Students’ Argumentation Skills across Two Socio-Scientific Issues in a Confucian Classroom: Is transfer possible?

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Students’ Argumentation Skills across Two Socio-Scientific Issues in a Confucian Classroom: Is transfer possible?

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This paper argues the possible simultaneous development and transfer of students’ argumentation skills from one socio-scientific issue to another in a Confucian classroom. In Malaysia, the Chinese vernacular schools follow a strict Confucian philosophy in the teaching and learning process. The teacher talks and the students listen. This case study explored the transfer of argumentation skills across two socio-scientific issues in such a Form 2 (8th grade) classroom. An instructional support to complement the syllabus was utilised. The teaching approach in the instructional support was more constructivist in nature and designed to introduce argumentation skills which is uncommon in a Confucian classroom. The two socio-scientific issues were genetically modified foods and deforestation. This paper presents a part of the bigger case study that was conducted. Data collected from written arguments were analysed using an analytical framework built upon Toulmin’s ideas. The whole class analysis indicated progression in students’ argumentation skills in their ability to give more valid grounds and rebuttals during the transfer. The individual analysis suggests progression in the majority of students’ performance, while several students demonstrated non-progression when they faced a different socio-scientific issue.

Keywords: Argumentation; Transfer; Socio-scientific issues; Confucian classroom

Introduction

Today, it is increasingly difficult to neglect the importance of argumentation skills, by which informed decisions need to be made. Educators and researchers have described
these skills as having the ability to think scientifically, logically and creatively about a world phenomenon (van Gelder, Bissett, & Cumming, 2004; Jimenez-Aleixandre, Rodriguez, & Duschl, 2000). Many socio-scientific issues have been studied across subject disciplines, including the various disputes of genetic engineering (Chang & Chiu, 2008; Dawson & Venville, 2009; Ekborg, 2008; Halverson, Siegel, & Freyermuth, 2009; Lewis & Leach, 2006; Sadler & Donnelly, 2006; Sadler & Zeidler, 2005a; Simonneaux, 2001; Walker & Zeidler, 2007; Zohar & Nemet, 2002), biodiversity and environmental science (Castano, 2008; Grace, 2009; Jimenez-Aleixandre & Pereiro-Munoz, 2002; Lin & Mintzes, 2010; Patronis, Potari, & Spiliotopoulou, 1999; Uskola, Maguregi, & Jimenez-Aleixandre, 2010), and cancer risks due to electromagnetic waves (Albe, 2008; Kolsto, 2006). These studies have shown that students can learn to articulate valid grounds, limitation of their decisions or alternative solutions. Nevertheless, one aspect which is still unclear is that of students’ ability to transfer the argumentation skills acquired from learning one issue to another issue (Topcu, Sadler, & Yilmaz-Tuzun, 2010). Subsequently, one key question is how students’ argumentation skills may be transferred from one socio-scientific issue to a different one (Yang & Tsai, 2010). The importance of argumentation skills needs to be justified with the advancement of science and technology. Science and technology in the twenty-first century is developing at a rapid rate and this progression inspires both futuristic wishful thinking and anxiety. With the advance of science and technology, many scientific dilemmas are coupled with social impact upon mankind (Sadler, 2004; Sadler & Donnelly, 2006; Zeidler & Nicholas, 2009). These emerging dilemmas have widely been described as ‘socio-scientific issues’ (Sadler, 2004). Mankind faces difficulties in handling these controversies (Acar, Turkmen, & Roychoudhury, 2010; Kolsto, 2006; Simonneaux, 2001). For instance, the controversies surrounding genetically modified foods centre upon various aspects ranging from economics, health, people’s choice, and social and environment impact (Lerner & Lerner, 2009; Spangenburg & Moser, 2006; Wexler, 2008). Other issues in dispute include genetic engineering, cancer risks from nuclear reactors, and climate change due to overwhelming industrial development. Therefore, decision-making and policy documents related to these socio-scientific issues often invite debate among the policy makers, scientists and the public (Acar et al., 2010; Sadler & Zeidler, 2005a, 2005b; Wexler, 2008).

At the rate science and technology have been evolving, the future in these areas is unknown (Learner & Lerner, 2009; Spangenburg & Moser, 2006). History shows the first successful transfer of animal genes to other species in the year 1981 and now its application is widespread in agriculture, medicine and food production (Learner & Lerner, 2009). As concluded by Lewis and Leach (2006), if science in the future is unknown, then what are the future socio-scientific issues and what are the socio-scientific issues that should be taught now? In other words, there is much that is unknown about what are the possible future issues and what are the resources (e.g. skills, knowledge) required to grapple with the issues. Therefore, there is a renewed interest among educators in justifying the importance of students’ acquiring argumentation skills related to socio-scientific issues. Future socio-scientific issues
might not be taught to students of today, but the skills required to deal with future socio-scientific issues can be taught (Curriculum Development Centre, 2001a, 2001b; Kauffman, 1976). To this end, many previous studies have shown students can learn and acquire argumentation skills. However, there is a need to show that students can transfer their acquired argumentation skills across different socio-scientific issues (Papadouris & Constantinou, 2010; Sadler, 2009; Simonneaux & Simonneaux, 2009; Yang & Tsai, 2010). This paper discusses a part of a case study designed and conducted in a selected Confucian classroom where a unique ideology exists with the purpose of exploring to what extent the transfer of argumentation skills is possible across different socio-scientific issues in such a situation.

