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EXPLORATION OF PRESERVICE SCIENCE TEACHERS' WRITTEN ARGUMENTATION SKILLS IN A LABORATORY COURSE: A TOULMIN-BASED ANALYSIS

Abstract

The aim of this study was to explore Preservice Science Teachers' (PSTs) written argumentation skills and to explore what the nature of argumentation patterns presented by PSTs in response to the different experimental contexts. The participants of the study were fifty PSTs (66% female) from the department of elementary science teacher education program at a large university in Turkey. The instruction continued in the laboratory course, which is a required course in the science teacher education program in Turkey. Data sources for this study consisted of students' laboratory reports written during lab sessions during a twelve week period. Data was analyzed by using the TAP framework, Toulmin (1958). This study provides an initial picture of the argumentation writing practices of PSTs engaged in elementary science laboratory experiments. The notable finding of this study was that, while PSTs frequently used data to support their claims, they rarely used rebuttals to refute counter claims.

Key Words: Preservice Science Teachers, Written Argumentation, Science Laboratory

FEN ÖĞRETMEN ADAYLARININ FEN LABORATUVAR DERSINDEKİ YAZILI ARGÜMANTASYON BECERİLERİNİN İNCELENMESİ: TOULMIN ARGÜMANTASYON ANALİZİ

Özet

Bu çalışmanın amacı, Fen Bilgisi Öğretmen Adaylarının fen laboratuvarı dersinde yapmış oldukları farklı bağlamlardaki fen deneyleri sonucunda yazdıkları raporlarda ortaya çıkan argümantasyon becerilerini, Toulmin Argümantasyon Modeli kullanarak analiz etmek ve modelde ortaya çıkan bileşenler arasındaki örüntüyü incelemektir. Araştırmanın katılımcıları Türkiye'de büyük bir üniversitede ilköğretim fen bilgisi öğretmenliği bölümünde öğrenim görmekte olan elli öğretmen adayından (% 66 kadın) oluşmaktadır. Uygulama, müfredat programında zorunlu ders olarak yer alan fen laboratuvarı dersinde yapılmıştır. Çalışma nitel araştırma yöntemi kullanılarak dizayn edilmiştir. Çalışmanın veri kaynakları oniki haftalık uygulama esnasında öğretmen adayları tarafından doldurulan deney raporlarından oluşmaktadır. Veriler Toulmin (1958) argümantasyon modeli kullanılarak analiz edilmiştir. Bu çalışma ilköğretim fen laboratuvar uygulamaları dersinde argümantasyon kullanımı hususunda bir örnek teşkil etmektedir. Çalışmanın temel bulguları arasında öğretmen

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adaylarının geliştirmiş oldukları iddiaları desteklemek için veri topladıkları ve bu verileri kanıt olarak kullandıkları, ancak karşı iddiaları çürütmek için nadiren çaba gösterdikleri görülmüştür.

Anahtar Kelimeler : Fen Bilgisi Öğretmen Adayı, Yazılı Argümantasyon, Fen Laboratuvarı

INTRODUCTION

Argumentation has been an important part of scientific advancement and interactions throughout history. This can be seen not only in daily life activities (Voss & van Dyke, 2001) but also in school practice (Sampson & Clark, 2008). In recent years, a significant amount of research has highlighted the contributions of argumentation in science education (Aufschnaiter, Erduran, Osborne, & Simon, 2008; Duschl & Osborne, 2002; Erduran & Jimenez-Aleixandre (2008); Rivard & Straw, 2000). Students' scientific decision-making strategies (Driver, Newton, & Osborne, 2000), responses to environmental issues (Kortland, 1996) and socioscientific issues (Zeidler & Lewis, 2003) are investigated in that research. These studies have shown consensus on the claim that argumentation increases students' understanding of science processes (e.g., Kelly, Chen, & Prothero, 2000; Kuhn & Udell, 2003; Newton, Driver, & Osborne, 1999), and argumentation-based learning environments promote students' conceptualization of science (Bell & Linn, 2000).

Argumentation can be defined as " a verbal, social and rational activity aimed at convincing a reasonable critic of the acceptability of a standpoint by putting forward a constellation of propositions justifying or refuting the proposition expressed in the standpoint" (van Eemeren & Grootendorst, 2004, p. 1). As it can be seen from the definition of argumentation, it has not only verbal but also social and rational characteristic. While verbal and social processes of argumentation enhance students' communication skills, rational processes of argumentation enhance cognitive process skills (i.e., argument construction and discourse strategy) (Felton, 2004).

The theoretical framework for the present study links argumentation writing and scientific inquiry through the laboratory activities. The framework, Toulmin's (1958) definition of argumentation, has been applied as a methodological tool. We used Toulmin Argumentation Pattern (TAP) to explore the PSTs laboratory reports. Data, claims, warrants, backings, rebuttals, and qualifiers are known as the main components identified by Toulmin (1958). These components are:

- Data: these are the facts that those involved in the argument appeal to in support of their claim.
- Claim: this is the conclusion whose merits are to be established.
- Warrants: these are the reasons (rules, principles, etc.) that are proposed to justify the connections between the data and the knowledge claim, or conclusion.
- Backing: these are basic assumptions, usually taken to be commonly agreed that provide the justification for particular warrants.
- Qualifiers: these specify the conditions under which the claim can be taken as true; they represent limitations on the claim.

