

# A study of Argument Skills by using a Questionnaire test through Scientific and Non-scientific concepts of Grade 9 students

**Pawinee Rattanakorn and Pattamaporn Kaewkhongkha**

*Lecturer, Suan Sunandha Rajabhat University,  
Bangkok, 10300, Thailand*

## Abstract

Argumentation is one of the important topics in science education interesting and increase in current because it is one of the basic processes of explaining scientific concepts and promote the development of scientific literacy. The one way to support students' development of an argument is teaching by the socioscientific issues in science education.

The study of the students' reason through the use of argumentation skills questionnaire related to socioscientific issue has a purpose to 1) examine the reasoning of the students responded argumentation skills questionnaire related to socioscientific issue in situations of trafficking surrogacy, future alternative energy and social technology & environment in a test is not indicated for use scientific concepts and tests specified for use scientific concepts; 2) study the argumentation skills level of the students using the argumentation skills questionnaire specified to use scientific concepts. The result of the study showed that the argumentation skills questionnaire assigned to answer by using scientific concepts resulted in the way students cannot apply scientific concepts learned that have been used as a reason to question. The majority of students will use the knowledge in other reasons such as ethics, morals, economics, values and emotions of the reasons for the reply result argumentation skill level of students, mostly in moderate and low.

Key words: Argumentation, socioscientific issues, scientific concepts

## Introduction

For many decades, Science learning has had a focus on encouraging students to use the knowledge from observations and experiments to verify or explain things. The application of scientific knowledge was therefore limited, inhibiting students to use thinking and recognition process of scientific knowledge by the means as those of scientists' (Driver, et al., 2000 cited in Faize, et al., 2018) Moreover, school science teaching was also inconsistent with learners' daily life. Science thus became difficult and distant (Shamos, 1995 as cited in Matthews, 2018). As a result, students could not explain and apply scientific knowledge in a different situations other than what they had learned in schools. This is evident from the results of the Quality Assessment of Student Thailand under the PISA (Programme for International Student Assessment) since 2012- 2015 found that the average score of Thai students was lower than Shamos standard score of OECD (Organisation for Economic Co-operation and Development) (OECD, 2018).

As a sequence, science study should adapt a new perspective by accepting science as a social process of knowledge creation from dispute. This is because scientific knowledge should not be only created by a survey or remembering of facts, but also through an augmentation as an explanation of the phenomenon (Osborne, et al., 2004 as cited in Okumus and Unal, 2012). Consistent with the concept of , who noted that science is a social activity and argumentation is the key. Therefore, argumentation should be used in science education to promote science conception that is not limited to scientific knowledge or facts. Argumentation has an important role to learn more science as a way to help the students develop the understanding how scientists create knowledge to explain the natural world and evaluate their created knowledge. Dawson and Venville (2010) explains the advantages of the argument when apply in the science classroom that 1) the argument is the development process and check the validity of scientific knowledge, that begin by understanding the criteria and scientific debate and make the students understand how scientific knowledge create; 2) the argumentation activities allow students to participate in the exchange and understanding of scientific concepts by speaking or writing to explain the concept. It aims to develop the ability to learn science as

promotional of ideas and decisions. An understanding of scientific concepts better; 3) the argumentation encourages the students have the ability to reason, create a process of thinking with a carefully considered reasoning. But the learning in the traditional science classroom does not focus on the argument. The students do not use the argument skills to learning progress. How to encourage students to learn the argument skills one way is to teach using socioscientific issue (Cavagnetto, 2011). The socioscientific issue is socially controversial topics or issues which have a scientific component, but also incorporate other disciplines and which involve the evaluation of moral and ethical aspects (Evagorou and Osborne, 2013). The socioscientific issue can serve as a good teaching and learning context, allowing students to understand the importance of science in everyday life and developing scientific literacy.

### **Definition and Elements of Argumentation**

Active learning is an important strategy for student skills development which students become as active participants in their own class. Meyers and Jones have maintained that the active learning consists of three factors that are basic elements; learning strategies; and teaching resource. (Meyers and Jones 1993 as cited in Srma and Pakphot, 2018). Argumentation is held to be a reasoning strategy, and thus comes under the reasoning domains of informal logic and critical thinking (Jiménez-Aleixandre et al, 2000 as cited in Eskin and Bekiroglu, 2013). According to Jorde and Dillon (2012), argument refers to the substance of claims, data, warrants, and backings that contribute to the content of an argument, whereas argumentation refers to the process of assembling these components. The common feature of the definitions given above is that argument includes producing an idea and giving the reason or the evidence behind that idea while argumentation is the process of arguing. Thus, argumentation is central to scientific practice because scientists frame arguments, weigh evidence, construct warrants in support of hypotheses, and discuss alternative explanations (Toulmin, 1958 as cited in Kuhn, 1993).

