Effect of Argumentative Discourse based Intervention on Argumentation Ability: A Study of Demographic Factors

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Abstract

Argumentation can be viewed as an important activity in science education aiming at a better understanding of science topics. This article is drawn from doctoral research aiming to assess the effect of an argumentative course-based intervention on argumentation ability in complement with other variables. This section highlights how students with demographic variations differ in their argumentation ability and how do they respond to the intervention. The population of the study comprised of school students in their transition stage of cognitive development from concrete to abstract thinking; correspondingly, Grade 5 students were selected. An argumentative discourse framework was developed for the contents of the school Science subject adapting to the Toulmin model. 18 weeks of intervention was provided, including 4 weeks introductory training phase followed by a pretest of argumentation ability. Analysis revealed that demographics like gender, age order among siblings, family type, and achievement level play their innate role in determining argumentation ability, and students respond to the intervention correspondingly.

Key Words: Argumentation, Science, Demographics, Gender, Achievement

Introduction

Argumentation is widely used as an instructional strategy to teach science in the developed countries (Berland & Reiser, 2009; Erduran & Jimenez-Aleixandre, 2008) with the aim of better understanding of the natural world, and they become able to apply the scientific knowledge in the daily life. Argumentation in science education is regarded as a crucial activity that can enable students to improve their expertise in reasoning by developing the science process skills, knowledge assessment standards, scientific literacy and other subsidiary expertise (Erduran, Ozdem, & Park, 2015; Berland & Reiser, 2009; Erduran & Jiménez-Aleixandre, 2008). The idea of scientific argumentation as a key ability in schools has gained popularity among policymakers across the globe in the past decade. It is this exchanging of ideas that assist in developing a conceptual understanding of the nature of science (Faize,2015; Osborne et al., 2013). As a key aspect of scientific literacy, argumentation has become an intriguing subject of study in science (Iordanou & Constantinou, 2015; Emig & McDonald, 2014; Evagorou & Osborne, 2013). The quality of argumentation is very important in improving conceptual understanding and other subsidiary skills. The quality of arguments is influenced by different factors (Dawson & Schibeci, 2003). The quality of arguments is mainly affected by the prior content knowledge, achievement of the students, social environment and gender (Sampson & Clark, 2011; Simon, Erduran, & Osborne, 2006).

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Statement of the Problem

In Pakistan, argumentative discourse in the classroom is a novel concept. Close observation of people's behavior reveals that we generally lack argumentative skills. This aspect of the cognitive domain may be particularly important in Pakistan to prevent students from cramming and rote learning during exams. The reason for this is simple: engaging pupils in an interactive manner of reasoning will assist in the clarification of many aspects of the topic. Keeping in view the general lack of argumentation, the current study aimed to explore the factors affecting students' ability to develop arguments in the subject of science.

Research Objective

The major objectives of the research were:

1. To assess the effect of argumentative discourse on the argumentation ability of students of grade V.
2. To know the influence of demographic factors that facilitate the development of argument construction ability of students.

Research Questions

1. What is the initial and final level of students' argumentation before and after intervention?
2. How is the development of argumentation affected by the demographic factors (e.g. gender, family type, achievement, age and order among siblings)?

Significance

The findings of the study will be helpful in implementing the argumentation practices in the science classroom by imparting knowledge about factors that affect the argumentation ability of the students. The study will help the teachers in engaging the students in argumentation successfully. This research will help the educationist to know about the factors affecting the ability to develop arguments, so they better able to engage the students in argumentative discourse.

Literature Review

Argumentation is a discursive, complex mechanism where an argument is constructed and accepted in order to persuade and refute the alternatives of others (Osborne & Patterson, 2011). Teaching argumentation is a new method of engaging pupils in their studies (Erduran, Simon, & Osborne, 2004; Ryu & Sandoval, 2012). Argumentation helps to develop thinking skills (Kaya,2013) to help students make an informed decision and also alters the attitude of students towards science (Van Gelder, Bissett, & Cumming,2004). Activities of argumentation can elicit scientific justification (Jim'enez-Aleixandre, Bugallo Rodríguez, & Duschl.,2000), enhance the ability to advance, critique and explain arguments, facilitate formative evaluation (Duschl & Osborne, 2002; Osborne, Erduran & Simon,2004), and situate the production of knowledge in original contexts (Abi-El-Mona & Abd-El-Khalick, 2011). The emphasis on argumentation is consistent with the purpose of enhancing the reasoning of students in problem-solving and the capacity to advance, criticizing and explain arguments (Kuhn & Udell, 2003). In addition, argumentation activities include opportunities to study science content, learn about scientific practices, and understand the role of language, history and social interaction in the knowledge construction process. (Abi-El-Mona & Abd-El-Khalick, 2011). Kathpalia and See (2016) advocated that it is essential for students to learn argumentation skills. Rather, it should be one of the objectives of science education to develop the skills of scientific argumentation in students (Osborne, Erduran, & Simon, 2004).

