International Journal of the Physical Sciences Vol. 5(13), pp. 2075-2083, 18 October, 2010
Available online at http://www.academicjournals.org/IJPS
ISSN 1992 - 1950 ©2010 Academic Journals

Full Length Research Paper

Development and validation of measuring instruments of contextualization of science among Malaysian and Nigerian serving and pre-service chemistry teachers

Kunle Oke Oloruntegbe, Sharifah Norul Akmar Syed Zamri, Rohaida Mohd Saat and Gazi and Mahabubul Alam*

Faculty of Education, University of Malaya, Kuala Lumpur, Malaysia.

Accepted 14 September, 2010

The purpose of this study is to develop and validate instrument for assessing Malaysian and Nigerian serving and pre-service chemistry teachers' contextualization of science knowledge, skills and attitudes and their application outside classroom. Forty item test and twenty item inventory were initially developed. A panel of experts was used for content validity. Readability of the instrument was determined using a sample of 25. Data on pilot study were collected from administration of the instrument on further 85 subjects. The data were used to determine internal consistency and reliability of the instruments. Twenty five items of the test and the entire ones of the inventory were left after these determinations. The results indicated that the instrument possesses high internal consistency and coefficient values, and that it is adjudged significantly suitable for the purpose and other researchers would find the instrument very useful.

Key words: Measuring instrument, development and validation, contextualization of science.

INTRODUCTION

That the world is experiencing unprecedented growth and advancement in science and technology is obvious. We have various evidences of the growth and advancement all around us. The world stands to benefit more with the efforts being put in place by our scientists and technologists (Alam et al., 2009). Yet, there are numerous problems staring the world glaringly in the face to which the scientists and technologists seem unable to proffer solutions. Talk about the economic downturn, the diseases ravaging the entire human race and the fluctuations of global climates resulting in disasters in some parts of the world. The list of inabilities is as long as that of abilities of scientists and technologists in making life worth living on the earth (Hashim et al., 2010).

The inabilities mentioned above might not be unconnected with the ways the young people of today conceptualize science knowledge, skills and attitudes in solving problems of daily living and in decision making. The situation may not be that different with the teachers who teach in our secondary schools too. Studies are constantly reminding us that these young ones are no longer interested in science (Djallo, 2004; Sjoberg, 2005), particularly in developing countries (Orlando, 2004). As in Malaysia, there are only 43.9% of undergraduate students taking science and technical studies in both public and private high institutions (Ministry of Higher Learning, 2009). Internationally there are serious concerns with the state of chemistry education (Gilbert et al., 2002). Specifically, enrolments in the subject, which is one of the enabled sciences, are in decline in the upper class with serious implications for social and economic development (Watters, 2004). Hardworking scientists are no longer role models but football players, film stars and pop artists (Orlando, 2004). The image of a conscientious and diligent scientist of the past is gradually becoming a stuff of history (Sjoberg, 2001). The eagerness to use new technology is not matched with eagerness to study the disciplines that underlie them (Sjoberg, 2005). Of

*Corresponding author. E-mail: gazi.alam@um.edu.my, gazimalamb@yahoo.com. Tel: + 603-7967 5077. Fax: + 603-7967 5010.

more grave concern too is the absence of the virtues and ethics of science and technology in the lives of graduates from our schools (Connect, 2004). Of late Sergeant (2010) sounded an alarm that eight millions adult in United Kingdom alone are “economically inactive” and that the schools are churning out unemployable graduates. Terry Leahy cited in the same paper (Sergeant, 2010) puts it bluntly that “Too many children in United Kingdom have been leaving school after 11 or 13 years of compulsory education “without the basic skills to get on in life and hold down a job”. He said five million adults were functionally illiterate and seventeen millions others could not add up properly. “On-the-job training” cannot act as a “bandage or sticking plaster” for “the failure of our education system”. The above revelations point to the fact that the schools are not doing enough and have not come to term with the reality of the ever changing and growing global market economy.

The situation pictured above is not helped by the way science is being delivered in the schools. The development of scientific ways of thinking is abandoned in favour of the learning of definitions and standard procedures (O’Connor, 2003). Ezike (1985), Gallagher et al. (1998) and Zoller (1993) observed that eighty five percents of teachers’ questions and methods do not provoke high-order thinking but recall or simple comprehension of materials of learning. As a result students tend to perceive science as a dull subject, hence they are disenchanted. Kracjik et al. (2001), Osborne and Collins (2001), Sjoberg (2001) and Holbrook (2009) declared that students see chemistry teaching as unpopular because there is a gap between their wishes and teachers’ teaching (Yager and Weld, 2000; Holbrook and Rannikmae, 1999). The situation is not changing because teachers are afraid of change themselves and need guidance (Alkenhead, 1997; Bell, 1998; Rannikmae, 2001).

