Pre-Service Teachers' Perceptions of Argumentation: Impact of a Teacher Education Project in Rwanda

Sibel Erduran, Ebru Kaya and Pınar Seda Çetin

Abstract

In Rwanda, the national curriculum is increasingly promoting the engagement of students in active learning strategies and scientific inquiry. Related to this goal, the articulation of argumentation in teaching and learning is a significant topic. Argumentation involves the coordination of evidence and theory to support or refute an explanatory conclusion, model or prediction. Despite the research and policy rhetoric, the implementation of argumentation in everyday classrooms remains far from reality. In this project, we drew on evidence from research on professional development on argumentation to develop a pre-service teacher education program in Rwanda. This study was guided by the following key question: what is the impact of a series of workshops about teaching and learning of argumentation on Rwandan pre-service teachers' perceptions of argumentation? The study was conducted with 25 pre-service teachers who participated in argumentation workshops that aimed to facilitate their understanding of the nature and teaching of scientific argumentation. As argumentation is a form of discourse practice, the participants' perceptions of the role of language and discourse in learning were also investigated. The results indicate that majority of pre-service teachers had positive perceptions of the use of argumentation in science lessons. Further results on pre-service teachers' perceptions on argumentation are discussed with implications for teacher education in Rwanda.

Key words: Rwanda, argumentation, pre-service teacher education, science education

Introduction

Argumentation in science education has emerged as a significant educational goal in recent years (e.g. Aydeniz, Pabuccu, Cetin, & Kaya, 2012; Driver, Newton, & Osborne, 2000; Erduran & Msimanga, 2014; Erduran & Jimenez-Aleixandre, 2007). Argumentation involves the coordination of evidence and theory to support or refute an explanatory conclusion, model or prediction (Toulmin, 1958). Stephen Toulmin's book entitled *The Uses of Argument*, has made a significant impact on how science educators have defined and used argument. Toulmin's definition of argument (i.e. Toulmin's Argument Pattern or TAP) has been applied to the study of a wide range of school subjects including science (e.g. Osborne, Erduran, & Simon, 2004a), history (Pontecorvo & Girardet, 1993) and English (Mitchell, 1996). It has also been used for supporting student learning. For example, Mitchell (1996) and Erduran & Villamanan

Sibel Erduran,, University of Oxford & National Taiwan Normal University, Taiwan,
sibel.erduran@ul.ie
Ebru Kaya, Bogazici University, Turkey, Faculty of Education, Department of Primary Education
ebru.kaya@boun.edu.tr>
Pınar Seda Çetin, Abant Izzet Baysal University, Turkey, Faculty of Education, Health Research and Application Center
pnrsarier@gmail.com

(2009) have successfully adapted TAP as a heuristic to scaffold university students' writing. The applications of argumentation in science education has primarily focused on the development of strategies that would support students' learning and evaluation of the quality of argumentation (e.g. Erduran & Jimenez- Aleixandre, 2007; Driver, Newton, & Osborne, 1999).

In the context of the African continent, numerous studies have begun to explicitly integrate argumentation in the analysis of curriculum and instruction (e.g. Erduran & Msimanga, 2014; Erduran, 2007; Lavelle& Erduran, 2007; Lubben, Sadeck, Scholtz, & Braund, 2010; Sholtz, Braund, Hodges, Koopman, & Lubben 2008; Ogunnuyi, 2007) although the necessary complementary professional development provision seems missing in many cases. As a key scientific practice, argumentation can promote conceptual change (Driver, Newton, & Osborne 2000), critical thinking (Kuhn & Udell, 2007), and understanding of scientific epistemology (Berland & Reiser, 2011). Yet very few studies have actually investigated pre-service teachers' perceptions of argumentation (e.g. Kaya, Erduran, & Cetin, 2012). Teachers play a critical role in creating a learning environment that promotes argumentation (Jimenez-Aleixandre & Pereiro-Munoz, 2002; McNeill & Pimentel, 2010; Venville & Dawson, 2010).

