

Scientific Reasoning Skills Among Arabic Secondary School Students and Its Relationship With Teaching Styles of Arabic Secondary School Brunei Darussalam Teachers

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Abstract. This survey research aims to gauge the levels of students' scientific reasoning skills and teachers' teaching style at three Arabic secondary schools in Brunei Darussalam. The research design employed was that of a survey research. Using the stratified random sampling, a total of 60 students and 60 teachers were involved as the respondents of this study. Two research instruments were used for the data collection, namely the Scientific Reasoning Skills Test, and Teachers' Teaching Style Inventory. The data were analysed descriptively using the frequency, percentage and mean, and inferentially by means of a t-test and Pearson Moment Product Correlation. The findings indicated that there are generally three levels of scientific reasoning skills, of which 83.3% of the students achieved the Level 1 (concrete operational), 16.7% achieved the Level 2 (transition operational), and none of the students achieved the Level 3 (formal operational). Generally, the scientific reasoning skills of Year 10 students at the Arabic secondary schools was at Level 1 (concrete operational) with an overall mean of 2.47. The thinking patterns indicate that, while 40 to 60% of the students were able to master the theoretical aspect, more than 85% of the students were weak in the aspect of giving reasons or correctly reasoning to the theory. On the basis of students' perceptions, the findings also indicated two dominant teaching styles, namely the Expert and the Delegator. Overall, the correlation between students' perceptions on teacher teaching style and the levels of scientific reasoning indicated that there was no significant relationship between the two variables. Accordingly, the dominant teaching styles of the teachers could not be matched to the levels of scientific reasoning skills of the students. In conclusion, this research not only manifests a benchmark of scientific reasoning skills among students in the Arabic secondary schools in Brunei Darussalam, it also opens an avenue for other researchers to explore scientific reasoning skills at depth so that a teaching model could be generated to reinforce students' scientific reasoning skills.

Keywords: *scientific reasoning skills, teaching styles, Arabic secondary schools*

INTRODUCTION

In the 21st century, Brunei Darussalam is experiencing an era of globalization and as such, has to

constantly face new challenges. In preparation for addressing these challenges, the Ministry of Education is ceaselessly researching and refining the National Education System to ensure that it is always relevant at all times. The Brunei Darussalam Education Ministry is committed to providing an educational system that will prepare the younger generation for a future role as a capable, creative, intelligent and innovative people who will defend the social values embodied in the Malay Islamic Monarchy (MIB) concept. The phenomenon of globalization and digitalization in the 21st century has brought new challenges to education. Students must be equipped with knowledge and thinking skills so that they could give their critical and analytical views and opinions, make efficient judgments, produce quality works and inventions, solve problems effectively, shape courage, self-esteem, and skill, and finally, act logically and rationally.

In the process of teaching and learning, teachers need to develop the potential of students' intelligence by identifying their interest and learning styles. Students have multiple intelligences that include verbal-linguistic, logical-mathematical, musical-rhythmic, bodily-kinesthetic, visual-spatial, interpersonal and intrapersonal intelligences. Therefore, teachers are expected to use a plethora of approaches, methods, techniques, and strategies of teaching and learning that will enable all students to maximize their learning by matching to their respective ways of learning. Teachers should be mindful that different teaching and learning strategies and activities have different goals and strengths. There is no method that can be effective in all situations. It should also be acknowledged that each learning area has different needs.

In this new teaching and learning environment, the teacher's role is expected to change as aspired in the curriculum of the *Sistem Pendidikan Negara Abad Ke-21* (SPN21) or National Education System for the 21st Century. The role of the teacher changes to that of a facilitator of learning, consultant, counselor and assessors. Teachers should always use a variety of interesting teaching and learning approaches that will

encourage students to learn. This includes telling students about the learning goals and sharing about the successful experiences by taking into account their emotions and pride. Such telling and sharing are especially important for students with learning disabilities as well as those who show a much lower level of learning than their actual abilities. In the teaching and learning environment of SPN21, teachers are also expected to use a variety of teaching and learning resources, ICT materials, concrete materials, diagrams/charts, newspaper cuttings and other teaching resources that make learning more fun and interesting.

