US-China Education Review A 4 (2012) 473-481
Earlier title: US-China Education Review, ISSN 1548-6613

Psycho-social Issues in Females Study of Science and Technology

Omoniyi Mary Banke Iyabo, Oloruntegbe Kunle Oke
Adekunle Ajasin University, Akungba-Akoko, Nigeria

The study investigated the relationship between psycho-social factors with females study of science and technology course at the institutions of higher learning in Nigeria and its counseling implications. Three research questions and hypotheses were raised to guide the study. The subjects for the study comprised 240 undergraduate female students from the Faculty of Education, Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria. The causal comparative (ex-post-facto) research design was employed and a self-constructed validated questionnaire used to elicit information from the subjects. Pearson moment correlation inferential statistics were used for data analysis. The results showed that girls' attitudes towards science had a significant relationship with their anxiety towards mathematics. Societal expectation and teachers' methods of teaching were weakly related to girls' performances in science. The counseling implications were discussed and recommendations were made.

Keywords: psycho-social, science, technology, female, teacher

Introduction

Despite of the efforts aiming at improving science and technology in Nigeria, the benefits of scientific and technological development seem to have been unevenly distributed. In particular, the benefits seem not to have been the same for boys and girls. In educational institutions, girls and women over the years have tended not to study science and technology when compared with boys and men (Agueler & Agwagalu, 2007; Djallo, 2004; Ogunleye, 1999). There is a persistent gender stereotype. Djallo (2004) noted that, "Being a scientist appears to be one of the most stereotyped of all occupations and there is quiet a psychological barrier to overcome, if more girls are to be attracted to science subjects". The problem of dwindling girls' enrolment in science exists all over Africa. This has necessitated the development of several projects, one of which is "FAMSA (Female Education in Mathematics and Science in Africa)". This regional NGO (non-governmental organization) aims to improve the participation and performance of girls in science and technological subjects at primary and secondary levels. It sets up national centers to provide teacher capacity building and a forum for brainstorming by women scientists.

From Table 1, it can be seen that the number of females in both primary and secondary schools is greater than that of males. But what percentages of these females offer science, it must be noted that women in developing countries are a repository of indigenous technologies because of the nature of activities in which they are traditionally involved (Daris, 2006). This should be a boost for female participation in science and

Omoniyi Mary Banke Iyabo, Ph.D., Department of Guidance and Counselling, Adekunle Ajasin University.
Oloruntegbe Kunle Oke, Ph.D., Department of Science and Technical Education, Adekunle Ajasin University.

technology, if the knowledge possessed by women is used to relate local learning experiences to science and technology in the school curricula.

Table 1

Females as Percentage of Males in Primary and Secondary in Selected African Countries 2004

Country	Primary (%)	Secondary (%)
Cameroun	85	70
Kenya	94	93
Lesotho	100	127
Malawi	102	81
Mozambique	83	70
Nigeria	85	81
Tanzania	96	-
Uganda	100	79
Zambia	96	79

Note. Source: UNESCO. Global Education Digest (2006).

There are, however, some encouraging signs observed (Adetunde & Akinsina, 2008). In Ghana, for example, the government adopted the Science and Technology Clinic for Girls Program aiming at giving girls more accesses to science and technology education, and targeting at girls in secondary schools. In Botswana, also, there is a science and technology road shown for girls. These initiatives were launched in collaboration with the Commonwealth Secretariat and NOG, such as GASAT (gender in science and technology) (Adetunde & Akinsina, 2008).

Girls' underachievement and low enrolment in science are also pronounced in Nigeria (Agueler & Agwagalu, 2007), and being the most populous nation in Africa and having more females than males who are surprising, as it is a source of worry. According to the 1991 census figures, the population of women was 49.7%. The figure rose to 51.2% in year 2005. There is likely to be a consistent increase following this trend. It is, therefore, said that despite of this large number, women still underachieve and are underrepresented in science and technology in Nigeria. In a cross-national study and educational attainment at the university level, Dorman (2003) established that girls appeared to perform less well than boys in science and technological courses. Also, in the study of employment statistics according to occupation and sex in Nigeria industries, Adeife-Osemiekhian (1997) observed that women were more in secretariat jobs and very few in engineering and technological professions. Gorriz and Medina (2007) equally observed that for years, women have held a minority position in the high-status, high-salaried jobs in computer and technology fields. In their study, they found that many boys and young men are drawn towards these fields at an early age by their involvement with computer games and other high-tech activities. Their findings were also corroborated by the work of Comber, (2006) who also found that girls and young women often were less confident and less interested in computers and the skills associated with science and technology.