> Some studies on teaching of argumentation indicate that teachers have difficulties managing discussions due to time and curriculum constraints (Newton, Driver, & Osborne, 1999). Teachers may also feel unprepared in terms of their pedagogical skills in infusing argumentation in their teaching (Newton et. al, 1999). The main purpose of the study reported in this paper thus, were: (a) to educate pre-service science teachers in adopting argumentation strategies in their future teaching, and (b) to analyze their perceptions of argumentation before and after the implementation of a series of workshops designed to equip pre-service teachers with understanding of argumentation and its pedagogical aspects. The context was Rwanda where the national curriculum is increasingly promoting the engagement of students in active learning strategies and scientific inquiry. For example, the Rwandan science curriculum has advocated to "*emphasise learning by doing and active rather than passive learning and the acquisition of skills, whilst recognising the role of knowledge, especially for further studies*" (MINDEC, 2003). However despite the curriculum policy rhetoric, the implementation of active learning strategies such as argumentation in everyday classrooms remains far from reality. Teacher education was considered a key element in ensuring that future teachers are equipped with the skills to make argumentation a component of science lessons

Argumentation in Science Teacher Education

Research into teachers' professional development on argumentation remains limited. "*Until very recently, very little work has been done specifically about teacher education and professional development in the field of argumentation*" (Zohar, 2007, p. 246) although there are related areas of research such as the teaching of higher order thinking skills (e.g., Zembal-Saul, 2009). From the sociocultural perspectives on cognition, argumentation is a critical tool for science learning since it enables within learners the appropriation of community practices including scientific discourse (Kelly & Chen, 1999). If enculturation into scientific discourse is significant to science learning, then it becomes imperative to promote it in science teacher education and particularly in teachers' own learning so that they can begin to develop appropriate knowledge of argumentation.

Cochran-Smith and Lytle (1999) offer three ways to conceptualize teachers' knowledge and practice:

> Knowledge-for-practice – This view of teacher learning assumes a "distinctive knowledge base" for teaching that exists primarily within the university teacher education community and is delivered to prospective teachers during their teacher education programs. Teachers, whether pre-service or in- service, are consumers – not producers – of knowledge.
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> Knowledge-in-practice – This view of teacher learning assumes that much of the expertise for teaching lies within the artistry occurring in the moment-to-moment life of classrooms. Artisan teachers – those who have mastered the craft of teaching – have developed a portfolio of knowledge about classroom practice. Teacher learning hinges on reflection and analysis of one's teaching practices to develop deeper awareness of decision-making underlying the craft of teaching.
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> Knowledge-of-practice – This view of teacher learning assumes that the knowledge needed for teaching is co-constructed by groups of teachers as they systematically conduct inquiries into issues of teaching and learning, issues of subject matter and curriculum, and issues of schools and society. Teachers' practice extends beyond the practices occurring within their classrooms and includes the practice of collaborative inquiry for professional growth.

In the context of pre-service science teacher education, given the limited exposure of student teachers to teaching practice, the primary knowledge base for their learning would involve "knowledge-for-practice". As pre-service science teachers learn to appropriate argumentation in their teaching practice, their "knowledge-in-practice" and "knowledge-of-practice" can develop (e.g. Erduran, 2006). Exemplars of teaching practice from more experienced teachers can provide them with some indication of how to build their own repertoire in teaching argumentation.

In a case study of two science teachers with long term involvement in research and development projects on argumentation, Erduran & Dagher (2007) reported that in-service teachers are capable of displaying sophisticated understanding of argument as well as its teaching and learning. The teachers in these authors' study offered recommendations that centred on effective professional development to take into account a holistic presentation of teaching scenarios and a range of student abilities. Both teachers indicated that their own success with their engagement in argumentation projects was due to their persistence in learning something new and the nature of the workshops conducted with them and other teachers – which have been summarized, trialled and published subsequently. They also indicated that among many teaching strategies, they are now more conscious of doing group work and they view the ability to conduct and coordinate group discussions as a significant skill that can be transferred to other aspect of teaching. When asked to reflect on what kinds of developmental and cognitive skills they would expect students to undergo in the learning of argumentation, both teachers referred to a scheme used in the research project to analyze the quality of student argumentation in group discussions. The scheme derived from a theoretical account of argument based on Toulmin's work (1958) focussed on the use of rebuttals and the use of data and warrants to support one's claim while another person is in opposition to an original claim. Both teachers, whose classroom practices included meta-level language with students about the nature of rebuttals indicated that a development in argumentation skills would necessitate the presence of improved skills with rebutting an argument.