A Malaysian Chinese Confucian Classroom

Confucian heritage culture (CHC) originates from China. Confucian ideology emphasises the search for peace and harmony based on a hierarchical relationship between people (Berthrong & Berthrong, 2000). Today, Malaysia has a population of over six million Chinese which constitutes almost a quarter of the whole population. CHC has greatly influenced the local Chinese community, including the Chinese schools and students (Abdullah & Pedersen, 2003; Ho, 2008). In Malaysia, there is a Confucian Chinese Independent High School, which was established over 100 years ago. In addition, there are many other Chinese vernacular schools, which used the teaching and learning materials from China and were built before the independence of Malaysia in 1957. In the 1960s (i.e. after independence), many Chinese vernacular schools have conformed to the Malaysian national education system and they are known as National-Type schools or conforming schools, while those who refused to conform, have become the Chinese independent schools. The local community often refer to these schools as Chinese schools because the Chinese language (Mandarin), and Chinese culture and identity are conserved and retained in these schools (Ho, 2008; Tan, 2007).

In this paper, the Malaysian Chinese Confucian classrooms could be understood from Hofstede’s (1997) perspectives of power distance, uncertainty avoidance and individualism-collectivism. Interpreting Hofstede’s definition in the educational context, power distance between students and teachers could refer to the extent of students’ acceptance (as the less powerful members) of orders from teachers (as the people in power) in the classroom; uncertainty avoidance demonstrated by students could refer to the extent of students’ readiness in dealing with uncertain and unknown situations during the learning process (e.g. less structured student-centred classroom activity in which the chance of their answers going wrong is greater); individualism-collectivism in students’ learning style could refer to the extent of students’ preference to learn and work in groups during the learning process. These perspectives demonstrated during the teaching and learning process in a Confucian classroom are in contrast to the way socio-scientific issues need to be taught in Western science classrooms.
From the Confucian view of classroom management, the power distance means that students should respect their teachers in a way that they do not argue with their teachers because teachers are the authority of knowledge (Chin, 2007; Phuong-Mai, Terlouw, & Pilot, 2006; Wong, 2004). If a teacher’s authority is questioned, students are thought to be those who are impolite and without respect for their teachers. This is considered as a serious discipline problem because respect for teachers is an important rule in Chinese schools. An old Chinese idiom says, ‘He who teaches me for one day is my father for life’. Therefore, students should respect their teachers as they respect their father, as a father is the centre of the family and all his orders should be obeyed by the children. Confucianism sets an obligatory respectful position of a teacher. Based on this hierarchical relationship between teachers and students, a teacher’s duty is to teach actively and the students should listen quietly (Phuong-Mai, Terlouw, & Pilot, 2005, 2006). Meanwhile, students should not give their comments unless they are asked by teachers (Wong, 2004).

The uncertainty avoidance in a Confucian classroom is related to learning new knowledge. Chinese students like to be spoon-fed by their teachers and they lack initiative to explore knowledge for themselves (Phuong-Mai et al., 2006). This style of rote learning is historically tied to the nature of examination in ancient China. For many dynasties in ancient China, Imperial Examination was administered to test and appoint civil servants. The official curriculum was the Four Books and the Five Classics which record the values, thoughts and beliefs of Confucianism (Miyazaki, 1976). Candidates need to quote words of Confucius in their essays and this means a student needs to memorise more than 400,000 Chinese characters (Miyazaki, 1976). Although Imperial Examination was abolished in the Qing Dynasty, its history of 1,300 years has greatly influenced the view of the Chinese community on what education is. Chinese students traditionally ‘learn’ (i.e. understand) the content by memorising the information in the book. Chinese students prefer to be told by their teachers about what they need to know and learn in order to score well in examinations (Phuong-Mai et al., 2006). They like questions in which only one correct answer is found (Hofstede, 1997, 2001). Students memorise and write exactly the same things during the examination (Wong, 2004). It could be said that Chinese school students tend to memorise and re-write the information (as exactly found in books) because they are afraid that what they interpret might be wrong.

The individualism-collectivism demonstrated in a Confucian classroom teaches one to refrain from disagreements in order to keep the harmony of the group and to consider the dignity and prestige of others in the group (Hofstede, 1997, 2001). Therefore, in a Confucian classroom, confrontations and conflicts should be avoided (Hofstede, 1997). Chinese school students do not reject group work, but they are more willing to give up their own opinion, rather than have a different opinion from the other group members. Therefore, in a Confucian classroom, students’ group work is often conducted as a discussion, rather than argumentation and negotiation. This is because arguing, criticising and insulting group members might hurt the other person (Phuong-Mai et al., 2005).
The above description of Confucian teaching and learning can be seen as a problem in teaching argumentation skills in relation to socio-scientific issues in the Malaysian Chinese school classrooms. However, the nature of socio-scientific issues cannot avoid argumentation.

**Argumentation Skills**

Argumentation skills are the ability to contextualise knowledge for the purpose of justifying a decision. Argumentation skills can be demonstrated through one’s ability to analyse information, evaluate evidence, and generate and present an argument in making an informed decision. Given that socio-scientific issues are open-structured, ill-defined and disputable; the stages in argumentation could be explained in a dialogical context. In this paper, based upon previous literature, argumentation is divided into three stages, which are: (a) analysing information, (b) evaluating evidence, and (c) generating and presenting arguments.

