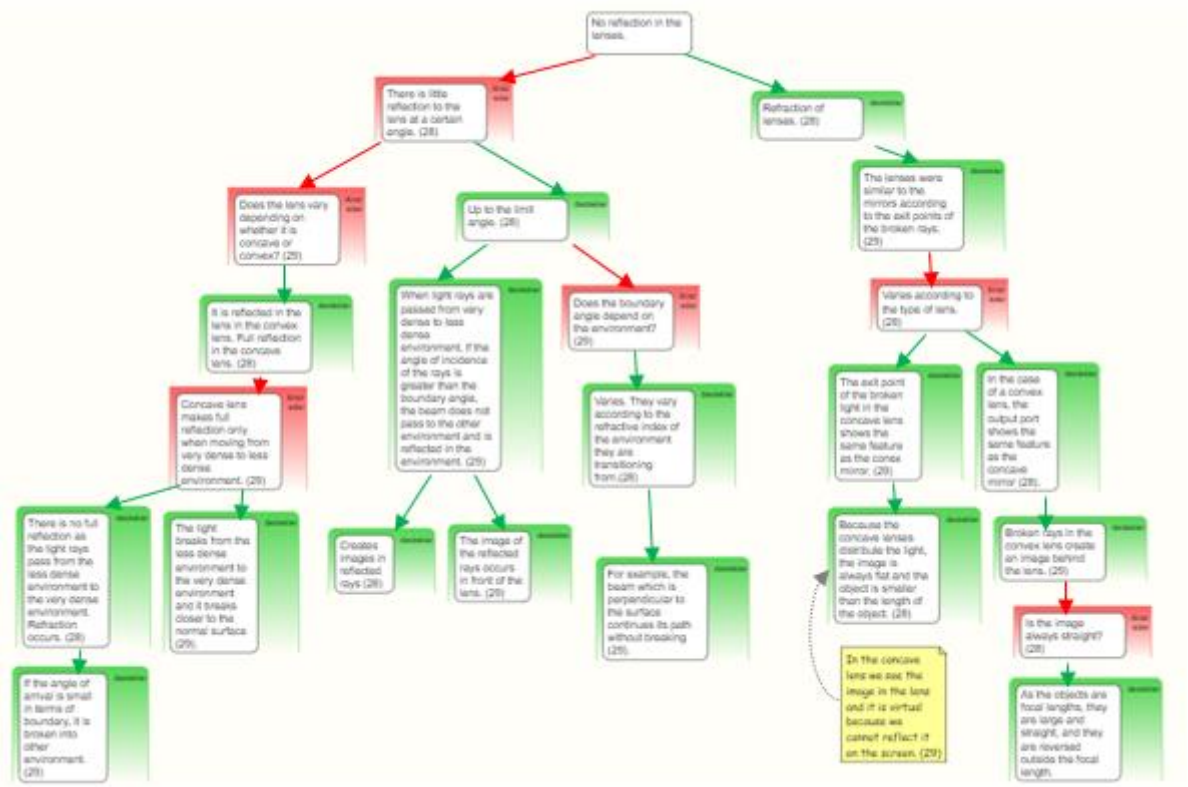

Figure 7. *An Example 1 of Interactive Argument Map*

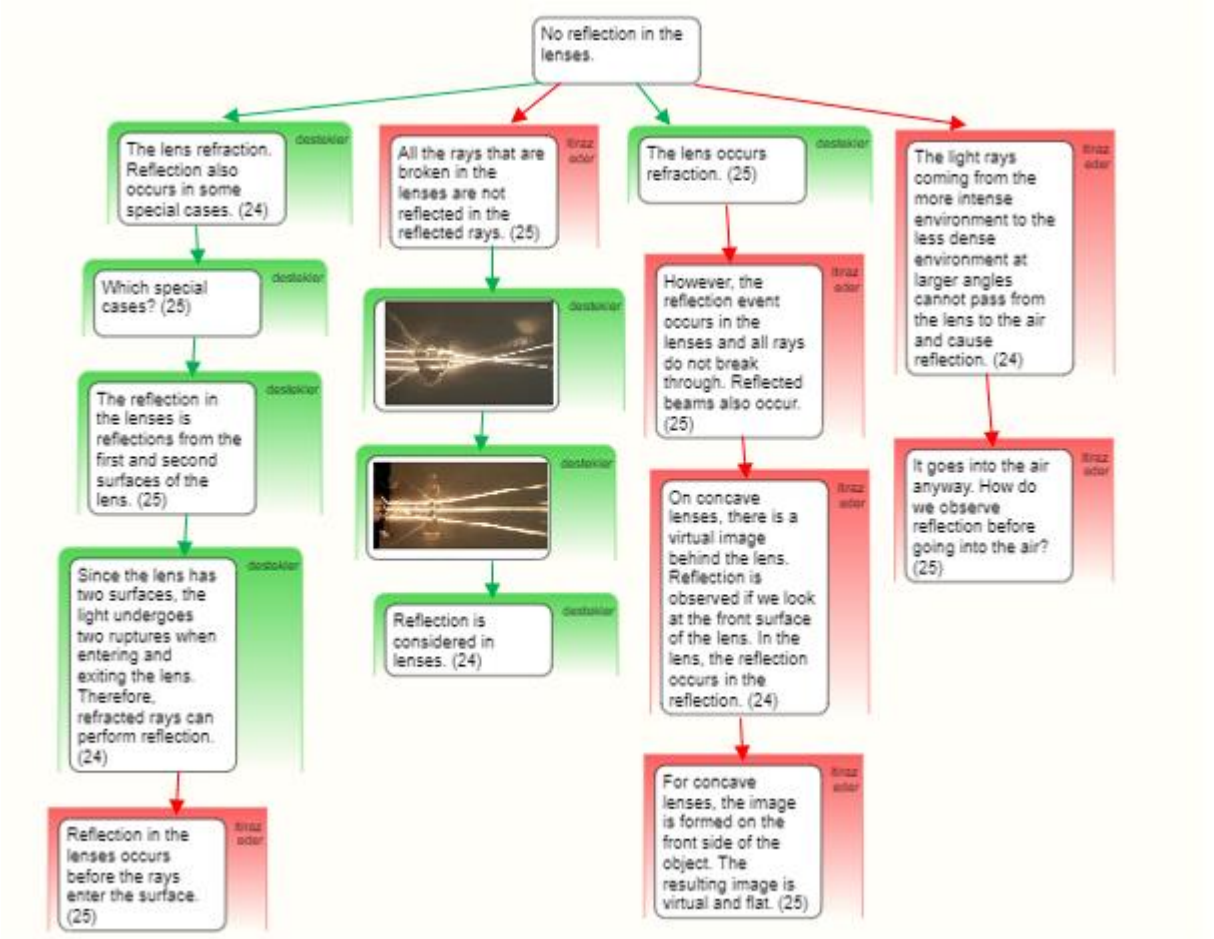

Figure 8. *An Example 2 of Interactive Argument Map*

DISCUSSION AND CONCLUSION

In the study, it was primarily attempted to define the argument map. Then the Rationale™ program used in creating the argument map was introduced in detail. An extensive example of application was performed with the preservice Science teachers within the scope of the subject of "Lenses" using the program. Argument map is encountered as an educational tool enabling students to structure arguments or counter arguments and contributing to discussions in learning environments. Argument map is effective on individuals to understand the structure of arguments. So why is it important to understand an argument structure? Davies (2009) summarizes it as follows; 1. Explain claim briefly and essentially, 2. Discern important results from others, 3. Determine important premises, 4. Put claims in an appropriate and logical order, 5. Display connections from premises to results. As is seen, it is possible to state that informational convergence concerning argument maps has actually been prevented and it makes it easier to adopt essential knowledge concerning a subject.

It can be suggested that argument maps do not have a deep-rooted history. According to van Gelder (2009),no relevant information had been encountered until the 19th century and the initial attributes were made by Richard Whately in a school book in 1836. Then a schema showing the argumentation process representatively was suggested by Toulmin in 1958. These schemas which were used in showing the argument structure at a baseline level used to be prepared manually with paper and pencil due to restricted technological opportunities, which would eventually cause loss of time and a boring process for map makers. Today, argument maps are created easily in the computer environment thanks to the proliferation of

computers and development of appropriate softwares. As these softwares provide a practicality in the utilization of boxes displaying contentions, reasons, objections and exceptions and arrows revealing their logical relationships, they make the process more effective.