The argumentation model was first developed in 1958 by Stephen Toulmin (Toulmin, 2003), which is known as Toulmin's Argumentation Pattern (TAP) or Toulmin model, which is a form of argument on the argument individual and used as a tool for the analysis and assessment of the strengths or weaknesses of the opposition. Toulmin's Argumentation Pattern contains the following elements: 1) Data; 2) Claim; 3) Warrant; 4) Backing; 5) Qualifier; and 6) Rebuttal (Bricker and Bell, 2008 as cited in Matthews, 2014). Toulmin's argumentation framework was taken as a basis to develop elements of a description of science in various forms. The one interesting framework and used to encourage students to have the skills to adequately argument is developed to adapt to suit the scientific issue to be used to build an argument took place with the students. The adjustments consist of four components (Lin and Mintzes, 2010):

- 1) Claim which is refers to issues or conflicts. The reasoning to support the claim (Warrant).
- 2) the giving of feedback / reason for opposing the controversial (Counter claim) which refers to an argument to the claim or dispute to reason that supports the claim.
- 3) the providing justification to argue (Supportive argument) as a reason to argue or reason to comment on the arguments of opponent.
- 4) evidence which is a quantitative and qualitative evidence or facts to support the argument.

### **Purpose of research**

1. examine the reasoning of the students responded argumentation skills questionnaire related to socioscientific issue in situations of trafficking surrogacy, future alternative energy and social technology & environment in a test is not indicated for use scientific concepts and tests specified for use scientific concepts.

2. study the argumentation skills level of the students using the argumentation skills questionnaire specified to use scientific concepts.

### **Participants**

Twelve ninth grade students of a demonstration school in Bangkok, Thailand was purposively selected according to the ability in learning science at a good level. All of them have never had an instruction to promote argumentation skills, There were 5 male and 7 female all through

learning about the topic: genetically, biotechnology, biodiversity, ecosystem, natural resources in the normal science classroom. They do the first test argumentation skills questionnaire (Ast1) and test them again by used the second test argumentation skills questionnaire (Ast2) over time, two months.

### Research methodology

This study employed a qualitative survey to gather the participants' response to 2 questionnaires (Ast1 and Ast2). The first test argumentation skills questionnaire (Ast1) consisted of 3 socioscientific issues about trafficking surrogacy, future alternative energy and social technology & environment (See Table 1). Each scenario included 4 questions used for exploring students skills of the claims, warrants, counter arguments, supportive arguments and evidence, adapted from an argumentation skills questionnaire of Lin and Mintzes (2010), as the followings:

Question 1 (Q1) : Do you agree or disagree with the issue? Please write down your ideas and reasons.

Question 2 (Q2): If somebody disagreed with the opinions you expressed in the first question, (s) he might have some reasons. What might his/her reasons be?

Question 3 (Q3): How would you convince somebody who disagreed with you if they had given such reasons in the second question?

Question 4 (Q4): If you were asked to provide evidence to support your own opinions in questions 1 or 3, what might the evidence be?

The Ast1 test is not indicated for used scientific concepts in answering to research and the second test argumentation skills questionnaire (Ast2) consisted of 3 socioscientific issues and questions as the Ast1 test but there are identified for students to answer questions by using scientific concepts. The students do the Ast1 test within 30 minutes at the end of ninth grade in the 2nd semester of the academic and after that 1 months, which is the period of during the semester and the students do not study more science content . The students take the test again by used the Ast2 test within 30 minutes.