Dawson and Schibeci (2003) found that the quality of the arguments is mainly affected by different factors, i.e. prior content knowledge and achievement. The students with high achievement can construct complex arguments, establishing the link between the quality of arguments and achievement (Sampson & Clark, 2011; Simon, Erduran, & Osborne, 2006).

First of all, research on cognitive styles has shown that, on average, girls tend towards a different cognitive style than boys, also referred to as 'connected way of knowledge' (Belenky, Clinchy, Goldberger, & Tarule, 1986). Accordingly, girls

emphasize understanding, empathy, acceptance, cooperation (Clinchy, 1989; Galotti, Clinchy, Ainsworth, Lavin, & Mansfield, 1999; Galotti, Drebud, & Reimer, 2001), and interaction with others through verbal conversation (Zohar, 2006). Moreover, girls are more socialized in collaborative problem-solving tasks and discussion practices, and they tend to take into consideration their own personal knowledge more than boys do (e.g., Baxter-Magolda, 1992; Miller, 2005)

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Zohar (2007) revealed that gender is a significant factor that affects the argumentation skills of the students. Female students can easily understand the problem stations, participate in group discussion and capable of understanding the idea as compared to male students (Asterhan, Schwarz, & Gil, 2012; Galotti, Drebus, & Reimer, 2001). According to Jeong and Davidson-Shivers, (2006), boys and girls have the same cognitive ability, but boys performed better in constructing high-quality arguments with rebuttals. Asterhan, Schwarz and Gill (2012) revealed that epistemic guidance is an instructional strategy used by the teachers to help the students to develop argumentation skills. They reported that epistemic guidance of argumentation affected discussions among middle school male students and female students. Research conducted on fifth graders to explore the effect of the intervention on students' argumentation ability. It was explored that male students progress better in the argumentation as compare to females. It is also found that students with low achievement performed better in argumentation due to their ability to interact with others effectively (Hong, Lin, Wang, Chen, & Yang, 2013). Martin, Mullis and Foy (2008) found no gender differences while they are engaged in argumentation at fourth grade, but they explored that male student performed better in science with the increasing age as compared to females. The quality of the argumentation of students improved over time when they are engaged in argumentation (Chen, Hand, & Park, 2016). Research revealed the connection between prior achievement and argumentation ability. They revealed that prior achievement affects the argumentation ability of the students (Von Aufschnaiter, Erduran, Osborne & Simon, 2008).

Methodology

The study was experimental in nature. The population for this study was comprised of school students in their transition stage of cognitive development from concrete to abstract thinking. Statistics related to our education system reveal that students of grade V constitute this population. A public sector primary school in district Lahore were selected through purposive sampling.
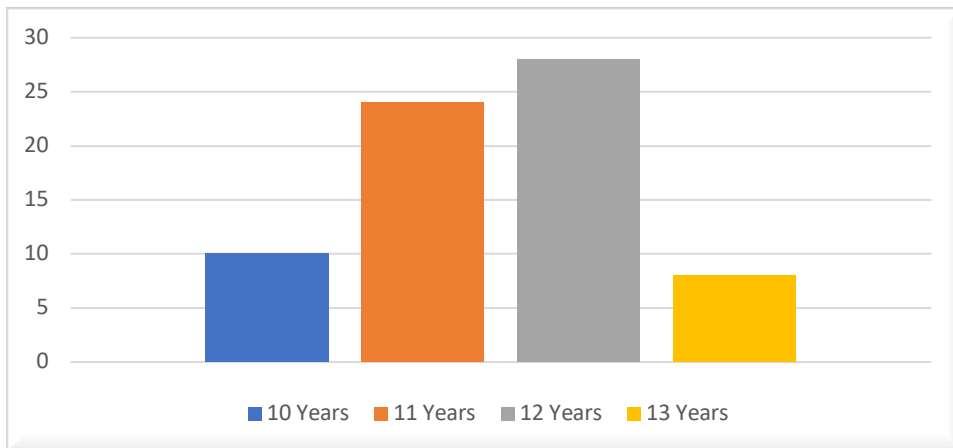
Figure 1: Distribution of Age in the Sample