Many researchers, DeRemer (2005), Sheila (2004) and Duyilemi (2006) had identified variables, such as religious factors, school environment, poor performances in mathematics, socialization patterns and gender-stereotyping among others as factors militating against the participation of girls and women in science and technological advancement. Added to these factors is girls' anxiety towards mathematics which is a core subject in science and technology. The counseling implications of girl-math anxiety need to be studied, if the downward

trend in participation of girls in science is to be curbed. Although, a strong correlation has been generally established between students' performances in mathematics and science, not much has been reported in Nigeria about how this factor is causing wider representation of girls in science and technology. The authors of this paper sought to investigate this girl-math anxiety relationship and draw the implications of it for counseling education.

Statement of the Problem

Science and technology has no small way contributed to improve the living standards in the areas of health, transport and communication to mention but few. In view of the importance of these courses, the Federal Government of Nigeria has consistently reviewed policies that favor the admission of more students into science and science-based careers in the higher institutions of learning—the ratio 60:40, 70:30 and 80:20 in favor of science (Federal Government of Nigeria, 2004). Faculties of science and science-based courses in many universities in Nigeria have not been able to fill this quota. More worrisome about the general dwindling enrolment is the case of under representation of girls. It becomes all the more problematic because of the high and increasing female percentage in the entire population. If females consistently outnumber males in the population and they do not show interest in science, there is going to be a time when there would be no one to make decisions on and fix the ever increasing and demanding science-related problems affecting the generality of the people, particularly women in the society. There is the need for the girl child to brace up and occupy her position. Of the contributing factors to this problem, the authors were concerned about the psycho-social issues related to female study of science and technology courses. The concept of psycho-social reflects the dynamic relationship and interplay between psychological and social issues. How have these contributed to under representation of girls in science? What contributions have societal expectations and teachers' teaching methods made to this problem? What can be done to increase the confidence and enlist the interest and enhance the performance of girls in mathematics and consequently in science? These are the problems the authors referred to, as psycho-social and are under investigation in this study.

Research Questions

The research questions of this study are as follows:

(1) Is there any relationship between girls' attitudes towards science and their anxiety towards mathematics?

(2) Is there any relationship between girls' performances in science and societal expectations?

(3) Is there any relationship between teachers' methods of teaching and girls' performance in the science?

Hypotheses

In order to answer the research questions raised in the study, the following null hypotheses were generated:

(1) There is no significant relationship between girls' attitudes towards science and girls anxiety towards mathematics;

(2) There is no significant relationship between girls' performances in the science and societal expectations;

(3) There is no significant relationship between teachers' methods of teaching and girls' performances in the science.

Method

Design

This study employed the causal comparative (ex-post-facto) research design. The research was conducted

after the variations in the independent variables that have occurred in the natural course of events. There was no manipulation of variables. Data collected were used to describe and interpret existing conditions as they concerned female and science related courses.

Subjects

The subjects were 240 female students in the Faculty of Education of Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria. There are four departments in the faculty, namely, guidance and counseling, social science, science and technical and arts education. The data contain the number of students in each of the departments according to sex which was obtained from the academic planning office of the university. The numbers of subjects randomly selected from each department were proportionate to the population of female students in the various departments.

Instrument

The instrument for the study was a self-constructed questionnaire. Some items of the questionnaire were adapted from Tapia (2006), Campell item (1997) and Culler (2003). The 25 item instruments consisted of four sections: A, B, C and D. Section A consisted of items soliciting information about the respondents' current levels, courses of study and performances in O'level science subjects including mathematics. Section B consisted of questions about the attitudes of respondents towards science courses and mathematics. Such question included, for example, "To be good at mathematics is more important for girls than boys", "If I do well in mathematics it is usually because I am lucky", "I do not feel confident about my ability in mathematics", "I belief science and mathematics are more useful to boys than girls", etc.. Section C consisted of items soliciting information about their opinions of their science teachers' methods of teaching. Such questions as: "My science teacher calls on boys to solve mathematical problems more than girls", "Science teachers are always males", "My science teacher scold boys that fail mathematics more than girls", etc.. Section D dealt with items about the society's expectations for girls in science courses. Items in this section include questions, such as: "In Nigeria, people believe that boys should do better in science and mathematics than girls", "Parents frown at boys failing in science more than girls", "People in our society believe that naturally, boys should be better in abstract reasoning than girls", "It is believed in our society that science courses make girls to be too independent", etc..