Issues for research

All these have provoked a barrage of questions. What is the purpose of science we teach in schools? How relevant is it to the students’ daily lives? How much of an influence does science have on the daily lives of people in our society? Are we giving students tools to make responsible decisions in future? Are we emphasizing there is a link between decision making and science?

None of these questions will be answered here because they have long been the focus of many studies (Watters, 2004; Sjoberg, 2001, 2005; Sjoberg and Schrener, 2004). But the main concern of this study is with the present crop of science teachers and the ones undergoing training in our colleges and universities. How are they conceptualizing science knowledge, skills and attitudes that they themselves are imparting to the students? Can we see science they teach in the teachers’ own lives? If the teachers who are saddled with the duty of science delivery in schools can not contextualize science in their real-world life, definitely there are not likely able to help the young ones to see and use science they study in school in their own daily lives (Alam, 2009). The band wagon effect is that the students will get disenchanted and defect from science disciplines to the social sciences, a place that Djallo (2004) described as a shelter for dropouts from science. Assessing the teachers with the intentions of finding solutions to remedy this downward trend and bridging the gap prompted this study

Aim of the study

There have been calls by Malaysian government to its people to imbibe sound ethics and attitudinal change in daily lives, particularly in workplace. Many times the teachers particularly science ones are blamed for not doing enough. The shortcomings that provoke these calls are evident in Nigeria and many other developing and even developed nations. So a comparative evaluation study of conceptualization of science among teachers of these two nations is conceived by this study. The teachers being the major determinants of success and lack of it at the foundational levels of science teaching need to be evaluated. To carry out such evaluation the researchers need measuring instruments in the cultural contexts in which the teachers operate. The purpose of this study therefore, is to develop and validate instruments for contextualizing of science among university graduates particularly secondary school serving and pre-service chemistry teachers.

Reason for decline in science enrolment

Some of the problems identified as common in both secondary and higher science education include lack of laboratory space, lack of funding, and inexperienced and fewer qualified teachers with poor salaries and lack of motivation. Beside these, Oloruntegbe and Ikpe (2010) and Oloruntegbe et al. (2010) reported that science curricula in many nations are not only discipline-specific but also examination-driven. This explains the tendencies by teachers to drive the students along to cover the overburdened syllabus at the expense of an in-depth understanding expedient in development of skills, scientific mindedness and the capacity to use science in solving real-life problems. There are fewer science-based jobs in many countries. The IT boom seems to be over (Alam, 2009). Most industries in the country do not have Research and Development (R&D) facilities. Science education is regarded as difficult and only attracts top students in schools and colleges. Science education is made more difficult by poor and unattractive teaching and too much unnecessary workload with poor or no facilities.

Even students with strong skills in physics, chemistry, and mathematics are opting for business studies. For instance in Bangladesh, in a typical private university, more than 50% of the students are enrolled in BBA studies because it is easier to get good grades and then good jobs (Alam, 2009b).

With the introduction of grading systems, students are more interested in ensuring the highest grades. This is discouraging students from attaining skills in mathematics and other science subjects. We need to write good science books. Salary and other benefits of teachers should be given due consideration. Commitment of the government to create a science and technology-driven economy to face challenges of the 21st century is important. We can organize competitive events to popularize science among children. Olympiad-type events do not require huge funds. One important way for students to find joy in science is through commonplace scientific experiments. By directly observing cause and effect students internalize knowledge. However, experiments are not emphasized in schools and colleges, partially due to insufficient funds for purchase of scientific instruments and constructing laboratories. It is true that equipping every school laboratory with imported scientific instruments and consumables is a significant investment; scientific instruments from indigenous materials may be used as an alternative.

Promoting science and motivating students in the 21st century

Many countries in around the world struggle to overcome the falling interest in university science studies. Bringing researchers into secondary schools motivates students by providing them with role models and a genuine picture of research. For example, communicating ideas and results at conferences is an essential part of scientific research – but one that is habitually overlooked when explaining to students what research actually involves.

When science is taught out of context and seems irrelevant to their lives, many students lose interest. And if a student's own motivation is disregarded, even the most careful preparation on the part of the teacher will be wasted. It is crucial, therefore, to highlight the importance of science and its relevance to students' lives. Students also need more positive and realistic demonstrations of the scope and limitations of science and scientists. Both of these challenges can be addressed by mobilising the scientific and engineering research community. However, even though more young people are entering higher education fewer students are choosing mathematics, physics and chemistry (HESA, 2005), resulting in a skills shortage. The key to reversing this trend is to inspire and enthuse young people in science and engineering throughout their school education. Mathematics and the physical sciences, however, lack positive role models and effective careers advice for aspiring students (Roberts, 2002; Rasekoala, 2001). A survey of 50 schools across the UK showed that although most students enjoyed learning science at school, few wanted to study science after school (Bevins et al., 2005). Physics in particular was seen as complex and difficult.

