Abstract:

Our current 21st century workplace requires workers to master the skills that are essential in a knowledge-based society as well as the new skills necessary to move beyond the information age into the conceptual age. Therefore, in order to succeed in this present economic scenario, students need to be equipped with digital age proficiencies. Analysis of current literature on this issue revealed that elements of the 21st century learning outcomes are the skills, knowledge and expertise students should master to succeed in work and later in life within the compound of the 21st century environment. As a social agent, educational systems of every nation need to transform their objectives, curriculum, pedagogies, and as well as assessments to help the younger generation achieve the outcomes required for a prosperous, attractive lifestyle based on effective contributions in work and citizenship. Essentially, the main purposes of this study are to profile the inventive thinking skills among primary school students in Malaysia and Brunei and to compare the inventive thinking skills among the students with regards to gender. The dimension of inventive thinking skills comprised of adaptability and managing complexity, self direction, curiosity, creativity, risk taking and higher order thinking and sound reasoning. This study, which employed cross sectional survey method, involved 1037 Primary school students from both countries. The results of the findings revealed that there are statistically significant differences in student’s inventive thinking skills from both countries in term of gender.

Keywords: Inventive thinking skills ; 21st century ; primary school

1. Introduction

The 21st century youths requires many sets of special skills in order to succeed in work and life. Therefore, educational systems must transform their objectives, curriculum, pedagogies, and assessments to help all students achieve the outcomes required for a prosperous, attractive lifestyle based on effective contributions in work and citizenship. In the early 21st century, income and wealth comes from applying technology and new ideas to create new products and processes. Adding value to products and processes is the key to growing jobs opportunities and incomes in this new economic environment (Aubert & Reiffers, 2004). Stevens & Weale (2003) stressed that in this new economic environment known as the New Economy, education plays an important role in maintaining national prosperity and stimulating economic growth. Markets in the New Economy are rewarding those who have high educational achievement and technical skill (Task Force on the Future of American Innovation, 2005). As a result, the workforce of the 21st century must have science and mathematics skills, creativity, fluency in information and communication technologies, and the ability to solve complex problems (Business-Higher Education Forum, 2005). Therefore, to accomplish this we must transform children’s learning processes and engage student’s interest in gaining 21st century skills and knowledge. Linking economic development, educational evolution, workforce
development, and strengthened social services is essential to meeting this challenge (National Academy of Science, 2006).

The main objective of this paper is to determine the inventive thinking skills of Science students in Malaysia and Brunei with regards to gender. It is hoped that this study will contribute to knowledge of Science students’ performance in inventive thinking skills. In addition, this study will also be able to provide the relevant authorities such as Malaysia and Brunei’s Ministry of Education with information regarding the students’ achievements and their level of inventive thinking skills in Science subject. It is anticipated that these findings will provide a framework for the development of policy for pedagogical methodology and curriculum innovation for schools in Brunei and Malaysia. But what are 21st century skills and why are they important to our education and the students?

2. Panorama of Science Education in Malaysia and Brunei

2.1 Science Education in Malaysia

As stated in the National Education Policy, education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner as to produce individuals who are intellectually, spiritual, emotionally and physically balanced. Such effort is designed to produce Malaysian citizens who are knowledgeable and competent, who posses high moral standards, responsible and capable of achieving a high level of personal well being as well as being able to contribute to the betterment of their family, society and the nation at large. Therefore, Malaysia needs to cultivate a society that is scientifically oriented, progressive, knowledgeable, possess a high capacity for change, forward looking, innovative and a contributor to scientific and technological developments of the future. In line with this, there is also a need to produce citizens who are creative, critical, inquisitive, open-minded and competent in Science and Technology. This National Education Policy is in line with Malaysia’s vision to become a developed nation by the year 2020. The Vision calls for a sustained, productivity driven growth that will be achieved only with a scientifically and technologically literate, critical thinking workforce prepared to participate fully in the global economy for the 21st Century. The National Science Education Philosophy stated “Under the National Education Philosophy, science education in Malaysia nurtures a scientific and technological culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency”. With this philosophy, science education in primary schools is aimed to provide opportunities for students to learn about themselves and the environment through everyday experiences and scientific investigations, to acquire knowledge and skills in science and technology, to apply these knowledge and skills based on scientific attitudes and noble values thus make decisions and solve problems in everyday life. Therefore, the learning process must emphasize on activities which stimulate thinking and encourage the learning of scientific concepts and its application. Various learning approaches such as inquiry, contextual learning, constructivism, mastery learning, meaningful learning and STS (science, technology and society) are applied in the classroom. Scientific skills which comprised of science process and manipulative skills are also stressed in the learning activities. This is a skill which promotes thinking in a critical, creative, analytical and systematic manner. Thus the mastering of science process skills together with scientific attitudes and approaches are vital to ensure students’ ability to think effectively.