Although encouraging results have been observed in teacher education aiming to improve teachers' skills in teaching argumentation, approaches to teacher learning will have little sustained impact if teacher learning is conceptualized as a linear process and educational change is positioned as a *"natural consequence of receiving well-written and comprehensive instructional materials"* (Hoban, 2002, p. 13). For sustainable educational change, more complex views of professional development is required, incorporating professional learning systems that only bring about sustained change over a long period of time. It is often acknowledged that educational change is complex and takes time (Fullan, 2001), and it was never anticipated that fundamental and substantial changes could be achieved within the time scale of a few workshops. Pre-service teachers' effective engagement in argumentation is a long term process and would involve sustainable participation in a community of practice (Lave & Wenger, 1991) in argumentation. However a balance has to be struck between encouraging teachers to take the risks needed for development, and providing them with sufficiently supportive strategies to try something innovative, particularly given that pre-service teachers are novices who are trying to master some rather basic classroom management strategies as well.

Science Education in Rwanda

There have been three major education projects in Rwanda since the mid-1970s (Ernest, 2006; Earnest & Treagust, 2004). The first project dealing with general education and increasing access to primary schooling in Rwanda was implemented in 1977 and completed in 1983. The second project, approved in 1982, supported secondary education. The third project, approved in 1986, included assistance for improving the quality of primary and post-primary education. By the end of 1991, just before the start of the civil war, primary enrolment rates had reached 62% but the number of qualified teachers, the provision of textbooks and the length of class time remained extremely low (Ministry of Education, 1998).

In Rwanda, teacher education consists of primary, technical and artistic teacher education. Technical and vocational education is composed of a dozen sections which include agricultural subjects, nursing and paramedical subjects, economics, commerce, accounting and secretarial studies (Ministry of Education, 1997). Only 22% of the student population completes primary education, and about 40% of the teachers are qualified and have been provided with teaching material and resources (International Monetary Fund, 2001). Trends from statistical data for the period 1992-1997 showed that the proportion of qualified teachers fell from 57% to 32.5%. The Rwandan government recognized that teacher training management and policies are central to reforming teacher training. While there were no institutions for the preparation of teachers prior to 1998, the same year the Kigali Education Institute was established to train teachers in science, mathematics, and technology.

Vision 2020 (Ministry of Finance and Economic Planning, 2007) was developed as part of a new way forward in the construction of the education system in post-genocide Rwanda. One of the key aims of Vision 2020 is the comprehensive human resource development, including education. As such the Vision recognized that with only 65% of the population being able to read and write, education and training remain

at all levels remain a high priority in Rwanda. The 2002 Poverty Reduction Strategy Paper (Government of Rwanda, 2002) has provided a roadmap where teacher training is critical in the development of Rwanda:

The government will continue to support quality in education, improving teacher training, distance learning for teachers, and reform of teaching methodology. The curriculum will be evaluated and reviewed in an effort to reduce the drop-out rates so that Universal Primary Education is Achieved by 2010, leading to Education for All by 2015." (p.48)

Yet according to the Ministry of Education documentation, in 2007 only 221 out of 1556 teachers teaching at higher secondary school level held a bachelor's degree with education qualification. Teacher training remains a key problem in Rwanda. In the context of the study reported in this paper, the main aim was to infuse argumentation, an innovative pedagogical strategy into teacher preparation at University of Kigali, the former Kigali Institute of Education.

Despite recent curricular developments to improve the quality of science teaching in Rwanda, problems persist, particularly in terms of how science is projected in science lessons. As Earnest and Treagust (2004) reported, teachers find it difficult to make sense of what is expected of them:

> a highly qualified science teacher in an elitist urban school tries to make sense of the detail in the curriculum in Rwanda: the course content of the science subjects is too detailed and there are too many topics to be covered and time is usually not on our side, there is too much to cover within a short period of time. I cannot understand why it is necessary to include so many subjects and have so much content (pp.17-18).

Considering the prevalence and dominance of the science content knowledge in everyday classrooms and despite the emerging curriculum reform calls for more active learning and student-centred instruction, there is limited innovation in pedagogy (Ernest, 2006). Professional development of teachers, particularly starting at the pre-service stage is significant in ensuring that future teachers can be equipped with sufficient skills to support active learning in science lessons. Teacher education however, needs to take into account the observation from professional development literature that teachers' perceptions about innovative pedagogical strategies may impact the uptake of the strategy in their classroom teaching practice (e.g. Zohar, 2007). The primary goal of the project reported in this paper, then, was to obtain a baseline data on Rwandan pre-service teachers' perceptions of argumentation, and to investigate the impact of a series of workshops on argumentation on their perceptions.