Students recognised that access to practising scientists and engineers would increase their interest and enthusiasm, as well as provide valuable information on careers and studies. They also felt that an expert in the classroom would help to put the subject into context and make classroom activities more exciting. Students also suggested that school visits by professionals and to their workplaces would help them to learn about and understand specific professions.

METHODOLOGY

An examination of the literature indicated that different types of instruments have been constructed and are in use. There are, for example, Test of Science Related Attitudes (Frazer, 1980), Test of Science Process Skills (TOSPS) (Oloruntegbe and Omoifo, 2000), Test your Scientific Literacy (TSL) (Carrier, 2001), Chemistry Attitudes and Experience Questionnaire (CAEQ) (Coll et al., 2002), Changes in Attitudes about Relevance of Science (CARS) (Siegel and Ranney, 2002) and several others. These are in addition to numerous tests of science knowledge particularly by examination bodies. A number of these instruments especially those measuring attitudes towards science or scientific attitudes have been criticized for construct validity. Though they are still being used in specified contexts.

No doubt science is a universal discipline. Application of the principles and methods of this discipline to solve problems peculiar to certain areas demands consideration of cultural milieu. Whereas many nations have many things in common, others have identifiable distinct culture and religions and how they get things done or get problems solved. These factors sometimes necessitate evolving curricular options and studies that serve dual functions of globalization and contextualization. Curriculum that prepares students not only for global market economy but equally for the purpose of helping them to solve daily life problems relating to their cultural environment tends to generate an unending reform. Constructing measuring instruments for contextualization science knowledge, skills and attitudes among their chemistry teachers bearing in mind these cultural resemblances is tried here. This study discusses the development and validation of the instrument.

The development

The theoretical framework for the development of instruments for the conceptualization of science knowledge, skills and attitudes is based on the theory of scientific literacy and the nature of science. First put forward by the National Research Council (1995) and the work of Murica (Murica, 2005), the theory as applied is illustrated in the Figure 1. The National Research Council (1995) as outlined in National Science Education Standards of 1996 stated that science content should embrace what students should know, understand, and be able to do in natural science. Murica (2005) extends this as a blend of three knowledge dimensions of the nature of science, interaction of science and the society and the enduring and importance of scientific terms and concepts. Knowledge of science will enable individual to use science as a tool for inquiry or

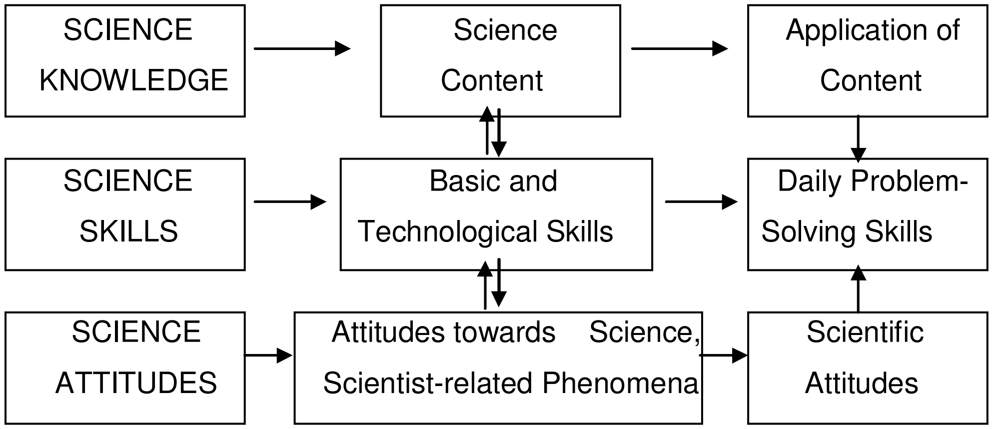

Figure 1. Conceptualization of science knowledge.

discovery, learning, informing and contributing to problem-solving activities and critically reflecting on the role of science in context. These dimensions are expanded in the model figure (Figure 1).

Forty item test covering three sections of science knowledge, knowledge application and skills application, and twenty item inventory on scientific attitude were constructed. The skill area included test on basic science processes, technological skills and daily problem solving skills. While the attitude dimensions sought responses on attitudes towards science and science-related activities and phenomena (n=10), as well as manifestation of appropriate scientific attitudes like honesty, objectivity, responsibility, suspended judgment and so on (n=10. The responses in this area were scored on 7 Point -Likert scale with positive statements earning +7 +6 +5 +4, +3, +2, +1 and negative items in the reversed order.