- Rebuttals: these specify the conditions when the claim will not be true. (Driver, Newton and Osborne 2000).

Present study explored PSTs written argumentation skills by using TAP. Writing in science has been perceived as a beneficial way of understanding scientific contexts, bridging prior knowledge with new learning, and constructing explanations from class discussions, textbooks, or laboratories (Santa & Havens, 1991; Prain & Hand, 1996). Writing tasks became popular in science education, because of its immediate relation with thinking (Applebee & Langer, 1983). Written assignments help students to construct an understanding of science (Kelly & Chen, 1999), and to structure and organize knowledge in a consistent manner (Rivard & Straw, 2000). "How can I know what I think until I see what I say" famous query of Wallas (1926) stresses the relationship between thinking and writing. Process of thinking or process of reasoning is hidden step of learning. Written argumentation texts expose this hidden step to view. Written arguments of students are worth to analyze because it develops higher order thinking skills, complex reasoning mechanism, and enhances reorganizing skills of students that help them to write in a coherent manner.

The practical significance of this study is manifested through its participants (preservice science teachers). The role of the teacher is seen as one of the most important factor in education process. Well-qualified teachers are initial factor to implement argumentation in science education. It is stated that the way of teacher assembles a scientific argumentation task affects the students' products (Kelly & Chen, 1999). Argumentation requires moving away from the role of the teacher as the source of right answers (Simon, Erduran & Osborne, 2006) and shifting towards the role of the teacher as a facilitator (Zohar, 2007). Argumentation education for teachers is prerequisite for the application of argumentation in classrooms, since teachers' lack of pedagogical strategies to support students in engaging in argumentation (Zembal-Saul, Munford, Crawford, Friedrichsen, & Land, 2002). In order to implement argumentation processes proficiently in science classrooms, teachers have to gain experience in argumentation (Zohar, 2007). Taking into consideration the fact that teachers are valued as key factor in argumentation construction (Tabak, 2004), we did research on PSTs argumentation writing skills in the current study. This study is a more detailed analysis of how argumentation was facilitated by PSTs. The present study examined Turkish preservice elementary science teachers' written argumentation skills and development of these skills with the increase in their argumentation experiences. The importance of teachers in these kinds of studies was stated by Driver et al. (2000). They found crucial, to improve teachers' knowledge, awareness, and competence in managing students' participation in argument and discussion. This is possible with organizing workshops for inservice teachers and increasing argumentation experience of preservice teachers during their undergraduate education. Both may contribute to future professional development of teachers.

Preservice Science Teachers were engaged with argumentation by many science researcher in the literature (e.g., Erduran, Ardac, & Yakmacı-Güzel, 2006; Zembal-Saul 2009; Osana & Seymour, 2004). The importance of argumentation in knowledge generation and justification phase was highlighted in these studies. Erduran, Ardac and Yakmacı-Güzel (2006) presented a case study for the promotion of argumentation in Pre-service teacher education program. 17 PSTs were trained using a special pack, IDEAS (ideas, evidences, and argument in science education) pack. PSTs were expected to prepare a lesson plan which is designed as an argument lesson and were expected to implement in real classroom environment. The study focused on PST training program and highlights the importance of implementation of argumentation in science education program. They suggest teacher educators that learning to teach argumentation from novice to expert should be given importance. Zembal-Saul (2009) examined PSTs problems of argumentation practices, and presented a framework creating coherence for the design of teacher education experiences. The study results showed that suggested framework is a powerful tool for PSTs understanding and practicing skills for argumentation. Researchers criticize the inexperience of PSTs as scientific inquiry learners and inexperience about the nature of scientific knowledge.

Osana and Seymour (2004) conducted a study to enhance PSTs argumentation and critical thinking skills about complex, educational problems. The researchers gave written text to PSTs and asked them to write critical argumentation essays regarding the topic. PSTs conceptions and use of evidence was primarily focus of the researchers since evidence is an important component of reasoning and argumentation. Their second focus was about use of research evidence as an argumentation tool. PSTs have a tendency to use research findings during argumentation construction instead of an opinion or unsupported belief. Literature highlights the importance of contemporary reforms in science education that emphasize content, practices and discourses of science since PSTs need to develop robust understanding of science and transform these understandings during their teaching life.