In the first stage, students obtain information from the mass media when they read newspapers and books, and surf the internet (Dawson & Soames, 2006; Maloney, 2007; Osborne, Erduran, & Simon, 2004). Through conversations, they receive information from peers (von Aufschnaiter, Erduran, Osborne, & Simon, 2008; Erduran, Simon, & Osborne, 2004; Garcia-Mila & Andersen, 2007). Students identify the key concepts within the abundant information gathered (Maloney, 2007). They further break down key concepts into smaller segments, when students identify pros and cons of a decision (Maloney, 2007). In the second stage, students begin to evaluate the processed information. They consider the causes and consequences of various possible decisions (Acar et al., 2010; Dawson & Venville, 2009, 2010; Garcia-Mila & Andersen, 2007; Osborne et al., 2004; Zohar & Nemet, 2002). They predict the impact of their decisions based on their experience, values and collected information (Castano, 2008; Chang & Chiu, 2008; Kolsto, 2006). When they hold different points of view, students prompt peers for clarification (Albe, 2007; Dawson & Venville, 2010; Lewis & Leach, 2006; Sampson & Clark, 2011). Students also probe for the integrity of information given by their peers (Dawson & Venville, 2009, 2010; Jimenez-Aleixandre, 2007; Kolsto & Ratcliffe, 2007; Osborne et al., 2004; Simonneaux & Simonneaux, 2009). In the third stage, students generate and present their arguments. It is assumed that, students should be able to generate informed decisions and present their decisions to an audience (Dawson & Venville, 2010; Garcia-Mila & Andersen, 2007; Jimenez-Aleixandre, 2007; Maloney, 2007). Meanwhile, students put forward reasons to defend their decisions (Albe, 2007; Jimenez-Aleixandre, 2007; Maloney & Simon, 2006; Means & Voss, 1996). The three stages in argumentation are summarised in Table 1. The stages indicated show the process of argumentation.

The stages ‘analysing information’, ‘evaluating evidence’ and ‘generating and presenting an argument’ would enable Malaysian students to demonstrate their argumentative skills. Consequently, if students have accomplished the three stages, they should be able to articulate an informed decision and this could imply the acquisition...
of argumentation skills. While this is ideal, teachers face problems in using these stages in any classroom, let alone in a Chinese school classroom with a Confucian ideology as explained earlier. This was the challenge that was faced in this case study.

**Theoretical Framework**

While previous studies have heavily focused on the students’ transfer of their acquired content knowledge, the understanding of students’ transfer of their acquired skills also needs to be expanded (Keiler, 2007). In this study, Gagne’s (1985) concept of transfer is used to explain the transfer of students’ argumentation skills. Originally, Gagne (1985) saw transfer as an application of students’ learnt intellectual skills when solving problems involving novel situations. In this study, it is seen as the application of students’ acquired argumentation skills (learnt through the genetically modified foods issue) when dealing with the deforestation issue. The pre-requisite for transfer to occur is students’ prior knowledge stored in their long-term memory (Gagne, 1985) in the form of schema and the following section discusses transfer of students’ argumentation skills, assuming that this pre-requisite is fulfilled. It is assumed that students have acquired a schema for argumentation skills through the use of scientific argumentation instructional support (SAIS) which was a complementary teaching-learning material for the Form 2 curriculum designed for the study.

In dealing with a novel situation, students’ recognition of the ‘right order’ is a condition for the transfer to occur (Gagne, 1985). Interpreting Gagne’s (1985, p. 129) concept of learning hierarchy, argumentation skills can be seen as one set of organised intellectual skills (Figure 1). When a student faces a novel situation (i.e. different socio-scientific issues), the student has to recall the order in making an informed decision. First, the student has to articulate a decision as the basis of an argument

<table>
<thead>
<tr>
<th>Stages</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>Analysing information</td>
<td>Read information from mass media</td>
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<td></td>
<td>Listen to oral information from peers during dialogical argumentation</td>
</tr>
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<td></td>
<td>Identify key concepts within the abundant information</td>
</tr>
<tr>
<td></td>
<td>Break down abundant information into smaller segments (i.e. pros and cons, causes and consequences)</td>
</tr>
<tr>
<td>Evaluating evidence</td>
<td>Consider the causes and consequences</td>
</tr>
<tr>
<td></td>
<td>Predict the impact of various decisions based on personal experience, values or collected information</td>
</tr>
<tr>
<td></td>
<td>Prompt peers for clarity</td>
</tr>
<tr>
<td></td>
<td>Probe for integrity of the source of information</td>
</tr>
<tr>
<td>Generating and presenting an argument</td>
<td>Generate an informed decision and present the decision to audience</td>
</tr>
<tr>
<td></td>
<td>Articulate reasons to defend the decision</td>
</tr>
</tbody>
</table>

Table 1. Stages in the process of argumentation as in literature
(see direction of arrow ‘a’ in Figure 1). Next, the student needs to provide valid grounds (with examples/elaboration) to support this decision (see direction of arrow ‘b’ in Figure 1). Finally, the student has to indicate the condition for this decision to break down (see direction of arrow ‘c’ in Figure 1). Together, all the components (e.g. a decision, valid grounds, and a rebuttal) form an argument.

In dealing with a novel situation, students’ recognition of the ‘right time’ is also a condition for transfer to occur (Gagne, 1985). In this study, when students face the deforestation issue, the events of instruction (Gagne, Wager, Golas, & Keller, 2005) are organised in a group setting, with little influence from the teacher. However, prompts and refutations that occur among the group members can be seen as one of the events of instruction (e.g. providing feedback about performance). For example, when a student articulates a decision, it is the right time to prompt him or her to provide supporting valid grounds. Subsequently, it is the right time for this
student to refute. Through a refutation, this student may elaborate in more detail or give examples to his or her supporting valid grounds. If this student is unable to refute, he or she recognises the weakness in his or her argument. Next, this student might reconsider his or her argument and this includes the recall of the order of making an informed decision. Therefore continuous prompts and refutations also stimulate the recall of students’ acquired argumentation skills. This is in line with one of the events of instruction, which is ‘stimulating recall of prerequisite learned capabilities’ (Gagne et al., 2005). In other words, when students argue a socio-scientific issue in a group setting, prompts and refutations among group members during the events of instruction assist students to recall and apply their acquired argumentation skills in the right order and at right time in order to generate an informed decision when dealing with a different socio-scientific issue. It also can be understood that the application of argumentation skills of a student in the right order and at the right time could depend on social interaction between group members to scaffold each other to learn new information (Vygotsky, 1978). Following the ideas of continuous prompts and refutations which have been mentioned earlier, a capable peer can prompt a student (i.e. weaker peer) for further clarification (e.g. valid grounds, examples, and elaboration). At other times, this student could teach the group. Each student is unique in their ability and they are able to teach each other (Schunk, 2009). This exchange of useful information between peers can occur in a group setting (Albe, 2007; Garcia-Mila & Andersen, 2007).