Methodology

The project focused on the following key research question: *what is the impact of a teacher education program on argumentation on Rwandan pre-service science teachers' perceptions of argumentation?* Given the scarcity of research in the Rwandan education context in general (e.g., Ernest, 2006) and in Rwandan teachers' engagement in argumentation in particular, the study aimed to investigate the pre-service teachers' perceptions of broader but related themes such as discourse as well. It is anticipated that the results of the study could provide some baseline data for future studies in

articulating how initial teacher education and continuous professional development in Rwanda can be structured and supported.

Participants

This study was conducted with 25 pre-service teachers in Rwanda. The subject areas of these pre-service teachers varied as physics, chemistry, biology, and mathematics. In order to develop pre-service teachers' argumentation skills and their perceptions of argumentation, three structured workshops were carried out.

Workshops

The workshops were based on published resources that included lesson materials as well as video clips of exemplary teaching (Osborne, Erduran, & Simon, 2004b). The resources, referred to as the IDEAS pack, first published in 2004 and reprinted in 2005, consists of 28 clips of ordinary teachers dealing with how to structure and approach the teaching of argument in science. They have been translated internationally to several languages including Chinese, Catalan, and German. The IDEAS pack contains materials to support 6 half day workshops exploring aspects of teaching argument: (1) how to introduce argument; (2) how to manage small group discussions; (3) how to teach argument; (4) what resources can be used to support argumentation by students; (5) how to evaluate arguments; and (6) how to model them for pupils. The materials come on CD ROM as Word and Powerpoint files. In addition, there is a set of resource materials to support the teaching of ideas, evidence and argument in school science education. This consists of 15 sample lessons which teachers can use to try out some or all of the approaches in the training sessions. Each of the activities comes with an introduction which provides: (a) the aims; (b) the learning goals of the activity; (c) teaching points which highlight aspects of background knowledge or what knowledge the students may need for the activity; (d) a teaching sequence which suggests how the materials might be implemented in the classroom; and (e) background notes for activities that require further elaboration on the science background some of the background science needs further elaboration.

The first workshop aimed to introduce argumentation and writing arguments. The second workshop focused on developing resources such as generation of their examples. The last workshop focused on pedagogical strategies and reflections related to argumentation. During these workshops, the pre-service teachers participated in many group work and discussions. They constructed posters related to argumentation, presented their posters, and prepared some lesson plans on argumentation. Throughout the workshops, advice was provided about how to structure classroom activities to emphasise scientific argumentation through encouraging the use of evidence to justify a position, and how to enhance scientific argumentation by posing open questions. A set of arguing prompts were devised, designed to elicit justification. Questions included: *'Why do you think that?', 'Can you think of another argument for your view?', 'Can you think of an argument against your view?' and 'How do you know?'* In line with a philosophy on science curriculum and professional development focusing on

argumentation (e.g. Erduran & Msimanga, 2014), pre-service teachers were introduced to a theoretical model of argument based on Toulmin's framework (Toulmin, 1958). Some of the resources used included writing frames that were developed based on Toulminian definition of argument: *'My argument is … ', 'My reasons are that … ', 'I would convince someone who does not believe me by … '.* These stems provide prompts necessary to construct a written argument and help record notes of discussions. Thus, the workshops were devoted to very tangible strategies for supporting the process of argumentation and the construction of arguments through both oral and written work (Rivard & Straw, 2000).

Perception of Argumentation Test

In order to understand pre-service teachers' perceptions of argumentation, *Perception of Argumentation Test* was administered as a pre-test before the workshops and as a post-test after the workshops (Appendix). This test adapted from Chin (2008) is composed of two parts. The first part which is related to discourse in classroom involves four questions. Two of them are open-ended questions on importance of discourse and quality of discourse. The other two questions are related to classroom activities encouraging scientific discourse. The second part which is related to argumentation in science and science education involves six questions. Two of them are open-ended questions about the significance of argumentation in science education and about scaffolding learning in argumentation. The other questions are related to activities for promoting argumentation in science classes and attitudes toward these activities.

Results

The pre- and post-data gathered from the administration of the *Perception of Argumentation Test* was analyzed by quantitative and qualitative approaches. The pre-service teachers were asked to select which activities encourage scientific discourse in their science classroom. The results of the frequency analyses with respect to pre-test show that group work, group discussion, experiment and practical activities were perceived to be used the most in science lessons to encourage scientific discourse. The post-test results with respect to this question show that pre-service teachers thought of debate as one of the most used activities in addition to group work, group discussion, experiment and practical activities. While role play and pair discussion were perceived to be used the least based in the pre-test results, post-test results show that role-play and lecture were perceived as the least used activities (Table 1).