A mixed-methodology approach (Coll and Chapman, 2000; Coll et al., 2002) was employed in this development. This is a kind of trade-up or mid-way solution to the dilemma of choice making between depths of understanding provided by the use of purely qualitative instrument like observation and generalisability of quantitative treatment using tests, questionnaire and inventory. Testing for laboratory practical skills will involve observation and perhaps interview. This will undermine the generalisability of the study since only few samples could be covered. The researcher also considered the contextualization aspect of the study. To embark on observation in the name of depth of study is possible but might be extremely difficult to carry out in the two settings. Tests and inventory were developed here.

Validation

The researchers determined content, construct and concurrent validities, internal consistency as well as the reliability of the instruments. A "panel of expert's" technique was employed in establishing the content and construct validity. This involved subjecting the instrument to analysis by experts, three academics, in the field that the instrument examines – chemistry (Germann, 1988; Krynowsky, 1988; Coll et al., 2002), and three in tests and measurement. The content validity is to ensure that both the instrument measure not only the content of study but also the spread on science knowledge, knowledge application, skill application and attitudes. The expert read through the questions and the statements, and provided detailed feedback about items addressed in the tests and inventory. From this exercise seven of the forty items were dropped with a few modified. All items in the inventory were modified based on suggestions of the experts.

This was followed by checking the readability and comprehension of the instruments. Twenty five serving and pre-service teachers outside the study sample, but within the population of the study were used for this. Another sample of 85 was used for the pilot study. The total number of subjects involved in the validation and pilot study was 110. These were randomly selected from science education undergraduates in University of Malaya, Kuala Lumpur and serving teachers in the city secondary schools (n = 45 and 40 respectively for the pilot study). An English language expert was engaged who read through for language correction. The determination of concurrent validity was to see if the test would differentiate between serving and pre-service teachers.

RESULTS AND DISCUSSION

The results of data analyzed show that the serving teachers had higher scores on knowledge and skill application (Table 2). This difference might be due to experience since many of the serving teachers might have been coming across some situations calling for applications of what they had learned in school days years back. Data from the pilot study was used to determine the psychometric properties and coefficient of reliability of the instruments. The psychometric properties determined for internal consistency of the test include item difficulty and item discrimination indexes. The same data was also analyzed for reliability using Kuder Richardson formula- 20 and Crombach alpha for the tests and the inventory respectively.

The thirty three test items were analyzed for item difficulty and item discrimination. The following results were obtained. Twenty five items have both "moderate" difficulty index and between "fair" and "good" discriminating index, with the criteria set by Cueto et al. (2009). Scores on items that were left out were not used in arriving at Table 2. The reliability coefficient of the instrument yields 0.86 and 0.81 using KR-20 and

Table 1. Item difficulty and item discrimination of the test.

Section	Item difficulty	Item discrimination	Judgment
A. Content-related = 10	50 - 78% = 10	0.25 - 0.35 = 8	Suitable = 8
B. Application- related = 12	51 - 74 % =10	0.23 - 0.36 = 9	Suitable = 9
C. Skill-related = 10	46 - 76?% = 8	0.25 - 0.36 = 8	Suitable = 8
	Moderate	Fair to Good	No = 25

Table 2. Calculated means on sections of serving and pre-service chemistry teachers.

Sections	Mean of serving Chemistry teachers			Mean of Chemistry (Pre-service teachers)		
	Mean	SD	n	Mean	SD	n
Chemistry knowledge	5. 43	1.46	40	5.62	1. 24	45
Knowledge application	5. 55	1.22	40	4.67	1.13	45
Skill application	6 03	1.43	40	5.20	1.24	45

Scores on content - not significant while those on applications are significant at P< 0.01.

Cronbach's Alpha respectively (See sample items and data in the appendix). The validation data on Table 1 was based on Cuato et al. (2009) suggesting that items with values below 25% as extremely difficult, those between 25 and 44 as difficult, between 45 and 54 as moderate, between 55 and 74 as easy and above 75 as extremely easy. On the other hand, the discrimination power of items is categorized by Cuato et al. (2009) as follows: extremely high (0.40 – 1), high (0.30 - 0.39), moderate (0.20 - 0.29), low (0 - 0.9) and to discard (<0). These were reflected on Table 1. Efforts were made by the authors to adhere strictly to the use of these criteria which are also contained in other books on test and measurement. The data on Table 2 was meant to show the characteristic behaviour of both subjects, pre-service and serving teachers on the test and inventory. The variations noticed in the mean scores might reflect or predict observations with larger sample as obtained by Coll et al. (2002).