As well as the importance of PSTs in science education, a significant number of researchers highlight the importance of laboratory in science curriculum (Freedman, 1997; Hofstein & Lunetta, 2004) and the emergence of taking argumentation as a core activity in science (Duschl & Osborne, 2002; Jiménez-Aleixandre, Rodrigez, & Duschl, 2000; Rivard & Straw, 2000). Many researchers have argued that scientific inquiry should encompass scientific argumentation as a central feature of science learning (Kelly, Druker, & Chen, 1998; Newton et. al., 1999; Osborne, Erduran, & Simon, 2004; Richmond &Striley 1996). In science education, laboratories provide experiential setting that are important in understanding the application of scientific concepts. However, in traditional laboratories, students are passive learners of science and follow step-by-step directions. Reforms in science education have called for student-centered laboratory experiences and use of scientific inquiry-based pedagogies in those experiences (Jeffries, Rew, & Cramer, 2002). Scientific inquiry is generally defined as a process of asking questions, devising means to collect data to answer those questions, interpreting data, and drawing conclusions (e.g., National Research Council, 1996). Therefore, it would seem logical that student-centered science laboratories are an appropriate venue to apply scientific argumentation. It is here that students should be engaged in hands-on and have chance to engage in inquiry based activities.

Argumentation research had trended to become one of the most popular issues in science education research. However, argumentation research in science laboratory settings has rarely been studied by researchers. PSTs should have the opportunity to engage in laboratory work during their professional education. Science laboratories are an important place for science learning and teaching, and the theoretical knowledge gleaned may be turned into practical experiences in these places. When argumentation experiences are integrated into PST's science laboratory experiences, PST's scientific inquiry skills have the potential to be developed and improved. Therefore, exploring and describing PST's current abilities in terms of argumentation development in scientific inquiry environments has an important place in science education research. Therefore, it is important to have a fundamental understanding of, how PST's argumentation patterns are utilized under different experimental contexts. Accordingly, the following research questions guided this investigation;

Research Questions:

1) What is the frequency of TAP components revealed in different contexts of science experiments?

2) What kinds of argumentation patterns are presented by PSTs in response to the different contexts of the experiments?

METHOD

Since the present study is an intensive holistic description and analysis of a bounded system, it is appropriate to invoke a qualitative case study design. PSTs laboratory manuals provided the main source of data. Qualitative research enables researchers to conduct in-depth studies about a wide range of topics (Yin, 2011) allowing for the exploration of human behaviors within the context of their natural occurrence (Bogdan & Biklen, 1992), and seeks to understand the world from participants' perspectives (Lincoln & Guba, 1985). Stake (1995) asserts that the qualitative researcher seeks to understand complex interrelationships that lie within systems and utilize inquiry to promote understanding rather than to explain it.

The study draws from University students in faculty of education, and documents were available from implementation of an elementary science laboratory course (Spring-2015). The aim of this course is to engage PSTs to scientific inquiry and science process skills, and to raise their awareness of the current research issues such as argumentation writing in this course. Issues related to different areas of science, such as physics, chemistry and biology were used as scientific topics throughout this course. There were twelve laboratory applications over a semester. Four topics representing fundamental biological and physical science concepts were selected as the context for current study and included the respiratory system, gas expansion, buoyancy and density.

Participants

The researcher used the convenient sampling method because this sampling strategy relies on available subjects who are easily accessible in a typical university intact class setting. College and university professors commonly use their students as subjects in their research projects (Berg, 2001) and it is the most common sampling strategy (Patton, 2002). The participants were 50 PST (% 66 female) from the Department of Elementary Science Education (ESE) at a large university in eastern Turkey. ESE program aims to develop teachers with a sound understanding of how children learn science so that their students are confident in using technology, capable of problem-solving, and attentive to human rights, democracy, and ethics. The students, enrolling the ESE program, take general science courses in their first and second years and then begin pedagogical courses in their third and fourth year. Participants in this study had completed science education courses in addition to other courses such as; physics, chemistry, biology, technology, history, and English. The participants also completed several pedagogy courses that prepared them for teaching. Pre-service teachers graduating from this program typically teach science in public and private setting from fourth to eighth grades in primary and middle schools. The study was conducted during the third year of the program in an elementary science laboratory course. Science laboratory reports of PSTs were written as a scientific argumentation paper.

Treatment

The treatment included a variety of experiments and argumentation writing activities. The instruction continued in the elementary science laboratory course. In the instruction process, there were twelve different science experiment contexts that were experienced by PSTs in order to write a scientific argumentation paper. Four out of twelve reports were selected as data source. Selected experimental contexts included the respiratory system, gas expansion, buoyancy, and density. Each experiment lasted two hours. There were standard questions given by the researcher to the PSTs about each experiment. Some of these questions were: *What effects human respiratory system? Smoking is identified as the single most important cause for most of the serious respiratory problems lung cancer, What do you think of this statement? How can you support your idea? Life style and environmental factors are important in contributing to and increasing the susceptibility to respiratory disorders. Do you agree this statement why? Why not?* For gas expansion experiment the questions were: *Why the balloon expanded when it was put out of the window how can you support your statement?* PSTs were required to argue these kinds of questions for each experiment.