The National Education System for the 21st Century (SPN21) was formulated by identifying some of the curriculum approaches as well as the principles of teaching that are perceived to be appropriate to primary and secondary education. The process of teaching and learning at both the primary and secondary levels emphasizes student-centered learning that entails active involvement of students either individually or in groups. The SPN21 curriculum recognizes that each student has its own learning capabilities and styles. It uses a variety of teaching methods categorized into Basic Level (Must be done), Intermediate Level (Need to be done) and Advanced Level (Can be done). SPN21 through the Brunei Darussalam Education Evolution also implemented value-added projects such as **Cognitive Research Trust (CoRT) Thinking Skills** in 1993, and **Learning Program Styles (LEAPS)** in 1994 (Ministry of Education, Brunei Darussalam, 2013). It is expected that these value-added projects would encourage schools to create an effective learning environment and to apply thinking skills during the teaching in the classroom. Therefore, there is a crucial need for studies to gauge the extent to which the value-added programs and projects under this SPN21 have achieved the goals

According to Zimmerman [1], it is necessary to conduct a basic research related to the understanding the students' scientific reasoning skills so that an effective model of teaching could be conceptualized to increase the mastery of thinking skills in terms of scientific reasoning skills. Mastery of these scientific reasoning skills is needed to study and understand nature, find answers to problems and make systematic decisions. This very valuable attribute should be possessed by students at secondary and university levels. However, such a level of scientific reasoning skills has not been extensively explored in Brunei Darussalam where there is no data to serve as a benchmark for students' level of scientific reasoning at the secondary or even tertiary level. The research findings by Maria Abdullah and Kamisah Osman [2] from the study on the "Scientific Inventive Thinking Skills among Primary Students in Brunei" indicated that the creativity, high order thinking and sound reasoning among Bruneian primary and secondary students is still low.

The objectives of this research were to: (a) determine the level of scientific reasoning skills (SRS) among students at Arabic secondary schools; (b) determine the patterns of Scientific Reasoning Skills among Arabic

secondary school students; (c) identify the teachers' teaching style based on students' and teachers' perceptions; and (d) map the instructional methods employed to the level of Scientific Reasoning Skills among Arabic secondary school students.

METHOD

This study employed a quantitative survey data-gathering method. Three Arabic secondary schools, chosen by means of stratification random sampling technique, were involved in this study: Arabic Secondary School Rimba (SMAR), Ma'ahad Islamic Brunei (MIB), dan Arabic Girls Secondary School Raja Isteri Pengiran Anak Hajah Saleha (SUAMPRIPAHS). A total of 60 students and 60 teachers participated in this study. The two research instruments used are (1) the Lawson's Scientific Reasoning Skills Test (LSRS), and (2) the Lecturers' Teaching Style Survey (LTSS). The LSRS test was adapted from the Classroom Test of Scientific Reasoning to measure students' scientific reasoning skills.

Scientific Reasoning Skills test consisted of 12 two-tier questions and for each question, the respondents were required to select one correct answer and to provide an explanation for the given answer, based on the list of alternatives answers provided. Scores will be given a value of 1 only if both the answers to every question are correct. If the answer to either or both of the tiers are incorrect, then no score or points will be given. Table 1 shows the range of scores of SRS test level, categorising them into three levels as suggested by Lawson.

Table 1 Scoring scheme for level of SRS Test

SRS Scores	Level of SRS
0 – 4	<i>Concrete</i>
5 – 8	<i>Transitional</i>
9 – 12	<i>Formal</i>

Students' scores that fall within the range of 0 – 4 on the test are categorised as *concrete* level while students' scores within the range of 5 – 8 are categorised as *transitional* level. Meanwhile, students' scores within the range of 9 – 12 are categorised as *formal* level. The LTSS was adapted from Teaching Styles Inventory to measure students' and teachers' perceptions on lecturers' teaching styles. The computed alpha reliability coefficients for both instruments, namely the SRST and LTSS, were 0.77 and 0.88 respectively. The descriptive statistics and the inferential statistics such as mean, t-test and Pearson correlation were used to analyze the data.