Conclusion

The instruments developed and validated here are meant to assess the contextualization of science knowledge, skills and attitudes by serving and pre-service chemistry teachers. They were developed for use with Malaysian and Nigerian samples in mind. However, they could be used in other cultural settings. The development takes into consideration the theories on scientific literacy and the nature of science. The main objectives of science center on the development of science knowledge, skill and appropriate attitudes and the daily application of the outcomes.

The researcher employed conventional methods in determining the validity and reliability of the instruments. These include the use of experts, whose suggestions were gracefully used in producing the drafts which were further used for pilot study. Data from pilot study were used in further determination of psychometric properties or internal consistency and reliability coefficients of the instruments. A few of the test items were dropped based on this determination. The instruments have high coefficients of reliability which make them suitable for the purpose they are intended for. Many researchers will however, find useful in several other area and settings. The paper was presented first at Canada International Conference on Education CICE-2010. The suggestions offered during the presentation were further used to prepare the article for journal publication.

ACKNOWLEDGEMENTS

We greatly acknowledge the fund given by the University of Malay to conduct the research form which the development and validation of this instruments of the article was taken. We also acknowledge Richard K. Coll et al. (2002) for their research that help in materializing this research.

REFERENCES

Alam GM (2009). Can governance and regulatory control ensure private higher education as business or public goods in Bangladesh? Afr. J. Bus. Manage., 3(12): 890-906.

Alam GM (2009b). The role of science and technology education at network age population for sustainable development of Bangladesh through human resource advancement, Sci. Res. Essays, 4(11): 1260-1270

Alam GM, Hoque KE, Khalifa MTB, Siraj S, Ghani MFA (2009). The role of agriculture education and training on agriculture economics and national development of Bangladesh. Afr. J. Agric. Res.,