Research Objective and Question

The larger study investigated the acquisition of argumentation skills in a CHC classroom about socio-scientific issues, in particular related to transfer of students’ argumentation skills. This setting is definitely in contrast to western classrooms which are much more student-centred. This paper discusses part of that study and focuses upon the question, ‘To what extent is there transfer of students’ argumentation skills across different socio-scientific issues in a Malaysian Confucian classroom?’

Methodology

The larger study mentioned employed an embedded single case study (Yin, 2003). This design enabled the researchers to observe argumentation skills of the whole class as well as of each individual student. This was because the overall class result does not necessarily reflect the cases in the finer individual analysis (Topcu et al., 2010). Many studies in argumentation related to socio-scientific issues have been conducted in Western countries (Topcu et al., 2010). This paper tries to present a distinctive Eastern context in the study of argumentation skills. The larger research explored both students’ argumentation process and product. This paper focuses upon the students’ written arguments which are the argumentation products.
The School, Teacher and Students Involved

The selected Chinese vernacular secondary school was established by the local Chinese community before the independence of Malaysia in 1957. In the 1960s, this school conformed to the national education system and it started using the national curriculum. The selected Chinese school is located in the outskirts of a small town in Perak (one of the 13 states in Malaysia). The selected school has an enrolment of about 2000 students from Form 1 (7th grade) to Form 6 (12th grade) and almost all students are Chinese. The students enrolled in this secondary school came from Chinese primary schools in the nearby neighbourhoods. Therefore, the students have experienced a Confucian teaching and learning environment since their primary education.

The nature of usual science lessons in this Malaysian Chinese Confucian classroom is teacher-centred and this is different from the Western context. Less-structured classroom activities are seldom conducted in this science classroom. It is also a norm that students ask, refer to and obey the teacher’s instruction when they have questions. Students passively receive and follow the instructions from teachers. Lectures are the dominant classroom activity. The teacher talks, students listen and seldom ask questions. In many ‘class discussions’, teachers ask students to voice out their answers. Whenever a student gives an alternative answer, the teacher would immediately tell the student that the answer is wrong. Teachers rarely offer students the chance to reason out their answers. Instead, the teachers would ask other students for the right answer or they would give the correct answers. Teachers decide which answers are acceptable and so the teacher is the authority in the science classroom. Due to the situation described above, the investigation in this study involved putting in place procedures to engage participants in argumentation and also to set the teacher as the facilitator and not the sole transmitter of knowledge. The main procedure was contained in the SAIS complementary teaching material for the Form 2 textbook.

One science teacher, Miss Yeop (not her real name) from the school volunteered to use the instructional support. Miss Yeop had a Biology major in her Science with Education Bachelor degree. Miss Yeop’s science class consisted of 35 Form 2 students (aged 14 years). To describe the nature of group activities conducted in this classroom before the start of the larger study, an interview excerpt with one of Miss Yeop’s students is given below.

Researcher: Then, how often do you have discussion activities, since Form 1?
Yoon-Yi: She (teacher) does not conduct discussions often.
Researcher: Why?
Yoon-Yi: Because we just write on our own, no discussion.
Researcher: Some students, they say, they don’t have discussion groups since Form 1, what is your comment?
Yoon-Yi: Yes.
Researcher: But you sit in groups during experiment?
Yoon-Yi: Just … teacher wants us to do … we do.
Researcher: How often does your teacher ask you to discuss?
Yoon-Yi: When doing an experiment.
Researcher: Then what do you do when teacher asks you to discuss?
Yoon-Yi: Just look at the book, what the book says, we follow. (Yoon-Yi, interview, 6 February 2010)

It is clear that the teacher seldom conducted group discussions and even when they sat in groups, they usually did not discuss but followed the instructions given in the books during experiments.

Socio-scientific Issues and the SAIS

In the larger research, the complementary teaching materials created—SAIS—was in line with the Malaysian Form 2 science curriculum. This additional support was created because there is a lack of support for introducing argumentation into the Malaysian science curriculum. SAIS aimed to introduce argumentation skills related to the genetically modified foods issue. SAIS was built upon ideas from previous workable interventions such as enhancement of content knowledge (Castano, 2008; Chang & Chiu, 2008; Zohar & Nemet, 2002), explicit teaching of argumentation skills (Osborne et al., 2004; Zohar & Nemet, 2002), authentic practices (Jimenez-Aleixandre & Pereiro-Munoz, 2002; Molinatti, Girault, & Hammond, 2010; Simonneaux, 2001), and instructor facilitation (Dawson, 2011; Erduran et al., 2004; Lewis & Leach, 2006; Sadler & Donnelly, 2006; Simon, Erduran, & Osborne, 2006). Considering that Malaysian students are generally learners of English as a Second Language, bilingual glossaries were provided in SAIS.