Table 1. Pre-Service Teachers' Perceptions of Classroom Activities Encouraging Scientific Discourse.

Activities	Percentage for Discourse (Pre-test)	Percentage for Discourse (Post-test)
Group work	92	92
Pair work	16	28
Pair discussion	12	52
Group discussion	72	88
Open discussion	32	44
Debate	36	88
Role play	4	8
Practical	72	64
Experiment	76	72
Lecture	32	16

Pre-service teachers were also asked how often they think they participate in scientific discourse themselves. Based on pre- and post- test results, most of them pointed out that they participate in scientific discourse (Table 2).

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Table 2. Pre-Service Teachers' Perceptions of the Frequency of Participation in Scientific Discourse.

Students' Participation	Percentage (Pre-test)	Percentage (Post-test)
Never	0	0
Rarely	0	0
Sometimes	40	52
Often	12	16
Every lesson	48	32

The results on pre-service teachers' perception of the use of argumentation in the classroom showed that most of them (62.5 %) thought that argumentation was sometimes used in science lessons. 29.2 % of them in the pre-test and 24 % of them in the post-test indicated that argumentation was used in every science lesson (Table 3).

Table 3. Pre-Service Teachers' Perceptions of the Frequency of Argumentation Use in Science Lessons.

Argumentation Usage	Percentage (Pre-test)	Percentage (Post-test)
Never	0	0
Rarely	4.2	0
Sometimes	62.5	72
Often	4.2	4
Every lesson	29.2	24

With respect to the question emphasizing whether argumentation had ever been used in science lessons that they took, in both pre- and post-test all of the participants indicated that the instruction based on argumentation was used in their science lessons (Table 4).

Table 4. Pre-Service Teachers' Perceptions of Argumentation Use in Science Lessons

Argumentation Usage	Percentage (Pre-test)	Percentage (Post-test)
Yes	100	100
No	0	0

In another question of the test pre-service teachers were asked the activities used in the science classroom for promoting argumentation. The results show that the percentage of the pre-service teachers who thought group work, pair work, pair discussion, group discussion, open discussion, and debate were the activities used for promoting argumentation in science lessons in the pre-test increased in the post-test (Table 5).

Table 5. Pre-Service Teachers' Perceptions of Activities Used for Promoting Argumentation in Science Lessons.

Activities	Percentage for Argumentation (Pre-test)	Percentage for Argumentation (Post-test)
Group work	80	92
Pair work	12	28
Pair discussion	16	44
Group discussion	60	92
Open discussion	32	44
Debate	32	76
Role play	4	12
Practical	60	60
Experiment	56	72
Lecture	20	12

In the last question, the pre-service teachers were asked how they felt about classroom activities promoting argumentation in science lessons. Majority of them (86.4 % in the pre-test and 95.8 % in the post-test) thought that they felt enthusiastic while classroom activities were based on argumentation (Table 6). According to this result, it can be said that they had positive attitudes toward the activities promoting argumentation.

Table 6. Pre-service Teachers' Attitudes toward Classroom Activities for Promoting Argumentation.

Attitude	Percentage for Discourse (Pre-test)	Percentage for Discourse (Post-test)
Enthusiastic	86.4	95.8
Reluctant	13.6	4.2
Bored	0	0
Irrelevant	0	0

The four open ended questions (the first two of which were related to the discourse in science classroom and the last two were related to argumentation in science classroom) in the pre- and post- *Perception of Argumentation Test* were handled qualitatively. We analyzed participants' written responses to generate codes and themes that describe participants' views on both discourse and argumentation. Through qualitative data analysis, 4 themes were as 'implementation', 'understanding',"actions by teachers", and "actions by students". Table 7 shows the trends under each theme.