Instrumentation

Test of Argumentation Ability

Two tests were pertaining to the argumentation ability were prepared according to the simplified version of the Toulmin model. These tests were content-based comprising, of course, contents covered in the class before intervention and during intervention serving as pretest and posttest, respectively. These tests were validated by the panel of experts having a background of science teaching at pertinent level, science teacher education and educational psychology. Tests were validated in terms of content validity, the potential of constructing arguments and the mental process assumed to be used by children during the construction of various levels of arguments. Each argument was analyzed according to the argument analysis framework adapting the Toulmin model. The score on each argument ranged from 0-4. Thus the total score of pretest and posttest; comprising of four arguments each, was 16.

Table 1. Argument Analysis Framework

Levels	Indicators	Score
Level 0	No Response/Blank Sheet	0
Level 1	Claim	1
Level 2	Claim with data	2
Level 3	Claim and counter claim with data	3
Level 4	Rebuttal of false claim with justification	4

Procedure of the Study

The experimental group of the study was engaged in intervention for 18 weeks. The intervention was comprised of two phases. In phase I, students were trained for argument construction. In this phase, the experimental group received intervention/training through different methods. Pictures and videos of the classroom dialogue were shown to the students. However, the 'argument play' performed by six girls of secondary level who volunteered themselves for taking part in study and training for argumentation. Four 'argument plays' were performed on socio-scientific issues by these girls. These plays were followed by the post-play discussion with the class guided by the researcher.

In phase II, topics of science were covered through argumentation-based practices. During the treatment, the participants intended to actively participate in classes and develop arguments in the

exercises. The students conducted exercises that required them to construct quality arguments during these exercises.

Argumentative Discourse Framework

This framework was developed in an analogy of the plant growth phases. The framework was guided by an argumentative discourse pathway. Students' participation and development of argumentation through argumentative discourse were observed, recorded and evaluated through this framework. Each students' phase in argumentation was determined by students' behavior, the nature and frequency of being involved in argumentative discourse. Five stages were characterized viz; dormant, sprouting, seedling, budding, flowering and fruiting. The pathway and framework of argumentative discourse are given as under:
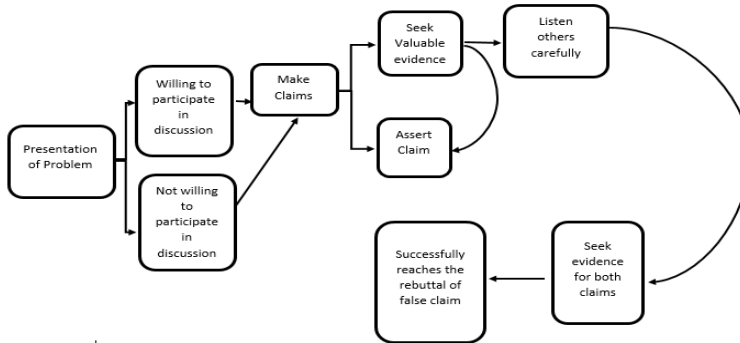

Figure 2: Argumentative Discourse Pathway

Table 2. Argumentative Discourse Analysis Framework (ADAF)

Phases	Indicators	Teacher's Role
Dormant OR Sprouting	Not willing to participate OR Willing to participate	Motivator Initiator
Seedling	Make claims, Assert claim	Observer
Budding	Makes a conscious effort to seek evidence and relate to the claim	Facilitator
Flowering	Listen to others' claim carefully and Seek evidence for both claims	Manager/ Guide
Fruiting	Successfully reaches the rebuttal of a false claim	Guide

A Posttest of argumentation ability was conducted at the end of the intervention.