A four-point response format ranging from "Strongly agree" to "Strongly disagree" was used to test the opinion of the subjects. The responses were scored as follows: Strongly agree = 4, Agree = 3, Disagree = 2; and Strongly disagree = 1.

Validation of Instrument

A "panel of experts" method (Coll & Chapman, 2002; Coll, Dalgety, & Salter, 2002) was employed in the validation. The instrument was given to four senior colleagues, two each in the Departments of Counseling and Educational Management, and Science and Technical for scrutinizing and possible corrections. Based on their various opinions, some items were removed completely, while some were added and some reconstructed. The final copy was generally agreed to possess both content and construct validity.

In order to determine the reliability of the instrument, a test-retest reliability method was adopted. This was done by administering the instrument on 30 subjects among the population, but outside the sample at an interval of two weeks. The two sets of scores obtained were subjected the Pearson product moment correlation test. A correlation coefficient of 0.83 was obtained and this was found to be significant at 0.05 levels.

Procedure

The questionnaires were administered on the subjects in the lecture rooms. Permissions were sought from course lecturers for the time in filling up the questionnaires. The purpose of the study was explained to the students. They were encouraged to be as truthful as possible. The entire copies of the questionnaires were collected duly completed by the students at the end of the session.

Data Analysis

Descriptive analysis was carried out using means and standard deviations, while Pearson product moment correlation test was used as inferential statistics.

Results

Hypotheses Testing

The analysis in Table 2 represents the results of the three hypotheses.

Table 2

Pearson Product Moment Correlations on Girls' Attitude and Math Anxiety, Girls Performance and Societal Expectation, Girls Performance and Teaching Methods

Variable	*N*	*df*	Correlation	Significant
Girls attitudes towards science and math anxiety			0.483	0.000
Girls' performances in science/society's expectations of girls' performances in science	240	238	0.186	0.000
Teachers' methods of teaching science/girls performances in science			0.151	0.000

Note. $P < 0.05$.

The following facts are revealed in Table 2. There are significant relationships between girls' attitudes towards science and math anxiety, girls' performances in science and societal expectation and performance in science and teachers' teaching methods. The relationship was positive but low for girls' attitudes towards science and math anxiety and very weak in the two others.

Discussion and Conclusions

The study revealed that there was a significant positive relationship between girls' attitude towards science and anxiety towards the study of mathematics. The findings of the research agreed with the work of Comber (2005) who uncovered some disabling belief and behavior of females about mathematics and science. She observed that females believe that one is either good in science or good in language and that one cannot be good in both. They also believe that there is only a right way to solve mathematical problems. According to her, majority of the females in her study also believe that mathematics and science disciplines are male domains and that for a female to do science, she must be extremely brilliant. She, therefore, asserted that these beliefs are internalized and determine the students' behaviors and consequent performances in these disciplines.

Wilson (2004) studied girls' attitude towards science and observed that learning attribution theory plays an important role in females' attitude towards science. According to him, even when girls succeed, they never took their success with confidence. Girls attribute success to external variables. When males succeed, they attribute their success to ability, while females attribute to "luck". Furthermore, when males fail, the failure is attributed to not enough effort, while females' failure is attributed to not enough ability. The attributes that are needed to

succeed in science include high analytical skills, strong ability to compare and contrast, question-finding skills and divergent as opposed to convergent thinking skills (Comber, 2005).

Sadker (2004) also investigated the perspectives and complaints of female students in their science courses. His study revealed that the girls complained about "missing the big picture" for they were unable to understand how everything fit together. Moreover, the girls in her study complained that their science teachers were teaching at too fast a rate, hence they were unable to experience the mastery of the subjects. This assertion goes some ways to confirm that there is a significant relationship between girls' performances and teachers' methods. Schmidt (2010) observed that girls learn math anxiety from the female teachers, because they are very few in number boost their ego by making the girls feel that mathematics is a difficult subject and demand more respect from them.