Table 7. Pre-Service Teachers' Perceptions of Discourse and Argumentation Pre- and Post-Workshops

	Discourse		Argumentation	
	Pre	Post	Pre	Post
Understanding	Increasing knowledge Increasing students' thinking ability Being familiar with topics Gaining many scientific issues Better understanding Preventing misconceptions Increasing learners' critical thinking Improving scientific skills	Knowing the reasons Better understanding Preventing misconceptions Increasing learners' critical thinking Improving scientific skills	Making conclusion quickly Remaining ideas in mind Discovering the level of knowledge Increasing students' levels Understanding others' ideas Better understanding	Improving memorizing Thinking deeply Increasing critical thinking Improving scientific skills Eliminating misconceptions Better understanding
Implementation	Making students being involved in lessons Constructing arguments Sharing views about nature of science Justifying ideas Analysing Discussion Decreasing of lecture methods Experiments Pair work Open discussion Sharing ideas Group work Exchanging ideas Group discussion Debate	Producing different ideas Learning actively Learning enthusiastically Improving interaction between students Improving interaction between students and teacher Relating topics with real life Using daily life examples Supporting ideas by providing facts Asking questions Using presentations Giving more claims about topic Matching with cultural context Argumentation Sharing ideas Group work Exchanging ideas Group discussion Debate	Exchanging ideas Analysing Enhancing science activities Giving homework Practical Discussion Supporting ideas Using learner-centred methods Sharing ideas Pair work Group discussion Debate Open discussion Group work Experiments	Using daily life examples Justifying ideas with evidence Relating science topics to daily life Criticizing Exchanging ideas Differentiating weak and strong ideas Searching convincing arguments Using evidence Using explanations Using modelling Modelling the topic Arguing prompts Telling story about topic Sharing ideas Pair work Group discussion Debate Open discussion Group work Experiments

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	Discourse		Argumentation	
	Pre	Post	Pre	Post
Actions by Students	Getting ready for any activity Not forgetting what you learned in discussion Being motivated Actively participating in science lessons	Being interested Becoming more attractive Working with others in group Being motivated Actively participating in science lessons	Starting to explore themselves Acquiring self-expression Listening to everyone's argument Actively participating in lesson	Being more interested in lessons Developing ideas Knowing to speak in public Actively participating in lesson
Actions by Teachers	Giving enough time for discussion Being planned Being organized Well explanation of topics Giving a chance to students to express himself/herself Encouraging students to participate in lessons Motivating students Guiding students	Giving students the chance of thinking and reasoning Knowing students' prior knowledge Knowing students' levels about topic Enhancing students to be familiar with the content Helping students to play an important role in lessons Helping students to become self-confident Evaluating students Avoiding fear in students Give opportunity students to use more time to talk Planning activities Valuing every student's ideas Allowing students to give different ideas Allowing students to state their evidences Giving feedback to students Reinforcing students Encouraging students to express their ideas Giving the chance students to think about the problem Encouraging students to participate in lessons Motivating students Guiding students	Knowing about students' improvement in talking and discussing Evaluating students Encouraging learners to work in group Encouraging students to learn from the mistakes Positive attitude of teacher Preparing for lesson Giving students more time to debate Improving teaching methods Motivating students Guiding students Giving a chance students to express their ideas Encouraging students to express their ideas	Knowing about students' ideas Allowing everyone to say his/her ideas Listening students' ideas Giving feedback to students Choosing appropriate method Designing activities on argumentation Using simple examples Motivating students Guiding students Giving a chance students to express their ideas Encouraging students to express their ideas

The qualitative data analysis related to pre-service teachers' perceptions of discourse and argumentation indicate that the perceptions were reflected under the same themes such as 'understanding', 'implementation', "actions by students", and 'actions' by teachers both before and after the workshops. However, these themes varied in terms of the categories under each theme before and after the workshops. One of the pre-service teachers' perceptions of discourse and argumentation is 'understanding'. With respect to the theme of 'understanding', the categories of "improving critical thinking", "improving scientific skills", and "preventing misconceptions" emerged as pre-service teachers' perceptions related to both discourse and argumentation. However, pre-service teachers also thought that "knowing the reasons" was related to discourse after the workshops. This is not an unexpected result since "knowing the reasons" can be interpreted as a kind of justification with reasons, and justification is a key aspect of argumentation discourse (von Aufschnaiter, Erduran, Osborne, & Simon, 2008).

Another perception category regarding discourse and argumentation is 'implementation'. Before and after the workshops, the pre-service teachers' perceptions were similar for this category prior to the workshops. For instance, they stated "group work", "group discussion", "debate sharing ideas", and "daily life examples" as examples under the category of implementation. After the workshops, the pre-service teachers indicated that "interaction between students and teacher", "interaction among students", "matching with cultural context" were related to discourse when compared the perceptions before the workshops. The pre-service teachers designed some activities and discussion which are related to Rwandan context and during these activities they were encouraged to participate in classroom discussions and group work. Hence, they were encouraged to make connections between interactions in classroom/examples in specific contexts and argumentative discourse. In addition, after workshops the pre-service teachers referred to 'modeling'. Modeling is an important aspect of scientific inquiry (Gilbert, 2004; Gilbert & Boulter, 1998) and works in unison with argumentation (Erduran & Dagher, 2014). In this respect, it is encouraging to witness that the pre-service teachers made a connection between argumentation and modeling.