**Table 1:** 3 Socioscientific issues used in Ast1 and Ast2 test

Issues	Scenarios
Trafficking surrogacy	Currently, it is popular in Thailand that husbands and wives who are not able bare their own children can use surrogacy method. This can be done by asking another woman from the same family as the wife to be a surrogate mother to get pregnant instead. Surrogacy is an arrangement that no matter the cost, but there might be problems such as refusing to lift a couple or have an affair with the husband. The selection of other women who are not relatives surrogacy also needs an agreement on wages, thereby causing the channel to more commercial surrogacy. Therefore, Thailand must pay an attention to the legal surrogacy more.
Future alternative energy	While electricity demand has grown yet the resources used to produce electricity is not enough to meet demand. As a sequence, the use of coal and nuclear fuel is becoming an important alternative because the process uses energy from coal is not terrible. The resulting carbon dioxide, which cause the greenhouse effect of the atmosphere. If you choose to use nuclear fuel to generate electricity rather than coal and not soot released into the environment. However, most people still feared for the safety of using radioactive materials and concerns about the disposal of radioactive waste properly.
Social technology & Environment	Beside from used as a communication tool, mobile phone is also an entertaining tool in many ways. It has developed to respond to the wide variety of applications. It makes most people to buy more and old mobile phones become electronic waste that does not want to work anymore. This causes problems, accumulating heavy metals in the components of consumer electronic products, mobile phones are harmful to the environment and

Issues	Scenarios
	quality of life. The disposal by incineration and destruction was invalid methods cause problems for the environment and community health.

After students finished each test, the researchers collected the responses and then categorized the answers into four categories as the followings: 1) Science related reasons (S), 2) Science and Non-science related reasons (S+NS), 3) Non-science related reasons (NS), and 4) No-science (N). Calculated the percentage of students in each category responded to compare the number of students in 2 questionnaires (Ast1 and Ast 2). Finally, the researcher analyzed the students' argument skill level by answering questions in Ast2 test that the students' reasons were analyzed for the score using the scoring rubric skills adapted from Argumentation skills questionnaire (table 2): ASQ of Lin and Mintzes (2010). The scores were interpreted to determine argument skills levels, using criteria based on the criteria used in the evaluation of González and Castillo (2012).

The criteria of the students' argument skill level used to interpret the results consist of the argumentation skills level and the total scores from rubric as the followings: very good (8-10 points), good (6-7 points), middle (4-5 points), low (2-3 points) and very low (0-1 points).

**Table 2:** Scoring rubric for Argumentation Skills Questionnaire developed from ASQ of Lin and Mintzes (2010).

Questions	Compositions	Scoring and explanation		
		0	1	2
Q1	Claim (C)	No answer or invalid claim	Acceptable claim but not clear	Acceptable claim and clear
	Warrant (W)	No answer or invalid warrant	Valid warrant or one warrant support claim	More than one valid warrants support claim
Q2	Counter argument (Co)	No answer or invalid counter arguments	Valid counter arguments but invalid warrant	Valid counter arguments and warrant
Q3	Supportive argument (S)	No answer or invalid supportive argument	Valid supportive argument and increase reliable (compare Q1)	Valid supportive argument and reliable (compare Q2)
Q4	Examples/Event (E)	No example or supplementary explanation	Invalid example or event that supports the comments inappropriate	Valid example or event

## Results

1. The analyzing students' reasons that response to 2 questionnaires (Ast1 and Ast2). The students' reasons can collect the responses and then categorized into four categories. The research found that the students tended to find science-related reasons and non-science-related reasons, aspects to explain the claim, warrant, counter argument, supportive argument and examples / event requiring for each socioscientific issues vary according to the students' prior knowledge or experience.

2. The students' reasons, comparing the percentage of response to 2 questionnaires showed that the Ast1 test, the students' answers science related reasons of 8.3% in situation regarding Future alternative energy. When they took the Ast2 test, the students' answers science related reasons of 8.3% for the situation about Future alternative energy. The researcher found the most reasons of students' answers are science and non-science related reasons which show in the students' reasons in the Ast2 test for the situation Trafficking surrogacy. The answer related reasons of science and non-

science are increased than the test Ast1 but in the Social technology & Environment, the students' answers science and non-science related reasons are decrease. The students' answers related non-science reasons in the Ast2 test for the situations Trafficking surrogacy and Future alternative energy are decreased in the Ast2 test but it increase in the situations Social technology & Environment (see Table 3).

**Table 3:**The comparison of students' reasons to Ast1 and Ast2 in 5 scenarios.

Issue	Questionnaires	percentage of students' reasons			
		S	S+NS	NS	NA
Trafficking surrogacy	Ast1		5 (41.7%)	7 (58.3%)	
	Ast2		7 (58.3%)	5 (41.7%)	
Future alternative energy	Ast1	1 (8.3%)	5 (41.7%)	6 (50.0%)	
	Ast2	1 (8.3%)	7 (58.3%)	4 (33.3%)	
Social technology & Environment	Ast1		8 (66.7%)	2 (16.7%)	2 (16.7%)
	Ast2		6 (50.0%)	6 (50.0%)	