The experiments were not only science experiments but also integrate the promotion of argumentation activities that were imposed in laboratory reports aimed to engage PSTs in evidence-based reasoning. The experiments immerse PSTs to generate their own explanations to account for the given situation. After each experiment, PSTs were required to write laboratory report including scientific claims, data, warrant, backing an rebutal regarding the experiment. PSTs were expected to form a strong argument in order to make a good claim. They were also required to support that claim with evidence. PSTs were required to support their claims with evidence but this is not enough to write well developed scientific paper. They also should infer valid conclusion from available data if they want to form well developed paper. The researcher also asked some leading questions to help students discuss and negotiate elements of the experiments. For example, regarding the "buoyancy" experiment, the question "*how can you explain the sinking of backgammon dice and the floating of the paper-ship on water?*" was asked by the researcher. These types of guiding questions were also asked for the other experimental contexts as well. PSTs were expected to make a claim and to provide evidence for their claims. The researcher was neither the source of correct answers nor the source of authority to judge the PSTs responses to the questions. PSTs written argumentation reports were analyzed each week. Each paper were assessed weekly, researcher wrote feedbacks on each paper and discussed these feedbacks with every participant individually. As the course progressed (in each case) at the beginnings of the writing sessions, the researcher explained common deficiencies of papers and typical weakness of the previous weeks to the PSTs. At the end of the each lab sessions, researcher interacted with the students and maintained a dialogue with them about their ideas and perceptions about the feedbacks.

Data Collection

PSTs were engaged with the different science topics throughout this course and they were expected to write a laboratory report about these topics for twelve weeks. Writing activities have been commonly used in science lessons by many practitioners (McDermott & Hand, 2010; Kelly & Takao, 2002; Keys, Hand, Prain, & Collins, 1999; Rivard and Straw, 2000). The uses of scientific writing, as reported by these researchers, have focused on analysis of students' products and views about science, showed a range of applications of writing to learn and learning to write. Written assignments help students to construct an understanding of science and to structure and organize knowledge in a consistent manner.

Each student wrote twelve reports in total and selected four reports were used as data source to examine the PST's nature of written argumentation and their argumentation patterns. PSTs were told the purpose of the application at the outset of the term. Moreover, it was explained to them that their papers would serve as their midterm for the course. The researcher interviewed the participants individually regarding any deficiencies in their scientific paper writing. These interviews helped ensure participants would not make the same mistakes in their following reports.

Data Analysis

Merriam (1988) assert that data collection and data analysis must be a simultaneous process in qualitative research. The present study aimed to conduct these two steps simultaneously. In order to examine the PST's nature of written argumentation, the TAP framework (Toulmin,1958), was used. Despite its use as a framework for defining argument, the application of TAP to the analysis of laboratory reports has yielded difficulties. The main difficulty has been in the clarification of what counts as claim, data, warrant, and backing. This difficulty was pointed out in previous research by many science education researchers (Duschl, Ellenbogen, and Erduran, 1999; Erduran, Simon, and Osborne, 2004; Kelly, Druker, and Chen, 1998). Still present research used TAP to explore PSTs natüre of argumentation as TAP enables one to link existing ideas to new ideas. In order to persuade people or refute an idea, one needs to understand deeply components of this framework and to be able to use them in a correct manner. The first analysis was done by identifying the components of a scientific argumentation from the students' reports. The same analysis was done for four reports and percentages of each component are shown in Figure 1. Then, the researcher compared the percentages of the components of the scientific argumentation papers regarding each experimental context. This analysis is shown in Figure 2. The last analysis highlighted the argumentation patterns in the student papers. Figure 3 represents these patterns. These patterns entail combinations of TAP components such as claim-data, claim-data-warrant, claim-data-backing, or claim-data-warrant-rebuttal.

The PST's scientific papers were assessed by the course instructor and one science education researcher. Overall scores were summarized with figures stated below. The researcher and the course instructor scored one of the reports in a cooperative manner discussing each of the criteria. Following this initial scoring procedure, the researcher and the instructor scored PSTs reports independently to achieve an acceptable individual inter-rater reliability. Both researchers negotiated the differences between their grading and reached an agreement about the discrepant point of views. The rate of agreement on the scoring analyses exceeded 90 %. The remaining papers were assessed by the course instructor, eliminating potential researcher's biases and giving a chance for member checking and researcher triangulation to enhance the credibility of the study (Merriam, 1998, p.204).

Credibility, Trustworthiness and Transferability

Lincoln and Guba (1985) presented a framework to enhance the credibility and trustworthiness of the qualitative studies. These may be thought to be analogues to validity and reliability but Lincoln and Guba make it clear that these constructs are ontologically and epistemologically distinct from one another. Three techniques was used in order to have credible and trustworthy findings which are triangulation, member checking and providing thick description. To enhance the trustworthiness of the data analysis, researcher triangulation was used to establish inter-rater fidelity of the data analysis. The different researchers scored each paper line-by-line, and graded papers by using the TAP model.