"Actions by students" and "actions by teachers" emerged as main categories in participants' perceptions. With respect to "actions by students", the pre-service teachers specified "working in groups" as a category related to discourse after the workshops. They also referred to "knowing how to speak in public" when talking about students' actions in argumentation based activities. In other words, they could see the value of argumentation as a skill in promoting public speaking. With respect to "actions by teachers", especially after the workshops the pre-service teachers addressed teachers' actions such as "encouraging students", "being aware of students' levels", "giving feedback to students", and "evaluating students". These themes are consistent with the research evidence that indicates the centrality of the teacher's role in coordinating argumentative discourse in science lessons (McNeill & Pimentel, 2010).

Conclusions and Implications

Although the importance of argumentation in science teaching has now been well established, there is limited number of studies on pre-service teachers' perceptions of argumentation (Kaya, Erduran, & Cetin, 2012), and there are no reported studies in the context of Rwanda. This study is the first that aimed to investigate the impact of teacher education project on Rwandan pre-service teachers' perceptions of argumentation. The results illustrate that the percentage of the pre-service teachers who thought group work, pair work, pair discussion, group discussion, open discussion, and debate were the activities used for promoting argumentation in science lessons in the pre-test, increased in the post-test. According to this result, it can be said that the pre-service teachers' attitudes towards argumentation improved following the workshops aimed at promoting argumentation in teaching and learning. Overall the study contributes to a much scarce body of literature on science education research in Rwanda.

The quantitative data analysis on pre-service teachers' perceptions of argumentation before and after the workshops revealed some noteworthy results. First, the pre-service teachers' perceptions about the activities that are used for promoting argumentation in science lessons have changed substantially after the workshops. Pre-service teachers realized that group work, pair work, discussion (i.e. pair, group or open), debate and experiment can be used to promote argumentation. Similarly they noticed the incompatible nature of didactiv lectures with interactive argumentation. Thus, the percentage of the pre-service teachers choosing lecture as an activity used for promoting argumentation decreased from 20 to 12 percent after the workshops. It can be said that the activities in the workshops improved the pre-service teachers' knowledge on argumentation which changed their perceptions regarding the teaching and learning activities on argumentation. Considering the challenges that teachers face in implementing argumentation in their teaching (Newton et. al, 1999; McNeill, 2009) this result is promising that even after a short training period, the perceptions of pre-service teachers can be improved.

Second, the workshops seemed to have an observable influence on pre-service teachers attitudes toward classroom activities based on argumentation. After the workshops, the majority felt enthusiastic about argumentation-based implementation (95.8%). Extensive research has shown that there is a positive relationship between achievement and attitudes in school subjects (Mattern & Schau, 2002; Webster & Fisher, 2000). Therefore the teacher education project reported in this paper may help improve the participants' skills in argumentation by positively influencing their attitudes. However, as previously stated, approaches to teacher learning are unlikely to have sustainable impact if teacher learning is conceptualized as a linear process and educational change is positioned as a *"natural consequence of receiving well-written and comprehensive instructional materials"* (Hoban, 2002, p. 13). Further continuous professional development of the pre-service teachers engaged in the study is essential in order to build on their positive perceptions of argumentation and to support their teaching practice.

Future areas of research include situating the role of argumentation in influencing teachers' pedagogical skills and tracing the developmental stages in the

learning to teach argumentation from novice to expert teaching. Establishment of argumentation as a goal in pre-service science teacher education (Erduran, Ardac, & Yakmaci-Guzel, 2006), we believe, will help teachers in adapting and sustaining argumentation as a long-term pedagogical strategy. Given the observation that the performance of learners, especially girls in mathematics and science (e.g. Mattern, & Schau, 2002), is of concern, argumentation can be positioned as a strategy that will promote inclusive participation in science activities. We hope that the work reported in this paper contributes to the realisation of Vision 2020 (Ministry of Finance and Economic Planning, 2007) so that constructive community building and education can continue in post-genocide Rwanda.