2.2 Science Education in Brunei Darussalam

Science subject is a core subject for upper primary schools in Brunei Darussalam since 1982. In 2000, the syllabus was revised and now replaced by a new Upper Primary Science Curriculum. The learning process emphasised more on the development of communication through enquiry, conceptualising, reasoning, and problem solving skills. Traditionally, the mode of instruction emphasized the teacher as a transmitter of specialised information, but with the new syllabus, the teacher act as a facilitator using a variety of instructional techniques. Furthermore, process skills such as analysing, classifying, communicating, comparing, evaluating, inferring, measuring, and observing were taught through the activities carried out in the class and various projects done in the schools. Yet, previous research revealed that students in Brunei had low ability in problem solving and critical thinking skills.
As result of that, Brunei’s Ministry of Education introduced the Strategic Plan 2007-2011. This signals the ministry’s intentions to reform and upgrade Brunei Darussalam’s education system and its achievements in education. The Ministry of Education’s commitment towards excellence in education, as reflected in its vision and mission statements is seen as imperative in view of the current climate of rapid change and increasing competition in the educational environment. Critical and fundamental changes to the education system have been introduced through a newly proposed system known as the National Education System for the 21st century or (SPN 21) Sistem Pendidikan Negara Abad. In line with this aspiration, the SPN 21 curricular documents were aimed at meeting the goals of the Ministry of Education’s Strategic Plan on Quality Education. Existing curricular programmes have been restructured to bring them in line with 21st century needs and skills. The SPN 21 curriculum sets out to provide a holistic education to produce well rounded individuals. The national education system of Brunei Darussalam (SPN 21) is aimed at maximising the intellectual, spiritual, emotional, social and physical potential of every individual. This can be achieved by developing thinking skills and equipping learners with life-long learning skills necessary in an ever-changing world. The emphasis of developing thinking skills amongst our youth was pointed out by His Majesty The Sultan during the Teacher’s Day celebration in 2007. In relation to that, thinking skills is one of the essential skills highlighted in the new National Education System for the 21st century or Sistem Pendidikan Negara Abad Ke-21 (SPN 21). It is to be made explicit in the teaching and learning for all levels of schooling, either at primary or secondary level. The emphasis of thinking skills in teaching and learning would lead to a change in the teaching pedagogy.

Thinking skills is not a new aspect in the teaching-learning process. However, it is not explicitly taught to the learners. Studies indicated that mere exposure to tasks that require thinking does not on its own have a significant impact on learners’ thinking abilities (Beyer, 2000; Swartz, 2000). Those skills need to be taught explicitly through modelling, guided practice and training. Therefore, the Ministry of Education in Brunei hopes that by implementing the SPN 21 it will improve students’ inventive thinking skills and their achievements in Science.

2.3 Inventive thinking skills in science

According to the enGauge (NCREL, 2003), inventive thinking skill is a crucial element in surviving and thriving in the 21st century. This skill includes six elements. The first element is the ability to adapt and manage complexity. This would enable the students to recognize and understand that change is constant, at the same time deal with change positively by modifying their thinking, attitude or behaviour to accommodate and handle new environment. The second element in inventive thinking skills is self direction which refers to students’ ability to set goals related to learning, plan for the achievement of those goals, independently manage time and effort, and independently assess the quality of learning and any products that results from the learning experience. The third element is curiosity. This refers to the students’ desire to learn more about something and is an essential component of lifelong learning. Fourth is creativity which is the act of bringing something into existence that is genuinely new and original, whether personally (original only to the individual) or culturally. This implies that students’ are able to produce something new or original that is either personally or culturally significant. The student’s willingness to think about a problem or challenge, to share that thinking with others and to listen to feedback is known risk taking. Risk taking is defined as a willingness to go beyond safety zone to make mistakes, to creatively tackle challenges or problems with the ultimate goal of enhancing personal accomplishment and growth. Finally, higher order thinking and sound reasoning refer to the cognitive processes of analysis, comparison, inference and interpretation, evaluation and synthesis applied to a range of academic domains and problem solving contexts. The students are able to compare analysis, make inference and interpretation, evaluate and solve problems in the tasks given to them and in their everyday life.