Lincoln and Guba (1985) explain the importance of being able to transfer the findings of the study (again, analogous but conceptually distinct from generalization or external validity) by the term applicability, which refers to transferability. The issue of transferability for this study was met by using thick descriptions of participants, data collection procedure, data collection tools and finally data analysis procedure.

RESULTS

In present study, developments of written argumentation of PSTs in science laboratory were analyzed by using the TAP. Figure 1 and Figure 2 represent the nature of the PST's scientific argumentation papers. The frequency of each TAP component is given in Figure 1. It is clear that students have no difficulty in developing claims and supporting those claims with appropriate data. On the contrary, students have difficulty in using rebuttals and backings.

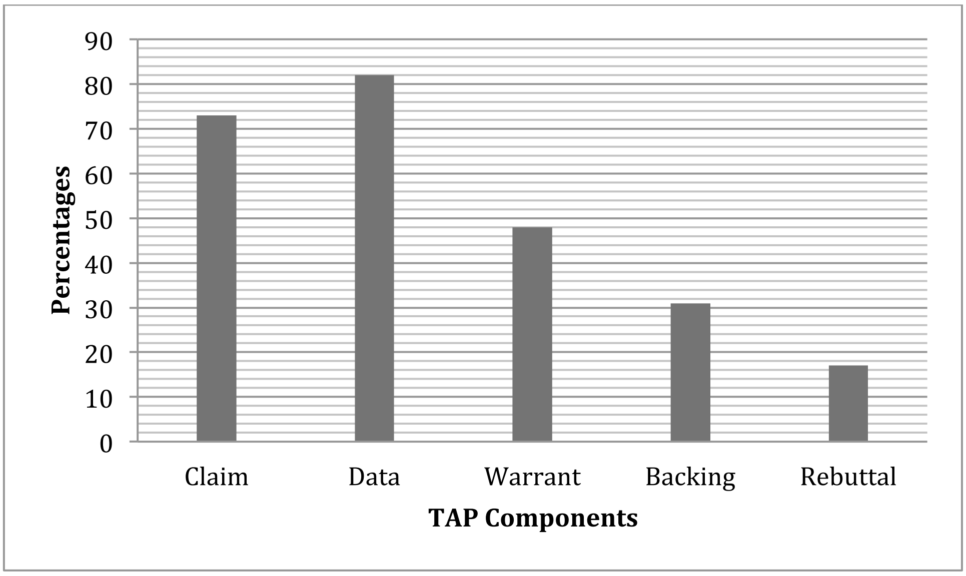

Figure 1. The percentages of the TAP components of written argumentation

As it is can be seen from the Figure-1 PSTs were good at making a claim and gathering data to support their claims. On the contrary, PSTs rarely used warrant, backing, and rebuttals in their explanations. Claim and data were the most commonly seen components across the papers. Analysis showed that 82 % of the TAP components were coded as data while 73 % of them were coded as claim. Presence of rebuttal perceived as significant indicator of quality of argumentation since a rebuttal forces the participants to evaluate the validity and strength of that argument (Erduran, Simon,& Osborne; 2004). Toulmin (1958) explained that good argument even as presented by a single individual in a rationalized way would have considered potential circumstances under which the main claim might not hold true (rebuttal). Unfortunately, the frequencies were below fifty percent for those components, 48 % warrant, 31 % backing, and 17 % rebuttal. The least component was backing which means PSTs failed to link between data and claim (warrant) therefore they failed to strengthen warrants.

Following quotations were examples of TAP components (i.e claim, data, and warrant, backing) for the respiratory system experiment.

Smoking is identified as the single most important cause for most of the serious respiratory organ diseases such as lung cancer, What do you think of this statement?

St-3: I agree, smoking has negative effects on lungs and cause severe respiratory diseases. (Claim)

How can you support your idea?

St-3: We know how respiratory system works and we made a model in the laboratory to show the mechanism. In that model we connected trachea to the lungs which is the same in human body (Data). As we know that there is direct connection between trachea and lungs (Data) which mean whatever we breathe it will directly go to the lungs (Warrant). If we breathe poisonous gas it destroys respiratory organs (Claim). On the other hand, tobacco smoke is made up of more than 7,000 chemicals (Data), including over 70 known to cause cancer (warrant) (American Cancer Society, 2015). We inhale those chemicals during smoking there must be hazardous effects of those chemicals to the lungs (Backings).

Next figure, Figure 2, is an illustration of TAP components those were seen in PSTs laboratory reports across different experiments.