SAIS consisted of nine activities. The activities include group discussions guided by reading materials, introducing an argument pattern related to socio-scientific issues, conducting a debate, students’ emailing questions to a local biotechnologist and a biotechnological talk for students (Table 2). Each activity was from 10 min (e.g. introduction), or 70 min (e.g. group discussion) to one month (e.g. if it involves emailing to an expert biotechnologist). SAIS was integrated by the participating teacher into the usual science lessons in the selected Confucian classroom. One or two activities were conducted in a week and SAIS was completed in approximately one month. The nature of SAIS includes teaching strategies which were student-centred and differed tremendously from the normal teacher-centred approach in a CHC school.

Data Collection

In leading up to the two tasks to assess students’ argumentation skills, students had completed the activities in SAIS. Through SAIS, the students had learnt about genetically modified foods and had been exposed to the ideal argument pattern for justifying their decisions. It was after the completion of SAIS that the first task which is related to genetically modified foods issue was administered. The task was divided into two sessions and each session took 15 min. In the first session, the teacher arranged
students in groups of three or four. The task was in the form of a written scenario and was distributed to every student. The scenario briefed students about the on-going public debate on genetically modified foods issue. This scenario did not present specific advantages and disadvantages of eating genetically modified foods. The instruction for students was given at the end of the scenario, which was ‘Would you eat genetically modified foods? Build an argument to support your decision’. After receiving the scenario, students organised their group discussions. The teacher remained neutral during students’ discussions and she did not impose her ideas. In the second 15 min session, students were required to respond individually to the given instruction, ‘Would you eat genetically modified foods? Write an argument to support your decision’. Students wrote their individual arguments without referring to any source. In summary, the first task took a total of 30 min and students’ written arguments were collected.

Four days after the administration of the first task, the second task was administered. The second task is related to the deforestation issue. In these four days, students did not receive any specific intervention from the teacher on the deforestation issue. However, it must be stated here that the students may have already been exposed to the deforestation issue through the Malaysian mass media. The second task was similar to the conducting of the first task except for the given socio-scientific issue. In the first 15 min session, students were given a written scenario about public debate on deforestation. No specific advantages and disadvantages of cutting forests were provided. The students were asked to discuss the question ‘Would you cut down trees to build houses, factories and farms? Build an argument to support your decision’ in groups (the students were in the same groups as in the first task). Students organised their discussions without the facilitation from the teacher. In the second 15 min session, students wrote their individual arguments in justifying their decision.
The implementation of the two sessions for a task was important to meet the ill-defined nature of socio-scientific issues. Decision-making on socio-scientific issues needs negotiation (Sadler & Zeidler, 2005a) and the first session (in each task) allowed students’ minds to engage in debate. Meanwhile, the second session (in each task) provided sufficient time for students to calm down, organise and articulate their ideas (Chang & Chiu, 2008).

Data Analysis

In the context of this study, a decision, valid grounds and a rebuttal are the structural components in an argument. The role of a rebuttal is to indicate the limitation of a student’s decision, or the condition under which this student changes his or her decision. Rebuttal is the most significant quality indicator because a student’s ability to pinpoint the limitation in decision could reflect the student’s higher-order thinking skills as compared to other students who do not construct a rebuttal in their arguments (von Aufschnaiter et al., 2008; Chang & Chiu, 2008; Lin & Mintzes, 2010). Figure 2 illustrates the layout for an argument pattern which consists of the structural components in an ideal argument. This ideal argument pattern was taught to students through the use of SAIS.

Students’ arguments were analysed and categorised using the grounds competency–argument pattern (GC–AP) analytical framework (Table 3) which was derived for the larger research. The analytical framework was built upon Toulmin’s (1958) argument pattern and incorporated several ideas of previous researchers. These incorporations included the collapsing of data, warrant and backing into a single category ‘grounds’ (Osborne et al., 2004), and elaboration and examples (that extend grounds) to distinguish between brief and detailed descriptions (Castano, 2008; Zohar & Nemet, 2002). The GC–AP analytical framework ranks students’ arguments into six argument patterns, in which a decision is the basic component in an argument and a rebuttal is the most significant quality indicator. In addition, the GC–AP analytical framework only considers valid grounds written in students’ arguments. The validity refers to the correct, relevant and specific content knowledge (Walker & Zeidler, 2007; Zohar & Nemet, 2002). The GC–AP

![Figure 2. Layout of an argument pattern](image-url)
analytical framework was an attempt to take into account the emphasis on structural complexity and depth of content knowledge. Our study (Foong & Daniel, 2010) explained an early development of GC–AP analytical framework. The need for such analytical framework for argumentation skills has been indicated in Sampson and Clark’s (2008) review of contemporary assessment tools.

An argument written by a participant Wan-Keng (not her real name) for the deforestation issue is shown below to demonstrate how students’ arguments were coded. In the second task, Wan-Keng rejected the idea to cut down trees to build houses, factories and farms. She wrote that,

No, I will not cut down trees to build houses, factories and farms because cutting down the trees will increase the carbon dioxide and decrease the oxygen. This can cause the weather of the whole world to change and become hotter and cause ice in the mountains to melt and cause floods. Besides this, cutting down the trees to build houses, factories and farms will cause soil erosion because the soil does not have the roots of trees to protect it. Cutting down the trees to build houses, factories and farms will also destroy the habitats of animals in the jungle. However, if there are ways to protect the habitats of animals and ways to decrease the carbon dioxide in the air, I will cut down trees to build houses, factories and farms. (Argument, Wan-Keng, Task 2, Group 1, 7 May 2010)

This argument was analysed sentence by sentence. Each sentence was matched with structural components such as a decision, valid grounds, examples/elaboration
and rebuttal (if applicable). For example, the sentence ‘No, I will not cut down trees to build houses, factories and farms’ explicitly shows that the decision made by Wan-Keng against deforestation. The detailed analysis is shown in Table 4.