3. The analyzed argumentation skills level of 12 students who take the Ast2 test by each student's answers were analyzed by scoring rubric argumentation skills and interpretation of the argument skills level, with the criteria that the researchers developed. The researcher found that most students had the argument skills level at moderate level (see table 4) . The majority of reasons was related to ethical, moral, and economic rather than argue that related to science as the reason have learned and they were also not an appropriate event to support the claim or counterarguments

**Table 4:** The students' scoring argumentation skills in each scenario.

Students no.	scoring argumentation skills			average scoring	argument skills level
	Trafficking surrogacy	Future alternative energy	Social technology & Environment		
1	5	7	5	5	middle
2	4	5	4	4	middle
3	4	7	4	5.2	middle
4	4	3	4	3.8	middle
5	3	2	2	2.6	low
6	5	3	4	4.4	middle
7	4	3	3	3.6	middle
8	4	4	5	4.4	middle
9	4	7	4	5	middle
10	3	3	3	2.8	low
11	4	6	4	4.2	middle
12	4	3	4	3.4	low

## Conclusion

This research study examined ninth graders' responses related to socioscientific issues with the purposes to examine students' responses to an argumentation-skill questionnaire related to socioscientific scenarios consisting of trafficking surrogacy, future alternative energy and social technology & environment. The study found that the students' answers have both claim that agree and disagree in issues. They gave the reasons for claim science related reasons and non-Science related reasons, such as morals, ethics, economic, social and senses. When did the study of reasoning students' answers response to 2 argumentation skills questionnaires (Ast1 and Ast2). The first test are not indicated for used scientific concepts in answering and the second test are identified for students

to answer questions by using scientific concepts. The students' answers have four categories of science related reasons, science and non-science related reasons, non-science related reasons and no-science. The result shows that the study results indicated that the argumentation skills questionnaires are not indicated for used scientific concepts in answering and the questionnaires identified for using scientific concepts are not make the students' answer science related reasons increased not differently. The results of determine students' argumentation skills levels from the responses to the argumentation skill questionnaire indicating students to use scientific concepts to answer. The results showed the most students (9 students) have the argumentation skill in the moderate level and there are some students (3 students) who are low level.

### **Discussion and Implementation**

The current learning in science classes focused on the exploration and interpretation of experimental results cannot encourage students to learn the science of attention. This is because students cannot apply the learned scientific knowledge to describes events or issues. The students also unable to link scientific knowledge to real life situations. This can be seen from the students who take the argumentation skills questionnaire are not indicated for used scientific concepts in answering and the argumentation skills questionnaire are identified for students to answer questions by using scientific concepts that students will not be able to use scientific concepts that have already learned the reasons of the question. Instead, they will use the knowledge related to science as the reason. Most students use in other reasons such as logic, ethics, morals, economics and emotions of their own to explain the reasons. Consistent with the result of study by Llawanera, et al. (2013) that they study types of arguments and which premises based on scientific knowledge and/or on values and beliefs in socioscientific issues related to human reproduction and gene therapy. The information was collected from 50 students, aged 16-18 years, from a public high school in Brasilia (Brazil). The researchers found that when students discuss about socioscientific issues, they don't use the scientific knowledge they have; instead of this, their arguments are mainly based on beliefs and values students shared, which coincide with those given to common sense in everyday contexts. The results of this study showed that the development of argumentation skills of secondary school students was limited if they were not explicitly taught despite the fact that the students in the secondary school who have argumentation skills to have science knowledge. The sample in this study interesting, such as the studies of Zohar and Nemet in 2002 (Eskin and Ogan-Bekiroglu, 2013). The researchers explored the learning outcomes following the biology unit in which explicit teaching of argumentation skills was merged into the teaching of human genetics. The participants in their study were 186 ninth-grade students divided into experimental and comparison groups. Due to the fact that students in the experimental group scored significantly higher than students in the comparison group in the test, they came to the conclusion that integrating explicit teaching of argumentation into the teaching enhanced performance in biological knowledge.

The learning in science class oriented in the development of argumentation skills of students by using socioscientific issues related to problems in the real life of students is therefore the issue that should promote learning in science class. As such, because the socioscientific issues are able to relate the learning of science to students' real-life experiences, allow them to apply their knowledge in real-world contexts, and provide them a real meaning of learning (Aligaen and Mangao, 2012 as cited in Yakob and Yunus, 2015). Consequently, a developing teach strategies to improve students' argumentation skills related socioscientific issue are so important and should be encouraged to happen in the science classroom.

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