Campell (1997) studied some attitudes of females that negatively affect science study. He found that the girls complained that when the first step is missed in a math question, it was difficult to go on and many of them become anxious about the subject, eventually lose interest and consequently drop out. In their minds, they are kind of leaving the math for the "elite" to continue. This is minus one for the participation of girls, because enrolment into science demands a good knowledge of mathematics.

The results of this research also agreed with the work of Fennema and Sherman (2003) who studied the affective attitudinal variables of females' study of science and mathematics. Among the girls, they observed that beliefs about the usefulness of science and confidence in learning mathematics were critical factors. Their study also revealed that males were discovered to provide evidence that they were more confident about learning math than females. The males also believed that math and science were more useful to males than females. Jacobs (2004) also observed that while young men did not stereotype mathematics as male domain, while female did. The males also believed as much as the females that math was more appropriate for males than females. This means that the attitudes of students towards the learning of science are largely determined by the kind of interest the students have towards mathematics.

Godwin (2001) described attitude as fundamental to the dynamics of behavior. He opined that students with positive attitudes towards science study, because they are positively inclined to it. Such students, according to him, get satisfaction from acquiring scientific ideas and find it rewarding. He observed that a consistent and defined interest (feeling of intentness, concerned or curiosity about an object) in activity, event or situation may lead to a definite attitude pattern to such activity, event or situation which is revealed in various performances.

In line with the result of this research, Sheila (2004) observed that with normal cognition, the information in the brain flow through the process pathways and on into the memory pathways of the brain. If the input information encounters emotional delays, the output memory pathway is harder to reach. According to her, when information is input, girls tend to have lots of emotional overlay, so that memory cannot be accessed. In line with this observation, Fennema (2003) in her research on autonomous learning behavior found that girls are torn between being agreeable, complacent and feminine as opposed to aggressiveness, assertiveness and autonomy. In her own opinion, in order to succeed, the latter attributes of aggressiveness, assertiveness and autonomy are the most desirable.

Feelings are very important to success. It is of paramount importance for the girl child to be able to identify the reason why she gets anxious during math lessons. She must be able to ask what is making math/science a difficult problem and how she can overcome or make the problem easier. This also encourages

an assertive behavior. According to Wilson (2004), assertiveness will power, focus, discipline and efficiency bring about confidence and confidence will bring about success especially in math/science.

Judith (2005) in her study observed that the girl child because of math anxiety has her brain pathway filled with static. According to her, the girls have learned the materials, yet they are unable to retrieve them. She, therefore, suggested that going back to class to share feelings about math, creating group bonding and changing the group dynamics from teacher-student centered to student-student centered will reduce math anxiety.

The findings of the research also showed that there is a weak relationship between societal expectation and performance of females in the sciences. This result is, however, contrary to the view of Duyilemi (2006) and Bamiro (2006). Duyilemi (2006) observed that the image of the scientist held by people in the society is a stereotype of a male. This, according to them, has had negative impacts on the performances of females in the science and their attitudes about potential for success in science and technology. While Bamiro (2006) in another instance observed that the society has greatly contributed to the low performance of girls in the science by making female to be scared of technology. According to her, girls are discouraged from toying with electrical equipment and discriminated against in their parental socialization process in the choice of toys that parents buy for their kids: baby dolls for girls, toy cars and guns for boys. According to her, many homes in the society replete with sayings, such as “You are only a girl”, “Girls cannot do that”, etc., which are derogatory to the girls. In her opinions, the society and various homes should bubble with “Yes, girls can”, “Girls do” and “Girls should”.

The results of the study also showed that there is weak relationship between teachers’ methods of teaching and females performances in science. This result is also in line with the work of Fennma and Leder (1990) who observed that it is relatively easy to identify differential teacher interactions with girls and boys. In particular, teachers interact more with boys than girls, praise and scold boys more than girls, and call on boys more than girls. However, the impact of these differential treatment and method of teaching is unclear and difficult to ascertain, especially for a weak relationship indicated in this study. In the same vein, Bluemenfield (1995) also observed that differential teacher treatments of boys and girls and different methods of teaching do exist in the teaching/learning process in science and math, but do not support as a cause for gender differences in mathematics and science. Koehler and Ledger (2002) also supported this view but added that other intervening variables do exist and concluded that differential teacher treatment of boys and girls is merely a symptom of many causes of gender differences in mathematics and science and that, as in medical practice, treating the symptom is not sufficient to change the underlying cause.