4(12): 1334-1350.
Alkenhead GS (1997). Changes Need to Succeed Where We Previously Failed. In Proceedings of the International Conference on Science Education, KEDI: Globalization of Science Education - Moving Toward Worldwide Science Education Standards, Ed.; May 26 – 30 1997, Korea.
Bell B (1998). Teacher Development in Science Education. International handbook for Science Education. Part Two. Kluver Academic Publishers, pp. 683-693.
Bevins S, Brodie E, Brodie M (2005). UK Secondary School Pupils' Perceptions of Science and Engineering. A report for the Engineering & Physical Sciences Research Council and the Particle Physics and Astronomy Research Council (unpublished).
Coll RK, Chapman R (2000). Evaluating Science Quality for cooperative educationprograms. Asia Pacific J. Cooperative Educ., 1(2): 1-2.
Coll RK, Dalgety J, Salter D (2002). The development of the chemistry attitudes and experience questionnaire (CAEQ). Chem. Educ. Res. Pract. Eur., 3(1): 19-32.
Connect (2004). Ethics of Science Technology. UNESCO International Science, Technology and Environmental Education Newsletter, 29(3–4).
Cueto S, Leon J, Guerrero G, Munoz I (2009). Psychometric characteristics of cognitive development and achievement instruments in Round 2 of Young Lives. Young Lives Technical Notes, No 15.
Djallo AB (2004). Science Education in Danger. Education for Today. The Newsletter of UNESCO's Education Sector, No 11.
Ezike EO (1985). The students' underachievement in science: who is to blame? The Proceedings of 27th Annual Conference of Science Teachers Association of Nigeria.
Frazer G (1980). Science teacher characteristics and student attitudinal outcome. Sci. Math., 80: 300-308.
Gallagher SA, Sher BT, Stephen WL, Workman D (1998). Implementing problem-based learning in science classroom. School Sci. Math., 95(3): 136-146.
Germann PJ (1988). Development of the attitude-toward-science in school assessment and its use to investigate relationship between science achievement and attitude-toward-science in schools. J. Res. Sci. Teaching, 25(8): 689-703.
Gilbert WH, De Jong O, Justi R, Treagust DF, Van Driel JH (2002). General preface. Chemical Education: Towards research-based practice, Dordrecht: Kluwer.
Hashim F, Alam GM, Siraj S (2010). Information and communication technology for participatory based decision-making-E-management for administrative efficiency in Higher Education. Int. J. Phys. Sci., 5(4): 383-392.
HESA (2005) Qualifications Obtained by, and Examination Results of, Higher Education Students at Higher Education Institutions in the United Kingdom for the Academic Year 2003/2004. SFR PR82. Cheltenham, UK: Higher Education Statistics Agency.
Holbrook J (2009). An Introduction to Ideas for Greater Relevance of Science Teaching for the Enhancement of Scientific literacy. ICASE Newsletter, June 2009.
Holbrook J, Rannikmae M (1999). Prompting Scientific and Technological Literacy through the Use of Supplementary Teaching Materials. In Proceedings of the International Cconference on Science Education for the 21st Century. Holbrook, J. and Rannikmae, M. Eds.; Szegel. Hungary, June 22 – 25.
Kracjik J, Mamlok R, Hug B (2001). Modern Content and the Enterprise of Science: Science Education for the Twentieth Century. In Education Across A Century: The Centennial Volume. One Hundredth Yearbook of the National Society for the Study of Education, pp. 205-237.
Krynowsky RA (1988). Problems in assessing student attitude in science education: A partial solution. Sci. Educ., 72(4): 575–584.
Ministry of Higher Learning (2009). 2009 indikator Pengajian Tinggi [Higher Learning Indikator]. Retrieved from http://www.mohe.gov.my/web_statistik/statistik_pdf_2008_05indikator_6-3.pdf.
Murica K (2005a). Science for the 21st Century: Teaching for Scientific literacy. Paper presented at 54th Conference of Australian Science Teachers Association, (CONASTA) Melbourne.
National Research Council (1995). National Science Education Standards. Washington DC.
O'Connor JP (2003). Innovations in Science and Technology Education. UNESCO Publications Vol VIII, Paris, 2003.
Oloruntegbe KO, Akinsete MA, Ayeni EO, Odutuyi MO, Gazi MA (2010). Rethinking development and sustainability of African economy: The roles of science education. Afr. J. Bus. Manage., 4(6): 811-819.
Oloruntegbe KO, Ikpe A (2010). Ecocultural factors in students ability to relate school and home science: implications for chemistry education. J. Chem. Educ. (In Press).
Oloruntegbe KO, Omoifo CN (2000). Assessing process skills in STM Education: going beyond paper and pencil tests. Educ. Thought, 1(1): 25-36.
Orlando H (2004). Focus. Science Education in Danger. The Newsletter of UNESCO's Education Sector, No 11, October-December, p. 4.
Osborne J, Collins S (2001). Pupil's View of the Role of the ScienceCurriculum: A Focus Group Study. Int. J. Sci. Educ., 23(5): 441-467.
Rannikmae M (2001a). Operationalisation of Scientific and Technological Lieracy in the Teaching of Science. Unpublished Ph D Thesis, University of Estonia.
Rasekoala E (2001). African-Caribbean Representation in Science & Technology (ACRISAT). London, UK: National Endowment for Science, Technology and the Arts.
Roberts G (2002). SET for Success: The Supply of People with Science, Technology, Engineering and Mathematical Skills. London, UK: Her Majesty's Stationery Office.
Sergeant H (2010). Schools are Churning out the Unemployable. The Sunday Times, February 21, 2010.
Siegel MA, Ranney MA (2002). Developing the changes in attitude about the relevance of science (CARS) questionnaire and assessing two high school science classes. J. Res. Sci. Teach., 40(8): 757-775.
Sjoberg S (2001). ROSE: The relevance of science education. A comparative andcooperative international study of the contents and contexts of science education. [Online] http://folk.uio.no/sveinsj/ROSE_files.htm.
Sjoberg S (2005). Young People and Science Attitudes, Values and Priority: Evidence from the Rose Project. A Keynote Presentation at European Union's Science and Society Forum, March 8 – 11, 2005, Brussel.
Sjoberg S, Schreiner C (2004). Perceptions and Images of Science and Science Education. Proceedings of the Conference on Communicating European Research , Brussel, 14 - 15 November, 2005.
Watters JJ (2004). Engaging with chemistry through contexts. Paper presented at the Royal Australian Chemical Institute, Tertiary-Secondary Interface Conference, August 2004, Brisbain.
Yager ER, Weld JD (2000). Scope, Sequence and Coordination: The Iowa Project on National Reform Effort in the USA. Int. J. Sci. Educ., 21(2): 169-194.
Zoller U (1993). Are lecture and learning compatible? Maybe for LOSC: unlikely for HOCS. J. Chem. Educ., 70: 195-197.

APPENDIX

Instrument for contextualization of science knowledge, skills and attitudes

1. Your friend asked. Do I stand any risk for taking food containing sugar every day? What answer would you give?

A. No risk, all food contains sugar;
B. Risky, run away from carbohydrate food;
C. No risk, even if you take a bottle of beverage after every meal;
D. Risky, run away from taking beverage after meal.

2. Consumers reported flat taste of manufactured products. Which of the following working hypotheses would give to the production manager of the factory?
A. Wrong ingredients were used; B. Shelf-life of the product had passed
C. Wrong amount of ingredients were used;
D. Shelf-life expiration of ingredients had passed;

3. What do you consider the best thing to do with the heap of polythene bags in your kitchen?

A. Take them outside and burn; D. Collect them and pass to the recycles
B. Bury them in the ground; C. Collect them and throw to the dunghill.