Rationale™ is a program developed for argument mapping. The program was developed by van Gelder (2007) and the benefits of the program are summarized in three items: Firstly; supporting reasoning activities, secondly; enabling the individual to determine the weaker and stronger aspects of her or his cognitive power, and finally; supporting the realization of reasoning and discussions in the convenience of daily reasoning and in the solidity of figural logic. As is seen, argument maps allow individuals to evaluate their own reasoning processes via arguments. By this way, individuals get the opportunity of supporting their stronger aspects and improving their weaker aspects even further in reasoning processes. If students map the arguments visually, they may develop a clearer comprehension and thus, strengthen their learning (Davies, 2009). This condition indicates that argument maps may become effective on learning the knowledge in association with each other.

Examining the literature; there are studies indicating that argument mapping not only increases meaningful learning, but also develops critical thinking (Twardy, 2004; Christopher, Michael, & Stewart, 2015). According to Twardy (2004), in order for a student to do critical thinking, she or he is required to realize the reasoning process, define the baselines of contentions and evaluate evidences. It is possible to state that suggesting a contention experienced by students in the mapping process, forming reasons and objections related to the contention with the help of evidences and also building these elements using the right relationships will support students' high-level thinking. Thus, it can be suggested that argument mapping can be used effectively in learning environments. In addition, feedback also plays a role at this point. The feedback to be given to individuals before, during and after the completion of the argument mapping process are of great importance. By this way, reasoning processes of individuals can be improved.

It is very important for individuals to be aware of their own thinking processes. Because by this way, they will be informed about their mistakes in the process and try to correct them. Thus, individuals will not only have meaningful learning, but also acquire high-level thinking skills like critical thinking. Rationale™ provides that. Therefore, it is important to use tools which may enable individuals to control their thinking processes, discuss about it and receive feedback in learning environments. The development and intense utilization of technology in every area of our lives including education is also an important point. Including technology in learning environments at every stage of education with the help of programs such as Rationale™ will be effective on preparing individuals to the future. By this way, the thinking levels of individuals will be improved and the knowledge will be learned in a more meaningful way. At this point, it is necessary to attach a greater importance to the education of especially preservice teachers who will raise the labor force of the future.

REFERENCES

Christopher, P., Michael, J., & Stewart, I. (2015). The effects of argument mapping-infused critical thinking instruction on reflective judgement performance. *Thinking Skills and Creativity, 16*, 11-26.

Davies, W. (2009). Computer-assisted argument mapping: a rationale approach. *High Education*(58), 799-820.

Garcia-Mila, M., & Andersen, C. (2008). Cognitive foundations of leaning argumentation. S. Erduran, & M. Jimenez-Aleixandre içinde, *Argumentation in Science Education* (s. 34). Springer.

Harrel, M. (2007). Using Argument Diagramming Software to Teach. Dietrich College of Humanities and Social Sciences.

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science . *Journal Of research İn Science Teaching , 41*(10), 994-1026.

Pashler, H. (2011). Argument mapping. Thousand Oaks, CA: Sage.

Sampson, V., & Gleim, L. (2009). Argument-driven ınquiry to promote the understanding of important concept &practises in biology. *The American Biology Teacher, 71*(8), 465-472.

ter Berg, T., & van der Brugge, E. (2013). Teaching critical thinking with rationale. *7th International Technology, Education and Development Conference.* Valencia, Spain.

Toulmin, S. (1958). *The uses of argument.* Cambridge: Cambridge University Press.

Twardy, C. (2004). Argument maps improve critical thinking. *Teaching Philosophy, 27*(2), 95-116.

van Gelder, T. (2002). Argument mapping with Reasonable. *APA Newsletter: Philosophy & Computers, 2*(1), 85-90.

van Gelder, T. (2007). The rationale for RationaleTM. *Law, Probability and Risk*, 1-20. doi:doi:10.1093/lpr/mgm032

van Gelder, T. (2009, February 17). What is argument mapping? November 2, 2018 tarihinde alındı.