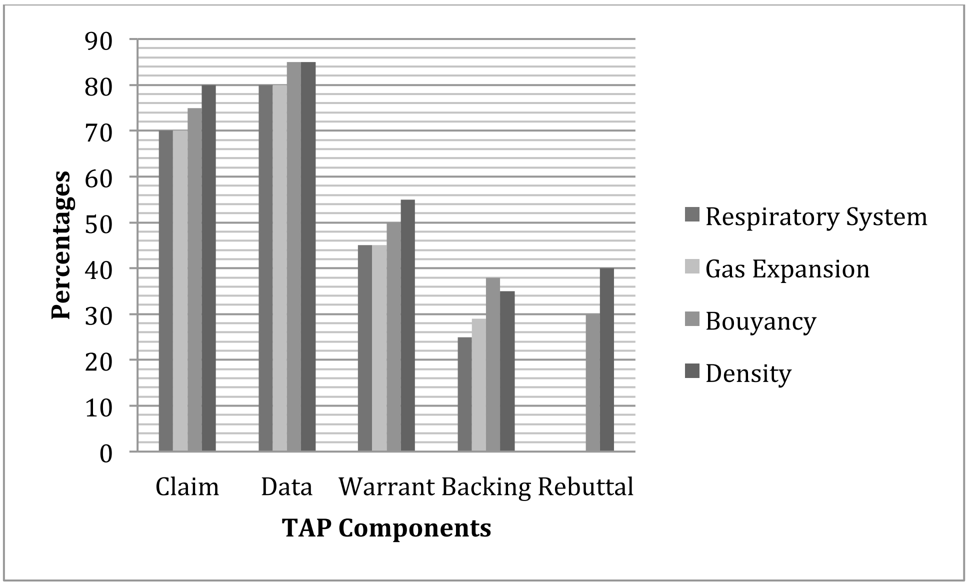

Figure 2. The percentages of the components of scientific argumentation paper regarding each experiment context

Figure 2 illustrates that PSTs use of each TAP component increased across the weeks. For example the percentages of claims were 70 for the first two experiments and it increased to 75 % and 80 % for the last two experiments. On the other hand, the percentages of "data" increased from 80 % to 85 %. Percentages of the remaining three components, which were perceived to present in complex argumentation, also increased from first experiment to last experiment. Sharp increase were shown in last component (rebuttal), PSTs had no attempt to think about counter arguments and they also had no attempt to think about whether their claim would not hold true for the first two experiment (Rebuttal: 0 %). However, they used rebuttals for the buoyancy (30 %) and density (40 %) experiments which means that they have concern about counter arguments and they tried to attempt to address opposing ideas and tried to refute these ideas. The PSTs who uses rebuttals are also more likely to acknowledge the limitations of their own conclusions, suggesting that they were open to revising their claims.

Some examples of coded data are summarized in the charts in Figure 3. Each color illustrates different combinations of TAP components. For example, first one indicates those instances where a claim was coupled with data and no other feature of TAP, second one is combination of claim-data-warrant and etc. Researcher counted the number of times that any single argument was formulated in terms of whichever combination of TAP features. The y-axis illustrates the percentages of instances that such permutations of TAP occurred within the experiment report. The x-axis indicates the experiment context (respiratory system, gas expansion, buoyancy, and density).

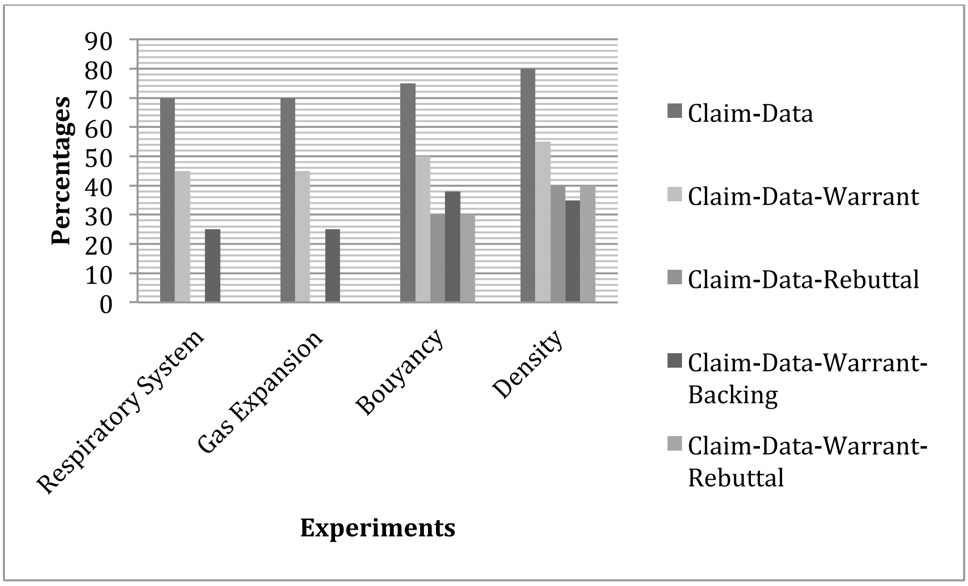

Figure 3. The percentages of combination of TAP components regarding each experiment context

Figure 3 illustrates the combination of different TAP components across different experiment contexts. As it can be inferred from the previous two figures PSTs uses of rebuttal and backing are weak. Therefore combination of these components was still at low percentages. PSTs frequently formed a claim. Meanwhile, among the argumentation patterns, the CDR (claim-data-rebuttal) and the CDWR (claim-data-warrant-rebuttal) patterns were considerably minimal observed across different experiment contexts since PSTs rarely used rebuttal in their written argumentation papers. This result is not surprising because of the limitation of rebuttals across the whole written argumentation papers.