RESULT

The level of scientific reasoning skills (SRS)

Table 2 shows the overall level of scientific reasoning skills among the Arabic secondary school students. The findings of the study indicated that 83.3% of the students achieved Level 1 (concrete operational) of scientific reasoning skill, 16.7% achieved Level 2 (transitional operational) and none of students achieved Level 3

(formal operational). The overall mean level of the SR skills was 2.47 indicating that generally, the Arabic secondary schools' students were at the concrete operational level in term of scientific reasoning skills. Analysing by schools, students at SMAR achieved the highest SR skills of Level 2 (transitional operational) with a percentage of 40.0% and this is followed by students at SUAMPRIPAHS and MIB with an equal percentage of 5.0%. The highest mean of scientific reasoning skills was achieved by students of SMAR (3.45), followed by the students of SUAMPRIPAHS students (2.55), and students of MIB (1.40).

Table 2 The Overall Level of SR Skills (SRS) among Arabic Secondary School students

School	N	Level SR Skills (%)			Mean SRS
		1	2	3	
SUAMPRIPAHS	20	19 (95.0%)	1 (5.0%)	0 (0.0%)	2.55
MIB	20	19 (95.0%)	1 (5.0%)	0 (0.0%)	1.40
SMAR	20	12 (60.0%)	8 (40.0%)	0	3.45
TOTAL	60	50 (83.3%)	10 (16.7%)	0	2.47

The Pattern of Scientific Reasoning Skills

The 12 two-tier questions of SRS are related to conservation of Mass and Volume (Q1-Q4), Proportional Reasoning (Q5-Q8), Identification and Control of Variables (Q9-Q12), Probability Reasoning (Q13-Q18), Correlation Reasoning (Q19-Q20), and Hypothetical-deductive Reasoning (Q21-Q24). Table 3 shows that scores obtained by the students for the 12 two-tier questions on SRS. 68.3% students correctly answered the questions related to conservation of Mass while 30% correctly answered the questions for the conservation of Volume. The percentages of students answered correctly for other scientific reasoning skills considered to be higher order thinking skills (HOTS) are 13.3% for proportional reasoning, 13.3% for correlation reasoning, 17.5% for identification of variables, 16.7% for probability reasoning, and 9.2% for hypothetical-deductive reasoning. This indicated that the Arabic secondary school students were not competent in theory and giving reasons to the questions related to higher order thinking (HOT).

Table 3 SRS Pattern Among Arabic Secondary Schools in Brunei Darussalam

Scientific Reasoning Skills	Two-Tier Question		No. of Students score 1 mark	Percentage Correct
Conservation of Mass	1	2	41	68.3%
Conservation of Volume	3	3	18	30.0%
Proportional Reasoning	5	6	8	13.3%
Advance Proportional Reasoning	7	8	8	
Identification and Control of Variables	9	10	20	17.5%
Identification and Control of Variables	11	12	1	
Probability Reasoning	13	14	4	16.7%
Probability Reasoning	15	16	13	
Advance Probability Reasoning	17	18	13	
Correlation Reasoning	19	20	8	13.3%
Hypothetical-deductive Reasoning	21	22	5	9.2%
Hypothetical-deductive Reasoning	23	24	6	

Dominant teachers' teaching style

Table 4 presents the overall students' perception on teachers' teaching styles. In general, the Expert and Delegator were the two dominant teachers' teaching

styles according to students' perception with 46 (76.7%) and 41 (68.3%) of the students, respectively, rated at the highest score level. However, the Personal Model teaching style was the lowest with 16 (26.6%) students rated it at the highest score level.

Table 4 Overall students' Perception on Teachers' Teaching Styles

Teachers' Teaching Styles	N	Level (%)		
		Low	Medium	High
Expert	60	3 (5.0%)	11 (18.3%)	46 (76.7%)
Formal Authority	60	6 (10.0%)	36 (60.0%)	18 (30.0%)
Personal Model	60	16 (26.6%)	28 (46.8%)	16 (26.6%)
Facilitator	60	12 (20.0%)	23 (38.3%)	25 (41.7%)
Delegator	60	0 (0.0%)	19 (31.7%)	41 (68.3%)

Table 5 summarises students' perceptions on their teachers' teaching style by the Arabic secondary schools. All three Arabic secondary schools students ranked Expert as the dominant teaching styles, with, in descending order, SUMPRIPAHS (mean=4.05), MIB (mean=3.86) and SMAR (mean=3.38). This is followed by Delegator as the second dominant teaching style with, in descending order, MIB (mean=3.74), SUMPRIPAHS (mean=3.33) and SMAR (mean=2.8). Other teaching styles were rated or ranked by the students as medium.