Inventive thinking skill is one of the important components of 21st century skills in enGauge 21st century skills. Consequently, 21st century education should equip students with this skill by moving from primarily measuring discrete knowledge to measuring students’ ability to think critically, examine problems, and gather information, collaboration communication, creativity and innovation required for success in their future.

3. Methodology
3.1 Research design and sample of the study

This study employed cross sectional survey method to determine the inventive thinking skills of students in Malaysia and Brunei within the context of science subject in schools. The survey focused on six elements of inventive thinking skills discussed earlier. 616 (273 male, 343 female) of Year 5 students in Malaysia and 421 (185 male, 236 female) of Year 5 in Brunei are involved in this study. The researcher employed stratified sampling to ensure equal distribution of sample according to gender.

3.2 Instrument of the study

The questionnaire was divided into seven sections. Section A consists of questions on student’s background and demographic namely, age, gender, level of class, race and student’s grade in Science. Section B consists of 34 items on inventive thinking skills which comprised of 5 items on adaptability and managing complexity, 4 items on self direction, 5 items on curiosity and creativity, 3 items on risk taking and 10 items on higher order thinking and sound reasoning. Next, Cronbach’s alpha coefficients were calculated to estimate the internal consistency of the instrument. The Values obtained for the various scales ranged from 0.58 to 0.73 (see Table 1). These values were comparable to data reported in the literature (Francis & Greer 1999, Fraser 1989, Jegede & Fraser 1989). Fraser (1989) stated that the alpha coefficients in the range of 0.58 to 0.81 indicate the instrument has satisfactory reliability. Therefore, the values of the alpha coefficients suggested the instrument displayed adequate internal consistency.

| Dimension                              | No. items | Cronbach’s Alpha |
|----------------------------------------|-----------|------------------|
| Adaptability and managing complexity   | 5         | 0.58             |
| Self direction                         | 4         | 0.61             |
| Risk taking                            | 3         | 0.59             |
| Curiosity                              | 5         | 0.70             |
| Creativity                             | 6         | 0.69             |
| Higher order thinking and sound reasoning | 10       | 0.73             |

4. Findings and Discussion

The findings of the study indicated several outcomes as presented in Table 2. A two-way between group’s analysis of variance was conducted to explore the differences in the inventive thinking skills of students in Malaysia and Brunei. The result of analysis revealed that there are significant differences on adaptability and managing complexity, self direction, curiosity and creativity between Malaysian students and their Bruneian counterpart.

| Dependent variable          | Source    | Type III Sum of Squares | df | Mean Square | F     | Sig.  |
|-----------------------------|-----------|-------------------------|----|-------------|-------|-------|
| Adaptability and Managing Complexity | Country   | 5.227                   | 1  | 5.227       | 18.660| 0.000 |
|                             | Gender    | 1.260                   | 1  | 1.260       | 4.499 | 0.034 |
| Self Direction              | Country   | 4.063                   | 1  | 4.063       | 13.491| 0.000 |
### Table 1: Inventive Thinking Skills