The GC–AP analytical framework only considers valid grounds. Table 5 shows the grounds competency demonstrated in Wan-Keng’s argument. It was found that three grounds written by Wan-Keng were valid. First, she justified the weather changes due to global warming. Second, she pointed out soil erosion as a result of deforestation. Third, she argued that deforestation destroys the habitats of animals.

The final analysis using the GC–AP analytical framework is shown in Table 6. Wan-Keng articulated a decision to oppose deforestation. She had written three valid grounds. Meanwhile, she elaborated these valid grounds. In addition, she wrote a rebuttal in her argument to indicate the limitation of her decision. According to GC–AP analytical framework, Wan-Keng’s argument demonstrates Argument Pattern 6.

In order to establish reliability for the coding results, two rounds of coding were conducted. In the first round, all students’ arguments were coded independently by the first author and the teacher. An agreement of approximately 87% was achieved. The coders discussed and resolved the discrepancies until they reached a consensus. In the second round, 50% of students’ arguments were coded independently by two post-graduate peers. They were science teachers and having a major in biology for their Science with Education Bachelor degree. Peer coding resulted in approximately 88% agreement. For the disagreements that emerged, discussions were carried out with these peers in resolving the discrepancies so that the students’ argument patterns could be finalised. The process of negotiation (in the first and second rounds) found that, coders’ main discrepancy was their different views in identifying numbers of valid grounds. Since argumentation involves uncertain knowledge claims, coders’

<table>
<thead>
<tr>
<th>Structural components</th>
<th>Sentences/phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision:</td>
<td>No, I will not cut down trees to build houses, factories and farms because …</td>
</tr>
<tr>
<td>Grounds #1</td>
<td>… because cutting down the trees will increase the carbon dioxide and decrease the oxygen</td>
</tr>
<tr>
<td>Examples/elaboration</td>
<td>This can cause the weather of the whole world to change and become hotter and cause ice in the mountains to melt and cause floods</td>
</tr>
<tr>
<td>Grounds #2 and examples/elaboration</td>
<td>Besides this, cutting down the trees to build houses, factories and farms will cause soil erosion because the soil does not have the roots of trees to protect it</td>
</tr>
<tr>
<td>Grounds #3</td>
<td>Cutting down the trees to build houses, factories and farms will also destroy the habitats of animals in the jungle</td>
</tr>
<tr>
<td>Rebuttal</td>
<td>However, if there are ways to protect the habitats of animals and the ways to decrease the carbon dioxide in the air, I will cut down trees to build houses, factories and farms</td>
</tr>
</tbody>
</table>
### Table 5. Grounds competency demonstrated in Wan-Keng’s argument

<table>
<thead>
<tr>
<th>Grounds/examples/elaboration</th>
<th>Competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounds #1:</td>
<td>Valid</td>
</tr>
<tr>
<td>… because cutting down the trees will increase the carbon dioxide and decrease the oxygen</td>
<td></td>
</tr>
<tr>
<td>Examples/elaboration:</td>
<td></td>
</tr>
<tr>
<td>This can cause the weather of the whole world to change and become hotter and cause ice in the mountains to melt and cause floods</td>
<td></td>
</tr>
<tr>
<td>Grounds #2 and examples/elaboration:</td>
<td>Valid</td>
</tr>
<tr>
<td>Besides this, cutting down the trees to build houses, factories and farms will cause soil erosion because the soil does not have the roots of trees to protect it</td>
<td></td>
</tr>
<tr>
<td>Grounds #3:</td>
<td>Valid</td>
</tr>
<tr>
<td>Cutting down the trees to build houses, factories and farms will also destroy the habitats of animals in the jungle</td>
<td></td>
</tr>
</tbody>
</table>

### Table 6. Final analysis of Wan-Keng’s argument

<table>
<thead>
<tr>
<th>Decision</th>
<th>Valid grounds</th>
<th>Rebuttal</th>
<th>Argument pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>No, I will not cut down trees to build houses, factories and farms because …</td>
<td>Valid grounds #1: … because cutting down the trees will increase the carbon dioxide and decrease the oxygen</td>
<td>However, if there are ways to protect the habitats of animals and the ways to decrease the carbon dioxide in the air, I will cut down trees to build houses, factories and farms</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Examples/elaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>This can cause the weather of the whole world to change and become hotter and cause ice in the mountains to melt and cause floods</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid grounds #2 and examples/elaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Besides this, cutting down the trees to build houses, factories and farms will cause soil erosion because the soil does not have the roots of trees to protect it</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid grounds #3: Cutting down the trees to build houses, factories and farms will also destroy the habitats of animals in the jungle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
interpretations could be different depending on their scientific beliefs (Kelly & Takao, 2002; Kolsto, 2006). Two rounds of coding (involving different coders) were aimed at minimising coders’ personal beliefs of the genetically modified foods and deforestation issues.

**Results**

An embedded case study design allows variations at the smaller unit level, however, the analysis should return to reflect the overview of the case (Yin, 2003). In the following sections, the Malaysian Confucian school students’ transfer of argumentation skills in terms of whole class and individual analysis is discussed.

**Whole Class Analysis**

As discussed in the methodology, students’ arguments were coded into six kinds of argument patterns. Figure 3 shows the distribution of students’ argument patterns obtained from the two tasks. Progression in students’ argumentation skills was generally observed. Specifically, the most frequent argument pattern demonstrated by students was the shift from Argument Pattern 3 to Argument Pattern 4 across the two tasks. The data supports a progression in students’ argumentation skills.