Peterson and Fennema’s (1996) study of sexist behavior among male and female is also worth mentioning here, such as those indicating that mathematics and science are more important for boys than for girls. They found that such behavior exists, but however, they did not find major examples of overall sexist behavior on the part of teachers. They found small differences in teacher behavior, which when combined with the organization of instruction, made up a pattern of classroom organization that appears to favor males. However, Peterson (2002) in another study found patterns of teacher behavior and classroom organization that influenced boys and girls differently. According to her, for example, the competitive activities in math class encouraged boys learning and had negative influence on girls learning, while the opposite was true for cooperative learning. She, therefore, concluded that since competitive activities were much more prevalent than cooperative activities in science classes, it appeared that classroom was often more favorable to boy’s learning than girls’ learning. A classroom atmosphere that engenders cooperation is more facilitative to girls’ science and math learning than competition.

Implication for Counseling and Recommendations

Without doubt, issues that bother on gender equity in the areas of science and technology are fraught with multifaceted challenges among which changes in attitudes and practice are paramount. As a result of personal belief system of the girls (lowered confidence, attribution style and belief in math/science usefulness), they do not participate in learning activities that enable them to become independent learners of math/science. It is, therefore, advocated that through working in teams to solve math/science problems girls can improve to become assertive in character and later have the confidence to learn independently. Math anxiety female students should be separated and given extra coaching to de-sensitize them of their fears and meet their needs. It is also important to have students understand their learning styles and make the best use of them. Since the good female math students feel in control, and therefore, do better in the course work, efforts should be made by the math teacher to instill confidence in the math anxiety students who do not feel in control and therefore perform poorly. The relationship between teachers and students is of paramount importance in the teaching and learning of science and mathematics. The teacher must always consider the community of learners that he/she is dealing with. He/she must be a good and objective facilitator and a supportive person. Like a mid-wife, teacher must build trust in the students, start out the lesson slowly, and can speed up later. He/she must realize that he/she is not the fountain of all knowledge. He/she must use the students' experiences to enhance their learning. There is the need for the teachers, therefore, to be familiar with what is going on with students and be prepared to solve their problems.

The methods of teaching math should include both cooperative and competitive experiences. Math competitions should include team problems as well as individual. Teachers must monitor male-female interactions in cooperative learning groups to make sure that those naturally more willing to write and use writing, as their own way of thinking are actually participating.

It is counseled that female should be encouraged to see science as enriching the quality of human life and look for evidence beyond what they can see. It is very important to generate girl-friendly science curriculum. This may include making sure that science experiments are set in context of the topics taught in class.

References

Adeife-Osemiekhian, T. (1997). Women and girls in science, technology and teacher education. Proceeding of *the 1st Annual Conference of Lagos State Science Teachers Association of Nigeria*. Lagos, September 10-14, 1997.

Adetunde, L. A., & Akinsina, A. P. (2008). Factors affecting the standard of female education: A case study of senior secondary schools in Kassena-Nankana district. *Journal of Social Sciences, 44*, 338-342.

Agueler, L. L., & Agwagalu, U. N. N. (2007). Female participation in STM (science, technology and mathematics) education in Nigeria and national development. *Journal of Social Science, 15*(2), 121-126.

Bamiro, O. A. (2006). The girl child in science, mathematics and technology. A keynote address delivered at *the 1st International Conference of Forum for African Women Educationist (FA WE)*, August 29, 2006.

Bluemenfield, P. (1995). Classroom experiences and student gender: Are there differences and do they matter? In Wilkinson, & C. B. Manett (Eds.), *Gender influences in classroom interaction.* New York: Academic Press.

Campell, P. (1997). *Gender and education: Ninety-second yearbook of the national society for the study of education.* Chicago: University of Chicago.

Coll, R. K., & Chapman, R. (2000). Evaluating science quality for cooperative education programs. *Asia Pacific Journal of Cooperative Education, 1*(2), 1-2.