Table 5 Students' Perception on Teachers' Teaching Styles among Arabic Secondary Schools

School	No. Students	Mean perception on Teachers' Teaching Styles				
		Expert	Formal Authority	Personal Model	Facilitator	Delegator
SUMPRIPAHS	20	4.05	3.66	3.86	3.86	3.33
SMAR	20	3.38	3.36	2.82	2.82	2.80
MIB	20	4.15	3.88	4.08	4.08	3.74
Overall	60	3.86	3.63	3.59	3.59	3.29
Categories		High	Medium	Medium	Medium	High

Mapping the level of SR skills into instructional methodologies.

Table 6 depicts the comparison among Arabic secondary schools which revealed that there was no correlation between the SR skills and the teachers' teaching style among the Arabic secondary schools that were investigated. Only for SMAR and MIB, there were negatively weak relationship between the two variables where the dominant teachers' teaching styles for SMAR were that of the Expert and Delegator with $r = -0.04$, and $r = -0.007$ respectively. Meanwhile, the dominant teachers' teaching style for MIB was that of the Delegator with $r = -0.004$.

Table 6 Correlation between students' perceptions toward teachers' teaching styles

School	No. Students	SRS	Students Perseptation Toward Teachers' Teaching Styles				
			Expert	Formal Authority	Personel Model	Facilitator	Delegator
SUAMPRIPAHS	20	3.69	-.112	-.080	-.060	-.062	-.150*
SMAR	20	4.37	-.004	-.085	-.019	-.028	-0.007
MIB	20	3.10	-.022	.041	-.013	.149	-.004

DISCUSSION

Scientific Reasoning Skills

The finding on the levels of scientific reasoning skills among the 10th grade (16 - 17 years) students of the Arabic Secondary Schools in Brunei Darussalam indicates an overall achievement of mean 2.47. This finding parallels the findings obtained from the study of Maria Abdullah and Kamisah Osman [2] on Scientific Inventive Thinking Skills among primary students in Brunei where the overall mean of higher order thinking and sound reasoning among students aged between 13 and 14 years (Form 1 and Form 2) is 2.15, which has been interpreted as low level. According to Maria Abdullah and Kamisah Osman [2], higher order thinking and sound reasoning refers to “the cognitive processes of analysis, comparison, inference and interpretation, evaluation and synthesis applied to a range of academic domains and problems solving contexts”.

According to Piaget's cognitive development theory [3], the cognitive development of 16-year-old students is at the formal operational level. Additionally, Piaget [3] contended that secondary school students aged 16 and above should have mastered the concepts related to conservation of mass, and conservation of quantity and volume. These conservation concepts are important principles and are prerequisites to rational thinking. Thus, the Scientific Reasoning Skills Test aims to gauge students' abilities of abstract thinking by thinking about conservation of mass and volume, proportional reasoning and probability reasoning when solving scientific problems and hypothetical-deductive reasoning which are high-level thinking.

The results from the Scientific Reasoning Skills Test of Year 10 (16 - 17 years old) students in the Arabic secondary schools indicated that they only mastered the conservation of mass in which 68.3% of the students correctly answered the related two-tier questions. However, the percentages of students correctly answered the two-tier questions on conservation of volume, proportional reasoning, identification and control of variables, probability reasoning, correlation reasoning, and hypothetical-deductive reasoning are 30%, 13.3%, 17.5%, 16.7%, 13%, and 9.2% respectively. The results demonstrate the weaknesses of students in Arabic secondary schools in abstract thinking, solving more complex problems and also in thinking in deductive or inductive fashion while solving a problem.

According to Lawson [4] and Melissa [5], the ability to think hypothetical-deductively indicates a higher level of scientific reasoning skills. Students with a higher level of scientific reasoning skills often practice reflective thinking, whereby they make assumptions through the knowledge they have acquired. The scientific reasoning skills require the ability to operate at Level 3 (i.e., formal operations). The study by Keating [6] found that high-performing students have better formal reasoning capabilities as compared to moderate- and low-achieving students. This shows that the inability of students to reason may cause the students to experience difficulties

in the academic field. Hence, the ability of formal operation reasoning is a key determinant to the success of students in acquiring knowledge.