Analysis and Results

Results obtained through pretests and posttests were analyzed through descriptive and inferential statistics in order to determine the effect of intervention as a whole and compare across the demographic variables

Table 3. Effect of Argumentative Discourse on Students' Argumentation Ability

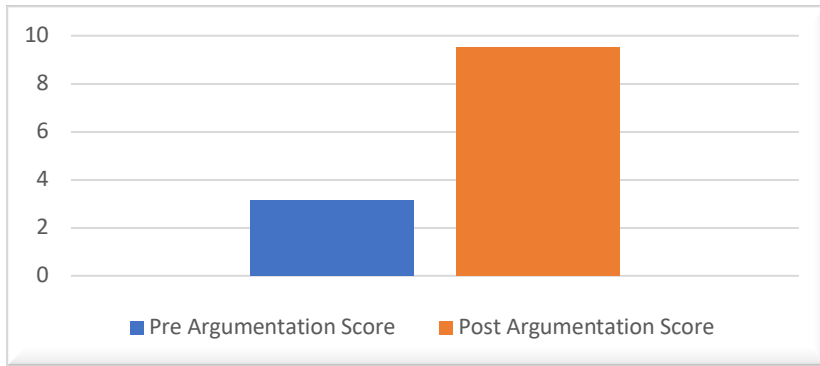| Variable	N	Mean	SD	t value	p-value
Pre-Argumentation Score	70	3.17	.75	17.75	.00
Post-Argumentation Score	70	9.51	2.41		

Figure 3: Comparison of pretest and posttest of Argumentation Ability

Table 4. Comparison of Argumentation Scores on the Basis of "Gender and Family Type"

Variable	Test	Groups	N	M	SD	MD	df	t	p
Gender	Pretest	Boys	34	3.47	0.61	0.58	68	3.54	.00
		Girls	36	2.89	0.75				
	Posttest	Boys	34	11.12	1.77	3.12	68	7.19	.00
		Girls	36	8.00	1.85				
	Gain	Boys	34	7.65	1.55	2.54	68	6.32	.00
		Girls	36	5.11	1.78				
Family Type	Pretest	Nuclear	34	2.94	0.63	0.47	68	2.76	.00
		Joint	36	3.41	0.78				
	Posttest	Nuclear	34	7.89`	1.75	3.35	68	8.21	.00
		Joint	36	11.42	1.65				
	Gain	Nuclear	34	4.94	1.57	2.88	68	7.89	.00
		Joint	36	7.82	1.49				

Table 5. Univariate Analysis of Variance for the Argumentation Scores of Students' on the Basis of Age, Achievement and Order among Siblings

Variable	Scores		df	SS	MS	F	p value
Age	Pretest Score	Between groups	3	5.34	1.78	3.61	.01
		Within groups	66	32.60	0.49		
		Total	69	37.94			
	Posttest Score	Between groups	3	204.25	68.08	23.75	.00
		Within groups	66	189.23	2.87		
		Total	69	393.49			
	Gain Score	Between groups	3	170.33	56.78	28.08	.00
		Within groups	66	133.43	2.02		
		Total	69	303.77			
Achievement	Pretest Score	Between groups	2	4.36	2.18	4.35	.01
		Within groups	67	33.58	0.50		
		Total	69	37.94			
	Posttest Score	Between groups	2	188.56	94.28	30.82	.00

Variable	Scores		df	SS	MS	F	p value
		Within groups	67	204.93	3.06		
		Total	69	393.49			
	Gain Score	Between groups	2	137.54	34.39	27.72	.00
		Within groups	67	166.23	2.60		
		Total	69	303.77			
Order among Siblings	Pretest Score	Between groups	2	8.34	4.17	9.43	.00
		Within groups	67	29.61	0.44		
		Total	69	37.94			
	Posttest Score	Between groups	2	252.20	126.10	59.80	.00
		Within groups	67	141.29	2.11		
		Total	69	393.49			
	Gain Score	Between groups	2	168.91	84.45	41.96	.00
		Within groups	67	134.86	2.01		
		Total	69	303.77			

Note: SS = Sum of Squares, MS= Mean Square

Table 6. LSD Post hoc Test for Multiple Comparisons of the Variables of "Age, Achievement and Order among Siblings "of the students