Coll, R. K., Dalgety, J., & Salter, D. (2002). The development of chemistry attitudes and experience questionnaire (CAEQ). *Chemistry Education Research and Practice in Europe, 3*(1), 19-32.

Comber, R. D. (2005). Sex differences in learning abilities and disabilities. *Educational Researcher, 18*(4), 17-19.

Comber, T. (2006). *Addition and subtraction: A cognitive perspective Hillsdale*. N. J.: Lawrence Erlbaum Associates.

Culler, P. (2003). Factors affecting female participation in advance placement programs in mathematics, chemistry and physics. *Women and the Mathematical Mystique, 5*(3), 126-139.

DeRemer, M. (2005). *Girls, science and technology, The problem—Our solution.* A program of Douglass College, the Undergraduate Women's College of Rutgers, The State University of New Jersey.

Djallo, A. B. (2004). Science education in danger: Education for today. *The Newsletter of UNESCO's Education Sector, 11*, 8-12.

Dorman, W. S. (2003). Arithmetic problem solving in Hispanic first graders. *Elementary School Journal, 52*, 306-316.

Duyilemi, B. O. (2000). Indigenous authorship and students' achievement in science: A biologists view. Proceedings of *the 27th Annual Conference of Science Teachers' Association of Nigeria* (pp. 183-187). University of Ife Conference Center, July 7-9, 2000.

Duyilemi, A. N. (2006). Empowering the girl child/women in science, mathematics and technology through role modeling. A Welcome Address Presented at *the 1st International Conference by FAWE/AAU*. Adekunle Ajasin University, Akungba Akoko, August 29, 2006.

Federal Government of Nigeria. (2004). *Educational enrollment in science and humanities.* Handbook of Federal Ministry of Education, Abuja,Nigeria.

Fennema, E. (2003). *New directions for equity in mathematics education.* Cambridge University Press.

Fennenma, E., & Leder, G. (1990). *Mathematics and gender: Influences of teachers and students.* New York: Teacher College Press.

Fennenma, E., & Sherman, J. (2003). Female participation in the study of mathematics: Towards gender equity in mathematics education. *American Scientist, 79*, 149-156.

Godwin, D. W. (2001). A large sex differences on a two-dimensional mental rotation task. *Behavioral Neuroscience, III*(4), 845-849.

Gorriz, J., & Medina, E. (2007). Social class, sex and fear of success in mathematics. *Journal for Research in Mathematics Education, 13*(12), 124-135.

Jacobs, J. (2004). Gender differences in math ability: The impact of media report on parents. *Educational Researcher, 14*(3), 20-25.

Judith, R. (2005). *Gender and science.* New York: Pergamon Press.

Koehler, P., & Ledger, G. C. (2002). *Handbook of research on mathematics teaching and learning: A project of the national council of teachers of mathematics.* New York: Macmillan.

Ogunleye, A. O. (1999), *Science education in Nigeria: Historical development curriculum reforms and research.* Lagos: Sunshine International Publications (Nig.) Ltd..

Peterson, P. L. (2002). Teachers' attributions and beliefs about girls, boys and mathematics. *Educational Studies in Mathematics, 21*(1), 55-65.

Peterson, P. L., & Fennema, E. (1996). Effective teaching, student engagement in classroom activities and sex-related differences in learning mathematics. *American Educational Research Journal, 22*(3), 309-335.

Sadker, R. (2004). The nature, effects and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*, 33-46.

Schmidt, K. (2010). Women in science and engineering. *American Scientist, 79*, 404-410.

Sheila, T. (2004). *Gender equity for science and mathematics.* Notes on Invited Faculty Presentations. CN 5281, Princeton NJ08543-5281.

Sherman, J. (2003). Sex related differences in mathematics achievement and related factor: A further study. *Journal of Research Mathematics Education, 9*, 189-203.

Tapia, M. (2006). The attitudes towards mathematics instrument. Paper presented at *the Annual Meeting of the Mid-South Educational Research Association*. Tuscaloosa, A. L. (ERIC Reproduction Service No. ED 404165).

Wilson, S. (2004). A review of school counseling outcome in science counseling: Implication for practice. *Journal of Counseling and Development, 75*(7), 412-426.