There was no Argument Pattern 1 in the second task. The number of Argument Pattern 2 had reduced from six to three students. This result shows that only a minority of the students did not provide valid grounds in the second task. It is also possible to compare Argument Pattern 3 and Argument Pattern 4. In the first task, 17 arguments were identified as Argument Pattern 3, this number decreased to seven arguments in the second task. There was an increment of eight Argument Pattern 4 in the second task. Argument Pattern 3 and Argument Pattern 4 are distinguishable from their brief and detailed description of grounds. Therefore, the data suggest that many students had provided more valid grounds, examples or elaboration in the second task. This also applies to Argument Pattern 5 and Argument Pattern 6.
In the first task, there were two arguments classified as Argument Pattern 5 and Argument Pattern 6. Both patterns increased to five arguments, respectively, in the second task. This implies that more students were able to justify their decision with detailed description of grounds. This also means that more students were able to construct a rebuttal in their arguments in the second task. By assessing students’ argumentation skills across the genetically modified foods and deforestation issues, it is clear that many students had provided detailed description of grounds and rebuttals when they dealt with the second task, which is the deforestation issue. In summary, the whole class analysis indicates evidence to show progression in students’ acquired argumentation skills. This progression can be taken as an indication of possible transfer across the issues.

**Individual Analysis**

In order to explore the transfer of students’ argumentation skills at the individual level, this study employed Grace’s (2009) method to see individual differences. Figure 4 presents progression and non-progression in students’ argumentation skills. There were 25 students who had demonstrated higher quality argument patterns in the second task. The most frequent progression can be seen by the 10 students who progressed from Argument Pattern 3 to Argument Pattern 4. This progression implies that these students had provided more numbers of valid grounds, as well as examples or elaboration to justify their decisions.

To provide a clear view of the progression, the case of Shiao-Chee is presented. In Task 1, Shiao-Chee supported the genetically modified foods consumption because for her, genetically modified foods contain more nutrition than foods she commonly...
eats. She gave an example that golden rice could provide vitamin A [non-genetically modified rice consists of carbohydrate and does not have vitamin A]. In Task 2, Shiao-Chee opposed deforestation for several reasons. First, she claimed the importance of photosynthesis to balance the amount of oxygen and carbon dioxide in the air. Second, Shiao-Chee argued that forests are habitats for animals and plants to live in. She also elaborated that deforestation could cause some species to become extinct. Finally, Shiao-Chee highlighted that forests store water and this can prevent soil erosion. The progression in Shiao-Chee’s argument patterns (i.e. gives more valid grounds) from Task 1 to Task 2 is shown in the layout of an argument pattern (Figure 5).

For the most significant progression, two students demonstrated Argument Pattern 3 in the first task and Argument Pattern 6 in the second task. This means, these students gave an identifiable decision to eat or reject genetically modified foods based on a brief description of grounds (i.e. one or two valid grounds with/without examples or elaboration) for the first task. In Task 2, they were able to give a more detailed description of grounds (i.e. three or more valid grounds with examples or elaboration) and they were also able to pinpoint a rebuttal of their decisions (e.g. limitation of the decision, the condition under which they would change their decision). The progression seen here can also be taken as indication of possible transfer across issues.

![Illustration in layout of an argument pattern](image)

**Figure 5.** Shiao-Chee’s progression from Task 1 to Task 2 in the layout of an argument pattern
It must be noted here that one student demonstrated Argument Pattern 6 for both tasks, which is the most sophisticated argument pattern.

Meanwhile, non-progression in students’ argumentation skills across the two issues was also observed. There were six students who indicated the same argument pattern for both tasks. One student each demonstrated Argument Pattern 2 and Argument Pattern 3, respectively, for both tasks. Three students demonstrated Argument Pattern 4. In addition, three students gave less valid grounds in the second task (e.g. from Argument Pattern 4 to Argument Pattern 3) and one student did not construct a rebuttal in her argument for the second task (i.e. from Argument Pattern 5 to Argument Pattern 4). Hence, the whole class analysis reported an overall progression in students’ argumentation skills; however the individual analysis revealed that six students did not progress and four students even indicated a lower quality argument pattern.

Discussion

The Confucian ideology teaches students to emphasise harmony in a group and avoid confrontations and conflicts (i.e. argumentation). The students and teacher involved in this study from a Confucian teaching and learning environment with the aid of SAIS had to engage in a less-structured and in a less teacher-centred teaching and learning environment. Students had to deal with uncertain knowledge claims involved (e.g. pros and cons, different causes and consequences, decision and rebuttal) in the genetically modified foods and deforestation issues and when students completed SAIS, 27 students in the first task and 31 in the second task were able to make a decision and supported their decisions with valid grounds. Students learnt to interpret and apply their previous learnt knowledge to argue their decisions upon these controversial issues. The above argumentative practices are uncommon in a Confucian classroom where students try avoiding uncertainty in the learning process (i.e. they prefer to learn by memorising and avoid interpretation). As for the teacher in this study, she had to shift from her previous role of the knowledge transmitter and become a facilitator. In her dealings with the students during the study, she did not influence students’ decisions, neither to support or reject genetically modified foods consumption, nor to accept or reject deforestation in the name of development. The introduction of argumentation skills through socio-scientific issues in this study appears to have overturned to a certain extent the traditional Confucian view of learning in a science classroom as the students took an active role in learning. This is because many students have progressed in their argumentation skills from the genetically modified foods issue to the deforestation issue. It can be said that these students appear to be adapting to argumentative practices. These argumentative practices included the group discussions which was a new experience for them.