|                           | Gender | Country | Gender |
|---------------------------|--------|---------|--------|
| Risk Taking               | 0.021  | 1       | 0.021  |
|                           | 0.098  | 1       | 0.098  |
|                           | 3.040  | 1       | 3.040  |
|                           | 0.071  | 1       | 0.071  |
|                           | 0.790  | 1       | 0.790  |
| Curiosity                 | 0.098  | 1       | 0.098  |
|                           | 0.098  | 1       | 0.098  |
|                           | 0.209  | 1       | 0.209  |
|                           | 0.648  | 1       | 0.648  |
|                           | 3.040  | 1       | 3.040  |
|                           | 6.493  | 1       | 6.493  |
|                           | 0.011  | 1       | 0.011  |
| Creativity                | 4536.100 | 1   | 4536.100 |
|                           | 4536.100 | 1   | 4536.100 |
|                           | 9.683  | 1       | 9.683  |
|                           | 0.002  | 1       | 0.002  |
|                           | 1863.456 | 1   | 1863.456 |
|                           | 1863.456 | 1   | 1863.456 |
|                           | 3.978  | 1       | 3.978  |
|                           | 0.046  | 1       | 0.046  |
| Higher order thinking and sound reasoning | 5192.527 | 1 | 5192.527 |
|                           | 5192.527 | 1   | 5192.527 |
|                           | 11.872 | 1       | 11.872 |
|                           | 0.001  | 1       | 0.001  |
|                           | 980    | 1       | 0.980  |
|                           | 602.667 | 1 | 602.667 |
|                           | 602.667 | 1 | 602.667 |
|                           | 1.731  | 1       | 1.731  |
|                           | 0.189  | 1       | 0.189  |
|                           | 385.903 | 1 | 385.903 |
|                           | 385.903 | 1 | 385.903 |
|                           | 1.108  | 1       | 1.108  |
|                           | 0.293  | 1       | 0.293  |

The findings also affirmed that there are significant differences on adaptability and managing complexity with $F(1,1033)=18.660$ and significant at $0.000 (p<0.05)$, and self direction with $F(1,1033)=13.491$ and significant at $0.000 (p<0.05)$. There is also a significant difference on curiosity between Malaysia and Brunei students with $F(1,1033)=9.683$ and significant at $0.002 (p<0.05)$. Furthermore, the differences on creativity is also significant at $0.001 (p<0.05)$. The curiosity level of students in Brunei is higher than students in Malaysia. However, the result of the findings also confirmed that there is no significant differences on risk taking $F(1, 1033) = 0.209, p = 0.648$ and higher order thinking and sound reasoning $F(1,1033)=1.731, p = 0.189$ in inventive thinking skills among students of both country.

In addition, results of the findings also revealed that there are statistically significant difference on adaptability and managing complexity $F(1,1033)=4.499, p = 0.034$, risk taking $F(1,1033)=4.499, p = 0.034$ and curiosity $F(1,1033)=3.978, p = 0.046$ between male and female students from both countries. Female students performed higher at risk taking and curiosity compared to male students. However, male students performed better at adaptability and managing complexity than female students. There are no significant differences on self direction $F(1,1033)=0.071, p = 0.790$, creativity $F(1,1033)=0.001, p = 0.980$ and higher order thinking and sound reasoning $F(1,1033)=1.108, p = 0.293$. Progress in International Reading literacy study of 2001 revealed that fourth grade females scored higher than fourth grades males in 33 countries worldwide (Mullis, Martin, Gonzales & Kennedy, 2003; Ogle et al, 2003). Several researchers such as Campbell, Hombo & Mazzeo (2001), Marx and Roman (2002), and Hargreaves (2005) support this argument. However, Halpern et al (2007) argued that biological factors, students’ attitudes, motivation, educational history on students’ conceptual learning, educational policy and cultural context affect the number of women and men who pursue advanced study in Science.

### 5. Conclusion

This study was aimed at determining the differences of inventive thinking skills in science subject between students in Brunei and Malaysia with regards to gender. The results of the findings affirmed that there are significant differences in inventive thinking skills between students in Malaysia and Brunei. Furthermore, there are also statistically significant difference between the two genders in term of adaptability and managing complexity, risk taking and curiosity between students from both countries. Since inventive thinking skill is one of the most important components of 21st century skills, students need to apply inventive thinking skills as well as develop new skills to cope and thrive in an ever-changing society. Therefore, education today should equip students with those skills since education plays a vital role in maintaining national prosperity and stimulating economic growth. The New Economy is driven by entrepreneurs, technology, and innovation and they reward those who possess excellent
educational achievement and technical skills (Task Force on the Future of American Innovation, 2005). As a result, the employee of the 21st century must have science and mathematics skills, creativity, expertise in information and communication technologies, and the ability to solve complex problems (Business-Higher Education Forum, 2005). To accomplish this we must ensure students are equipped with those skills and encourage them to continuously acquire new skills and knowledge in order to stay relevant in the workforce.

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