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APPENDIX

PERCEPTION OF ARGUMENTATION TEST (from Chin, 2008)

PART I (Classroom Discourse)

1. What are the different kinds of activities used in your classroom in order to encourage scientific discourse inside the classroom?

You are allowed to tick more than one.

- Group work
- Pair work
- Pair discussion
- Group discussion

- Open discussion
- Debate
- Drama (Role Play)
- Practical
- Experiment
- Lecture
- Other activities (please state:_____)

2. How often do you participate in the talks inside the classroom in science courses?

- Every lesson
- Often
- Sometimes
- Seldom
- Never
- Others (please state:_____)

From your view of point, is discourse important during science lessons? Please explain.

_____
_____
___ ___

How can be increased the quality of the talks that take place inside the classroom?

_____
_____
_____

PART II (Argumentation in Science and Science Education)

Argumentation is a scientific process among discourse, which involve activities such validating claims, justifying evidences, addressing to counterclaims, assessing alternatives and interpreting justifications. Inside the classroom, it is a process in which students justify their ideas through the use of evidences and reasoning power to produce strong arguments or well-justified claims.

For example, Toulmin's argumentation pattern is widely used to evaluate scientific arguments and its main components are: 1. Claim – idea, conclusion, hypothesis, or opinion 2. Data – scientific evidences or facts that support the claim 3. Warrants – scientific reasoning of how the data support the claim 4. Backings – commonly agreed assumptions that help justify warrants 5. Rebuttals – providing evidence to contradict or nullify other presented evidences 6. Qualifiers – recognizing where there are limitations or restrictions on a claim. 7. Counterclaim – opposing claim to the initiation An argument should comprise of one or more of the components above. Good quality

arguments are said to be accompanied by qualifiers and strong rebuttals against counterclaims.

Complete this section based on your understanding on what argumentation is.

1. How often is argumentation used during science lessons?
Never
Seldom
Sometimes
Once every week
Every lesson
Others (please state:_____)

2. Have you experienced a lesson been used especially to incorporate argumentation?
Yes No
If yes, what are the kinds of activities used during science lessons to support argumentation?
- Group work
- Pair work
- Pair discussion
- Group discussion
- Open discussion
- Debate
- Drama (Role Play)
- Practical
- Experiment
- Lecture
- Other activities (please state:_____)

3. How do you feel when a collaborative work to support argumentation is carried out in science lessons?
- Enthusiastic
- Reluctant
- Bored
- Unwillingness
- Others (please state: _____)

4. What is your average level of involvement to talk activities in science lessons?
100% 75% 50% 25%

5. From your point of view, is argumentation an important process in science education? Please explain.
_____

_____
_____

6. From your point of view, what can a teacher do in order to support argumentation in science lessons?

_____
_____

Matematik Öğretmenliği Programında Fen Bilimleri, Teknoloji ve Matematiğin Entegrasyonu Üzerine Görüşlerin İncelenmesi

Öz

Ruanda'da ulusal öğretim programı giderek öğrencilerin aktif öğrenme stratejilerine ve bilimsel araştırma-sorgulamaya katılımlarını teşvik etmektedir. Bu yüzden, öğretme ve öğrenmeye argümantasyonun eklenmesi önemlidir. Argümantasyon, açıklayıcı bir sonuca, modele veya tahminin desteklenmesi veya reddine yönelik kanıt ve teorinin koordinasyonunu içerir. Bu projede, "Argümantasyonun öğretilmesi ve öğrenilmesiyle ilgili gerçekleştirilen çalıştayların Ruanda'li öğretmen adaylarının argümantasyon algılarına etkisi nedir?" sorusunu sorduk. Çalışma, bilimsel argümantasyonun doğasını ve nasıl öğretileceğini anlamalarını kolaylaştırmayı amaçlayan çalıştaylara katılan 25 öğretmen adayı ile gerçekleştirilmiştir. Argümantasyon bir söylem uygulaması olduğu için, aynı zamanda katılımcıların dil ve söylemin öğrenmedeki rolü ile ilgili algıları da araştırılmıştır. Sonuçlar, öğretmen adaylarının çoğunun fen derslerinde argümantasyon kullanma konusunda olumlu algılara sahip olduklarını göstermektedir. Öğretmen adaylarının argümantasyon algılarıyla ilgili sonuçlar Ruanda'daki öğretmen eğitimi kapsamında tartışılmaktadır.

Anahtar Kelimeler: Ruanda, argümantasyon, öğretmen eğitimi, fen eğitimi