4. Which of the above answers is a good application of Dalton theory stating that matter cannot be created nor destroyed? A. B. C. D.

5. You want to demonstrate that chlorophyll contains xanthophylls, carotene and chlorophyll, which of the following would you use?

A. Thin layer chromatography; B. Column Chromatography; C. Gas-liquid chromatography; D. High pressure liquid chromatography.

6. Banjo queried his teacher. How do we control for the amount of shaking of conical flask in a reaction of HCl and $Na_2S_2SO_3.5H_20$ to monitor concentration effect on rare of reaction? What Banjo meant is

A. The result of the experiment remains valid whether you shake slightly or strongly; B. The result is invalid whether you shake slightly or strongly; C. The result remains valid only if we can control the amount of shaking; D. The result remains invalid even if we control for the amount of shaking.

7. Your advice to a friend to take plenty of water after a meal of bread and tea is based on your idea of

A. Alkaline effect of water; B. Acidic effect of water; C. Buffer effect of water; D. Neutral effect of water.

8. You got to a middle of a debate on green chemistry. Your not too science-oriented friend exclaimed, here come's the chemist. Tell your idea of green chemistry. Your answer is likely to be

A .To produce only materials that can help maintain the green nature of the environment; B. To produce and eat green food; C. To produce environmentally friendly materials; D. Ensure that your production and practice are environmentally friendly.

9. Which of the followings would give you the most accurate measurement of solutions in the laboratory?

A. Measuring cylinder; B. Pipette; C. Beaker; D. Burette.

10. Given all of the above, which one would you use to measure vegetable oil for cooking at home? A. B. C. D.

11. Your daughter wishes to separate tea from the debris after boiling. She calls, Mummy, I need filter paper! What would you tell her?

A. Decant the liquid; B. Wait to buy filter paper; C. Use sieve; D. Look for clean white cloth in the room.

12. GM Food looks attractive and welcoming, but they should be

A. sold along side the natural ones; B. labeled so that the consumer would know them and make choice; C. sold labeled or not; D. the only ones allowed to be sold in the market.

13. Husna takes the bus to work every day. Taking the bus to work helps the environment in what way?

A. causes more plants to grow B. causes a decrease in air pollution C. causes more fertilizer in soil D. causes the landscape to be all green.

14. Ms X was conducting a science experiment for her class. The experiment instructed her to heat samples in a beaker of water. Ms X put water into a beaker and placed the beaker on a hot plate. The samples she needed to heat were put in test tubes and placed into the beaker of water. After 5 minutes, she removed the test tubes and told the class to observe any changes in the samples. Which of the followings could Ms X have done to demonstrate laboratory safety to her students?

A. performs other tasks while heating the test tubes on the hot plate;

B. remove her gloves before taking the test tubes from the beaker;
C. use tong to remove the test tubes from the beaker;
D. turn the hot plate on and then gather materials.

15. Which of the followings best describes the next step in scientific inquiry if a hypothesis is not supported by an experiment?

A. adjust the hypothesis, and do an experiment to test it;
B. present the result as proof of the hypothesis;
C. repeat the experiment until it agrees with the hypothesis;
D. create a new experiment that will support the hypothesis.

16. A learner wanted to know whether an increase in the amount of vitamins given to children results in increased growth. How can the learner measure how fast the children will grow?

A. By counting the number of words the children can say at a given time;
B. By weighing the amount of vitamins given to the children;
C. By measuring the movement of the children;
D. By weighing the children every week.

17. A science teacher wanted to find out the effect of exercise on pulse rate. She asked each of three groups of learners to do some push-ups over a give period of time, and then measure the pulse rates: one group did the push-ups for one minute; the second group for two minutes; the third group for three minutes and then a fourth group did not do any push-ups at all. How is pulse rate measured in this investigation?

A. By counting the number of push-ups in one minute;
B. By counting the number of pulses in one minute;
C. By counting the number of push-ups done by each group;
D. By counting the number of pulse per group.

18. Munchi thinks the more the air pressure in a soccer ball, the further it moves when kicked. To investigate this idea, he uses several soccer balls and an air pump with a pressure gauge. How would Munchi test his idea?

A. Kick the soccer balls with different amount of force from the same point;
B. Kick the soccer balls having different air pressure from the same point;
C. Kick the soccer balls having the same air pressure at different angles on the ground
D. Kick the soccer balls having different air pressure from different points on the ground.