The progression of argumentation skills could also indicate the transfer of students’ argumentation skills across two different socio-scientific issues. Several possible explanations can be put forward for this. Guidance for learning and adapting scientific argumentation (in this case SAIS) as shown in Berland and Reiser’s (2011) study possibly could have helped this Confucian classroom to adapt argumentative
practices. In the second task, it is assumed that the students were more familiar with the nature of the task and the skills they needed to put into action. Therefore, progression in students’ argumentation skills could be due to their familiarity with what was needed to be done to write an argument (Lewis & Leach, 2006). Transfer can be exercised through practicing one set of intellectual skills in different situations (Driscoll, 2005). In this study, students had discussed and argued the genetically modified foods issue first and hence, when students were addressing the deforestation issue, they probably recalled their previously learnt argumentation skills from the genetically modified foods issue. By applying the previously learnt skills in the ‘right order’ and at the ‘right time’ (Gagne, 1985), it was possible for them to progress. The right time to facilitate transfer (Gagne, 1985) could relate to peer interaction during the group discussion. Students were engaged in the group discussion before they wrote individual arguments. Weak students could seek assistance from their capable peers. The scaffolding is grounded in social interaction (Vygotsky, 1978). For example, a student could ask his or her group the specific disadvantages of cutting the forests. When this student received information from the group, he or she might be able to improve his or her argument. In other words, a group member who provides the information is an ‘expert’ teaching other group members (Schunk, 2009). As a result, all group members can share their distinctive opinions of the advantages and disadvantages of cutting forests. The excerpts below show two examples of peer interaction during the first 15 min session for the second task. When dealing with the deforestation issue, Zee-Min and Shiao-Chee elaborated on each other’s opinions about the functions of the roots of trees. Shiao-Chee said that the roots of trees will hold the soil. Zee-Min responded and claimed that it prevents landslides. Shiao-Chee stated that it is related to soil erosion. Zee-Min articulated another function of roots of trees which is to absorb water.

58 Zee-Min: Prevent natural disasters, floods, and droughts.
59 Shiao-Chee: The roots of trees will hold the soil.
60 Zee-Min: Prevent landslides.
61 Shiao-Chee: Soil erosion.
62 Zee-Min: Absorb water. (Group discussion, Task 2, Group 6, 11 May 2010)

Peer interaction also included prompts and refutations. When dealing with the deforestation issue, Zee-Min argued that preserving the forests prevents natural disasters and landslides. Kah-Hing questioned him about the difference between a natural disaster and a landslide. Zee-Min explained that a landslide is the result of human activity while a natural disaster is like floods. Kah-Hing insisted that both incidents are disasters and he prompted Zee-Min for clarification.

124 Zee-Min: Prevent natural disasters.
125 Kah-Hing: Then?
126 Zee-Min: Prevent landslides.
127 Kah-Hing: What’s the difference between a natural disaster and a landslide?
Zee-Min: Not the same, landslide is human made, natural disasters are those like floods.

Kah-Hing: Also are disasters.

Zee-Min: Different.

Kah-Hing: What else can you tell about these? (Group discussion, Task 2, Group 6, 11 May 2010)

In a Confucian classroom such as the one reported here, the teacher seldom conducted group discussions in her science classroom. It could be said that active peer interactions occurred more often during the study when compared to the situation before the students were engaged in SAIS.

This study also investigated the possible transfer of students’ argumentation skills. For the right order to facilitate transfer (Gagne, 1985), students recognise the organised set of intellectual skills (i.e. a decision, valid grounds, a rebuttal) which they need to construct an argument. For example, students should first come up with a decision, then provide valid grounds and finally construct a rebuttal to indicate the limitation of the decision. If a student has forgotten (i.e. cannot retrieve from long term memory) particular structural components, he or she might be able to refine their arguments after listening to the peers’ comments. Prompts and refutations allow students to be aware of the weakness of their own arguments. In short, the concept of learning guidance through the right time and order (Gagne, 1985), as well as interacting with capable peers in the group (Vygotsky, 1978) could have facilitated the progression of argumentation skills when students dealt with the deforestation issue. This explains why many students in this study had progressed in their argumentation skills as they progressed from the genetically modified foods to the deforestation issue. The analysis of students’ arguments from the first task to the second task has demonstrated that argumentation skills can be acquired by the students and that possibly these students can transfer these skills to another issue to a certain extent.

However, it must be noted that most of the students in this study did not construct a rebuttal in their arguments when dealing with genetically modified foods and deforestation issues. This indicates that they were not aware of the limitation of their decisions. This lack has been observed in some previous studies. In Topcu et al.’s (2010) study, pre-service teachers struggled to articulate counter-arguments and rebuttals when they faced different socio-scientific issues. In several studies (Chang & Chiu, 2008; Lin & Mintzes, 2010; Osborne et al., 2004), many students had difficulties pinpointing the rebuttals in their arguments even after engaging in an intervention. The findings are also similar to Simonneaux and Simonneaux’s (2009) findings that students performed systematic reasoning when dealing with different socio-scientific issues; this is shown by the way students in this study gave valid grounds in order to justify their decision. The whole class analysis resulted in similar findings to Topcu et al. (2010) that many students were able to give valid grounds when facing different socio-scientific issues, but not many students constructed a rebuttal in their arguments.
In summary the paper has discussed how Confucian teaching and learning implies a very different practice from the Western context. In such a context, this paper has discussed how the situation can be changed so that activities can be planned to help students in a Confucian classroom acquire argumentative skills. It was also shown that it is possible to transfer these argumentation skills to another new issue.

References