Variable	Argumentation Score		Mean differences	Sig.
Age	Pretest Score	12 Years vs 11Years	0.50	.01
	Posttest Score	11 Years vs 10 Years	1.98	.04
		12 Years vs 10 Years	3.90	.00
		12 Years vs 11Years	1.91	.00
		13 Years vs 10 Years	5.90	.00
		13 Years vs 11Years	3.91	.00
	Gain Score	11 Years vs 10 Years	1.78	.02
		12 Years vs 10 Years	3.20	.00
		12 Years vs 11 Years	1.42	.02
		13 years vs 10 years	5.70	.00
		13 years vs 11 years	3.92	.00
		13 years vs 12 years	2.50	0.00
Achievement	Pretest Score	Average Achievers vs Low Achievers	.58	.00
	Posttest Score	High Achievers vs Low Achievers	3.47	.00
		Average Achievers vs Low Achievers	3.58	.00
	Gain Score	High Achievers vs Low Achievers	3.06	.00
		Average Achievers vs Low Achievers	2.99	.00
Order Among Siblings	Pretest Score	Middle vs Elder	0.83	.00
		Middle vs Younger	0.40	.04
		Younger vs Elder	0.43	.03
	Posttest Score	Middle vs Elder	4.58	.00
		Middle vs Younger	2.38	.00

Variable	Argumentation Score		Mean differences	Sig.
		Younger vs Elder	2.21	.00
Gain Score		Middle vs Elder	3.75	.00
		Middle vs Younger	1.98	.00
		Younger vs Elder	1.77	.00

Conclusion and Discussion

The current study was aimed at assessing the effect of argumentative discourse based intervention on the argumentation ability of students in their transition stage of cognitive development. Having this variable in common, the group was, however, consisted of demographic variations, for example, gender, age, order among siblings, family type and achievement.

Results of the study revealed that intervention had overall a significant effect on argumentation ability as informed by comparing the pretest and posttest scores. However, the differences were seen across the demographic variations of the students.

It is revealed that boys had significantly better argumentation ability as compared to girls. This difference was even more pronounced after the intervention. The findings of the study are supported by previous researches. Hong et al. (2013) found that gender differences can be related to argumentation ability. According to him, female students face more hurdles in constructing scientific arguments, which involves them in a high level of critical thinking. According to OECD (2009), females perform poor in oral argumentation as females are poor in critiquing others opinion, not able to evaluate others opinion. Galotti, Drebud and Reimer (2001) found that female students show sympathy, acceptance, support, and cooperation with others while male students have the ability to discuss various topics critically (Asterhan, Schwarz & Gil, 2012).

Compared across the different age groups, results of the study portrayed a trend of better argumentation ability for the student of higher age group as compared to lower ones. Response of older students towards intervention was also significantly better. The findings of the research are aligned with findings of the Heyman and Legare (2005). They revealed that critical thinking skills which are required for argumentation develop with the increasing age among the children. Likewise, According to O'Hare and McGuinness(2009), the critical thinking scores of third-year university students in Ireland were much higher than those of first-year university students.

Achievement level was also found to have significantly affected students' argumentation ability. Where average achievers were found to be most able in terms of argumentation, high achievers, however, demonstrated significantly better response to the intervention leading to conclude that intervention had a more promising effect on high achievers. Low achievers, however, scored least on both tests of argumentation ability. The results comply with findings of Von Aufschnaiter et al. (2008). They found that the students with prior high achievement are more able to construct high-quality arguments, and they are more able to critique others, while the students with low achievement are not able to construct arguments and critique others. Sampson and Blanchard (2012) found that students with low achievement have to face more problems when they are engaged in argumentation.

The study investigated two other variables less cited in the literature but has their roots in the culture where the study is conducted. First, the family type and second, the order among his/her siblings. The basic drive for studying these factors was the observation of the researcher and the co-existence of these groups in the population. It is commonly seen that children who live in the joint family system have to face more challenges as compared to their counterparts in terms of their needs and desires to be fulfilled. They show more convincing power in their daily matters and develop independence earlier. The same is true for the order among siblings. The elder child has to face fewer challenges as compared to their younger siblings. These assumptions were tested in terms of argumentation ability. Results revealed that children from the joint family system possessed already better argumentation ability than their counterparts. The difference continued to exist

and enhanced when they were engaged in argumentative dialogue. Likewise study reported that the middle order of siblings was most privileged in terms of argumentation ability, followed by the youngest group, while the elder group being the last one. This trend was also found statistically significant. It can be concluded that certain demographic variables play a significant role in developing argumentation ability. These factors must give due consideration while developing curriculum contents, employing teaching strategies and involving students in argumentative dialogue. Properly managed, these demographic variables can lead to a conducive environment for argumentative dialogue.

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