DISCUSSION & CONCLUSION

The aim of the current study was to engage PSTs with argumentation writing activities and to analyze their argumentation in light of their laboratory reports. Discussion section was framed around two research questions. First, we investigate PSTs' written argumentation skills regarding Toulmin argumentation pattern. Second, we explored the combination of TAP components of PSTs' scientific reports' across the four experiments. This study provides an initial picture of the argumentation writing practices of PSTs in elementary science laboratory works. Different from the traditional laboratory approach, including writing classical laboratory reports, in the present study, PSTs were assigned to write open-ended and flexible argumentation papers regarding selected experiment context.

One of the remarkable findings of this study regarding the variation of the PSTs' quality of argumentation with respect to different science experiments was that the PSTs frequently used data to support claim, but they rarely used rebuttals to refute counter claims. These results support previous argumentation studies (Erduran et al, 2004; Jimenez-Aleixandre, Rodrıguez, & Duschl, 2000) in which PSTs developed claims and necessary justifications rather than counter-positions and rebuttals. Future research will need to pay attention to this issue and to examine why students struggle to develop opposite claims and rebuttals. Answers to this question will enable science education researchers to develop a variety of instructional approaches to promote and support more productive argumentation writing experiences in science laboratory courses.

Argumentation has been the emphasis of many studies during the past few decades. These studies indicate that student engagement in scientific argumentation can support a better understanding of scientific process. Argumentation is one of the ways to help teaching and learning science (Duschl, Schweingruber, & Shouse, 2007). Argumentation is the process of asking questions, supporting claims with appropriate evidence, and evaluating counter claims. In present study PST were engaged in different science experiments and they were posed to answer open ended questions related with each experiment that forces them to make a claim and to support that claim with appropriate evidence, to think about opposing ideas and to refute them if it is possible. Results showed that PSTs use of complex TAP components (warrant, backing, rebuttal) increased over the weeks. This pattern of argumentation quality levels can be regarded as a positive indication that the engaging PSTs with open-ended questions those force them to think critically was effective in promoting argumentation and engaging the PSTs in generation of scientific argumentations with claims, warrants and rebuttals. Lemke (1990) highlights the importance of appropriate context to support argumentation in science classrooms. ın present study we used different contexts to support argumentation. To sum, although the PSTs use of complex TAP components increased across the weeks. There were variations of their argumentation quality in different contexts. The reasons for the variation of argumentation levels across different contexts could be attributed to several factors such as PSTs' general science knowledge regarding the experiment context, and the mass media such as television, newspapers and the Internet as they used these sources as an evidence to support their claims. However, in order to understand which contexts and issues promote argumentation in science learning, there is a need for further research which investigates the relationship between students' general knowledge and topics of argumentation.

REFERENCES

Applebee, A. N., & Langer, J. A. (1983). Instructional scaffolding: Reading and writing as natural language activities. *Language Arts*, *60*, 168-175.

Aufschnaiter, C. V., Euduran, S., Osborne, J., & Simon, S. (2008). Arguing to learn and learning to Argue: case studies of how students' argumentation relates to their scientific knowledge. *Journal of Research in Science Teaching, 45*(1), 101-131

Berg, B. L. (2001). *Qualitative Research Methods for the Social Sciences* (4^{th} edition). Needham Heights, MA: Allyn & Bacon.

Bell, P., & Linn, M. C. (2000). Scientific arguments as learning artifacts: Designing for learning from the web with KIE. *International Journal of Science Education, 22* (8), 797-817.

Bogdan, R.C. & Biklen, S.K. (1992). *Qualitative research for education: An introduction to theory and methods* (2nd Ed.). Boston, MA: Allyn and Bacon.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*, 287–312.

Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education, 38* (pp. 39–72)

Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (2007). Taking science to school. *Learning and teaching science in grades K-8. Washington, DC: National Academies Press*.

Erduran, S., Ardaç, D., & Yakmacı-Guzel, B. (2006). Promoting argumentation in preservice teacher education in science. *Eurasia Journal of Mathematics, Science and Technology Education*, *2*(2), 1-14

Erduran & Jimenez-Aleixandre (2008) Argumentation in science education: Perspectives from classroom-based research. Springer: The Netherlands.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: developments in the application of Toulmin'sargument pattern for studying science discourse. *Science Education, 88* (6), 915-933.

Felton, M. (2004). The development of discourse strategy in adolescent argumentation. *Cognitive Development,19*, 39 – 58.

Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching*, *34*(4), 343-357.

Hofstein A. & Lunetta V. N. (2004). The laboratory in science education: foundation for the 21st century, *Science Education*, *88,* 28-54.