Teachers' Teaching Styles at Secondary Schools

In general, the two dominant teaching styles of teachers in Brunei Darussalam Arabic secondary schools, according to students' perceptions, are the Expert and Delegator's teaching style with 84.0% and 87.5% respectively at high-level rating based on the scoring by Grasha and Riechmann-Hruska [7]. On the basis of the teachers' own perceptions, their dominant teaching styles are those of the Experts, Facilitators and Delegators with the means of 4.09, 3.92 and 3.70 respectively. This indicates that what the students perceived about their teachers' teaching style is not much different from their own teachers' views.

Accordingly, based on the students' and teachers' perceptions, the identified teaching styles can be categorized into two approaches namely teacher-centered approach and student-centered approach. Expert teaching style is teacher-centered while the Facilitator and Delegator teaching styles are student-centered. According to teachers' perceptions, their Facilitator and Delegator teaching styles are mainly student-centred approach. Such a student-centred teaching style gives students the opportunity to explore information independently, promote hands-on learning, and inculcate autonomy in the learning process. While these two styles of teaching were supposed to produce students who are capable of thinking, the reality was quite different where the findings indicated that more than 80% of the Year 10 students at the Arabic secondary schools are operating at the level of concrete reasoning, which is deemed low. Furthermore, the teaching style of the secondary schools teachers does not have a significant relationship with the level of scientific reasoning of the Year 10 students at the Arabic secondary schools. As such, it is likely that these Arabic secondary school teachers, in reality, implemented teacher-centered teaching. They practiced the Expert teaching styles, whereby students only received knowledge from teachers who were considered as the source of knowledge.

Students in this study believe that the majority of their teachers are concerned about the mastery of facts, concepts and principles in teaching. In fact, they also think that their teachers have extensive and profound knowledge, skills, and focus on information transmission. In addition, their teachers also act as resource persons when needed. Similarly with teachers, they are convinced that their students are able to perform tasks with minimal guidance. In addition to the above features, the teachers perceived that they also use the facilitator's teaching style which emphasizes on interaction in teaching.

According to McChlery, Visser, and Vreken [8], the mismatch of teaching styles and student learning styles can lead to failure in student programs, student outcomes and poor performance. As such, every teacher needs to know which teaching style they often use to their

students. The teaching style is a combination of teaching methods and techniques where a teacher or lecturer likes to use it while teaching. Among the good teaching principles, including promoting the relationship between student-educators (teachers) and collaborating and respecting diverse student learning styles [9].

Grasha [7] has combined the five teaching styles into four clusters, for example, by adopting a combination of two or three teaching styles and is used effectively to improve student thinking skills. According to Grasha [7], it is difficult for teachers or lecturers to change existing teaching styles, especially from the teacher-centered teaching styles to that of the student-centered teaching styles.

Mapping of Teachers' Teaching Style and Students' Level of Scientific Reasoning Skills

The findings of the study on the mapping of dominant teaching styles of the teachers to the levels of the Scientific Reasoning Skills among Year 10 (16 years) students at the Arabic secondary schools in Brunei Darussalam indicated no significant correlation between the two variables. Many studies show that inquiry teaching is an effective method of constructivist teaching that enhances conceptual understanding and develops scientific reasoning skills as compared to the traditional lecture-based teaching [10] - [13]. Strong relationships between specific teaching styles and the level of scientific reasoning skills can provide educators with information on the importance of translating specific teaching styles into teaching methods that are widely associated with higher level of reasoning skill. The findings of this study did not show a positive outcome where it is undeniable that the teaching style has contributed or can be mapped to a high level of science process skills. However, this study indicates that the styles of the Experts and Delegates practiced by most Arabic secondary school teachers did not contribute to the development of scientific reasoning skills among students. This study opens up opportunities for other researchers to explore the standard of teaching of teachers who are seen to be able to develop the level of scientific reasoning skills among secondary school students who should have reached the level of the cognitive developmental stage of formal operation. High-level thinking skills should be mastered by students so that they are able to sail through the challenging 21st century.

CONCLUSION

As a conclusion, the findings of this study can be used as a baseline for the levels of scientific reasoning skills at the secondary school level in Brunei Darussalam. This study also opens an endless source for other researchers to investigate more extensively on the scientific reasoning skills so that the potential instructional model can be developed to enhance students' level of scientific reasoning skills in secondary

school and also in the Public Institutes of Higher Learning in Brunei Darussalam.

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