19. In a radio advertisement, it is claimed that Surf produces more foam than other types of powdered soap. Chia wanted to confirm this claim. She put the same amount of water in four basins, and added 1 cup of a different type of powdered soap (including surf) to each basin. She vigorously stirred the water in each basin and observed the one that produce more foam. Which of the factors below is not likely to affect the production of foam by the powdered soap?

A. The amount of time used to stir the water. B. The amount of stirring done. C. The type of basin used. D. The type of powdered soap used.

20. Tan wanted to show her friend that the size of a container affects the rate of water loss, when water is boiled. She poured the same amount of water in containers of different sizes but made of the same material. She applied the same amount of heat to all the containers. After 30 minutes, she measured the amount of water remaining in each container.
How was the rat water loss measured in this investigation?

A. By measuring the amount of water in each container after heating it.
B. By using different sizes of the containers to boil the water for 30 minutes.
C. By determining the time taken for the water to boil in each of the containers.
D. By determining the difference between the initial and the final amount of water, in a given time.

21. Which of the followings is most likely to cause a rise in the average temperature of the Earth in the future?

A. Atomic warfare. B. CO_2 from fossil fuels. C. Dust clouds from volcanoes. D. Depletion of the Earth's ozone layer.

22. If each of the following meals provides the same amount of calorie, which meal requires the most land to produce the food?

A. Red beans and rice. B. Steak and a baked potato.
C. Corn tortilla and refried beans. D. Lentil soup and brown bread.

23. An advertisement claims that patients can be cured of common cold in 48 hours by vitamin C tablets with several mineral supplements. In a scientific experiment to test these claims, which data can be considered irrelevant?

A. The amount of vitamin C in each tablet. B. The chemical formula for vitamin C. The severity of the patients' cold systems. D. The amount of time before symptoms improves.

	Please indicate what YOU think about the following		
	CHEMISTS (SCIENTISTS)		
26	Social	___ ___ ___ ___ ___ ___ ___	Antisocial
27	Respect the opinions of others	___ ___ ___ ___ ___ ___ ___	Does not care of opinion of others
28	Flexible in their idea	___ ___ ___ ___ ___ ___ ___	Rigid in their idea
29	Mindful about the effects of their results	___ ___ ___ ___ ___ ___ ___	Only care about their results
30	Friendly	___ ___ ___ ___ ___ ___ ___	Unfriendly
	CHEMISTRY RESEARCH		
31	Tool for human development	___ ___ ___ ___ ___ ___ ___	Tool for human destruction
32	Solve problems	___ ___ ___ ___ ___ ___ ___	Create problems
33	Improve quality of life	___ ___ ___ ___ ___ ___ ___	Decreases quality of life
34	Products and inventions helpful	___ ___ ___ ___ ___ ___ ___	Products and inventions hazardous
35	Results are infallible	___ ___ ___ ___ ___ ___ ___	Results are fallible
	CHEMISTRY JOBS		
36	Interesting	___ ___ ___ ___ ___ ___ ___	Uninteresting
37	Challenging	___ ___ ___ ___ ___ ___ ___	Easy
38	Creative	___ ___ ___ ___ ___ ___ ___	Monotonous
39	Exciting	___ ___ ___ ___ ___ ___ ___	Boring
40	Satisfying	___ ___ ___ ___ ___ ___ ___	Not satisfying

24. John wanders what effects the time it takes ice cubes to melt. He decides to test whether the shape of an ice cube affects the time it takes to melt. How could he test this?

A. Use 5 ice cubes. All should have a different shape and weight. Use 5 identical jars, all at the same temperature. Observe the melting time of the ice cubes.
B. Use 5 ice cubes. All should have the same shape, but different weights. Use 5 identical jars, all at the same temperature. Observe the melting time of the ice cubes.
C. Use 5 ice cubes. All should have the same weight, but a different shape. Use 5 identical jars, all at the same temperature. Observe the melting time of the ice cubes.
D. Use 5 ice cubes. All should have the same weight, but a different shape. Use 5 identical jars, each at a different temperature. Observe the melting time of the ice cubes.

25. Lee wanted to find out which laundry soap was best for removing grass stain. Each soap was mixed with warm water. It was then used to scrub a piece of grass-stained cloth for 1 minute. Then the amount of stain left on the cloth was measured. What was the dependent variable?

A. Water temperature. . B. Amount of stain left on the cloth.
C. Scrubbing time for each cloth. D. Laundry soap

SECTION B

Here is an inventory of scientific (chemistry) attitudes on 7 point scale. Kindly place X on the line that expresses your disposition towards the followings. For example if you think chemists are midway between being very intelligent and very dull, place X on middle line, that is line 4. (Intelligent ___ ___ ___ _X_ ___ ___ ___ Dull)