Jeffries, P. R., Rew, S., & Cramer, J. M. (2002). A comparison of student-centered versus traditional methods of teaching basic nursing skills in a learning laboratory. *Nursing Education Perspectives*, *23*(1), 14-19.

Jimenez-Aleixandre, M., Rodriguez, M.,& Duschl, R. A. (2000). 'Doing the lesson' or 'doing science': Argument in high school genetics. *Science Education*, *84* (6), 757- 792.

Kelly, G. J., & Chen, C. (1999). The sound of music: Constructing science as sociocultural practices through oral and written discourse. *Journal of Research in Science Teaching, 36*, 883 - 915.

Kelly, G. J., Chen, C., & Prothero, W. (2000). The epistemological framing of a discipline: writing science in university oceanography. *Journal of Research in Science Teaching*, *37*, 691–718.

Kelly, G. J., Druker, S., & Chen, C. (1998). Students' reasoning about electricity: Combining performance assessment with argumentation analysis. *International Journal of Science Education, 20*(7), 849–87.

Kelly, G. J. & Takao, A. (2002). Epistemic levels in argument: An analysis of university oceanography students' use of evidence in writing. *Science Education, 86,* 314–342.

Keys C. W., Hand, B., Prain, V., & Collins, S. (1999). Using the Science Writing Heuristic as a tool for Learning from Laboratory Investigations in Secondary Science, *Journal of Research In Science Teaching, 36* (10), 1065-1084.

Kortland, K. (1996). An STS case study about students' decision making on the waste issue. *Science Education, 80*, 673–689

Kuhn, D., & Udell, W. (2003). The development of argument skills. *Child Development*, *74* (5), 1245–1260.

Lemke, J. L. (1990). Talking science: Language, learning, and values. Norwood, NJ: Ablex

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass.

McDermott, M. A., & Hand, B. (2010). A Secondary Reanalysis of Student Perceptions while Participating in Non- traditional Writing in Science. *Journal of Research in Science Teaching*.

National Research Council. (1996). National science education standards. National Academy Press, Washington, DC. 262.

Newton, P., Driver, R., & Osborne, J. (1999). The place of argumentation in the pedagogy of school science**.** *International Journal of Science Education*, *21*(5), 553–576.

Osana, H. P., & Seymour, J. R. (2004). Critical thinking in preservice teachers: A rubric for evaluating argumentation and statistical reasoning. *Educational Research and Evaluation*, *10*(4-6), 473-498

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, *82*(10), 63-70.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage.

Prain, V., & Hand, B. (1999). Students perceptions of writing for learning in secondary school science. *Science Education*, *83*, 151–162.

Richmond, G., & Striley, J. (1996). Making meaning in classrooms: Social processes in small-group discourse and scientific knowledge building. *Journal of Research in Science Teaching*, *33*(8), 839-858.

Rivard, L. P., & Straw, S. W. (2000). The effect of talk and writing on learning science: an exploratory study. *Science Education*, *84*, 566–593

Roth, W.M. (2012). Authentic school science: knowing and learning in open-inquiry laboratories. Springer: The Netherlands.

Santa, C. M., & Havens, L. T. (1991). Learning through writing. *Science learning: Processes and applications*, 122-133.

Sampson, V. & Clark, D. (2008). Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Science Education*, *92*(3), 447-472.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: research and development in the science classroom. *International Journal of Science Education*, *28*(2–3), 235–260.

Tabak, I. (2004). Synergy: a complement to emerging patterns of distributed scaffolding, *The Journal of the Learning Sciences 13*(3), 305–335.

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

van Eemeren, F. H., Grootendorst, R. (2004). *A systematic theory of argumentation: The pragma-dialectical approach.* Cambridge University Press, New York. 215.

Voss, J.F. & Van Dyke, J.A. (2001). Argumentation in Psychology. *Discourse Processes, 32(2&3),* 89-111.

Wallas, G. (1926). *The Art of Thought*. New York: Harcourt, Brace and Company.

Yin, R. K. (2011). *Qualitative research from start to finish*. New York, NY: The Guilford Press.

Zohar, A. (2007). Science teacher education and professional development in argumentation. In Erduran, S. & Jimenez-Aleixandre, M. P. (Eds), *Argumentation in Science Education Perspectives from classroom-based research* (pp. 245-268) Dordrecht, The Netherlands: Springer.

Zeidler, D.L. & Lewis, J. (2003). Unifying themes in moral reasoning on socioscientific issues and discourse. In D.L. Zeidler (Ed.), *The role of moral reasoning on socioscientific* *issues and discourse in science education*. The Netherlands: Kluwer Academic Press. (pp. 289-306).

Zembal- Saul, C., (2009) Learning to Teach Elementary School Science as Argument. *Science Education, 93*, 687 – 719.

Zembal-Saul, C., Munford, D., Crawford, B., Friedrichsen, P., & Land, S. (2002). Scaffolding pre-service science teachers' evidence-based arguments during an investigation of natural selection. *Research in Science Education*, *32*(4), 437–463.