NIGERIAN JOURNAL
OF
CURRICULUM STUDIES

Vol. 24 No. 3 2017

JOURNAL OF CURRICULUM ORGANIZATION OF NIGERIA (CON)
ISSN: 0189-9465

SCIENCE EDUCATION AND THE DEVELOPMENT OF DECISION-MAKING ABILITY: A CURRICULUM IMPLEMENTATION DIMENSION

Moemeke, Clara Dumebi (Ph.D)
Dept of Curriculum Studies and Educational Technology
College Of Education, Agbor.
E-mail:Claramoekphd@yahoo.co.uk

Abstract

The Curriculum is an instrument for the improvement of the quality of life and living of individuals and society. Quality science and eventful science practice demand the development of decision-making competencies with regard to science and societal problems. This study investigated the possibility of targeting the development of decision-making capacity among science students as an outcome of instruction. Four hundred and eighty SSII students in six intact classes of three purposively selected secondary schools participated in the study. A non-equivalent group design (factorial) was adopted. A 36-item Decision-Making Ability Test (DMAT) segment of Umoren (1991) Test of Science, Technology and Society (TOST) instrument was used to collect data after an eight-week treatment using the problems solving heuristics (PSH) as a science instructional tool. Experimental subjects showed better ability to make authentic science favoured decisions than their control counterparts. Sex and religion were also found to influence the ability to take decisions about science-related societal problems. The need to target its development via appropriate curriculum implementation devices was advocated.

Introduction

Science has systematically over the years sought and acquired relevance in all spheres of human endeavour. This search has continued to progress as man opens new avenues to increase his productivity and utilization of available natural resources. Since man's desires are ever-growing, the search has permeated aspects of improving man’s own ability not only to take advantage of his environment but also to develop him selves toward making adequate beneficial choices and decisions, the effect of which could impinge on his rationality as an intelligent being. The technology that man enjoys today is a product of this search. Science is thus said to be the greatest weapon invented by man to leap into the unknown.

Every sphere of life demands that accurate decisions be made by eliminating alternatives in order for success to be achieved. The world best-known breakthroughs in science, technology, management, arts, and communication are products of carefully made decisions. Making appropriate decisions and choices among alternatives therefore in an important aspect of human activity previously thought to be intuitive or at best, restricted to management sciences but which have also been found (Umoren, 1991) to have implications in science and productive science learning. If this is found to be so, greater emphasis in content and pedagogy should be placed on developing learner capabilities in making appropriate decisions as means of enhancing productive science.

The goal of science teaching the world over in this 21st century has changed from mere production of scientifically literate citizens to that of the production of individuals capable of rational, productive thought founded on explorative, experimental, and inventive sciencing. The stride that took Russia to space well before other nations in 1957 is reminiscent of this intellectual adventure. It means that the 21" century science learner must be equipped with the foundations necessary for the development of rational thought and principles for proper decision-making. Classroom activities must, therefore, as a rule, change to accommodate and fulfill these new goals and expectations. The learners' mind is a fertile ground for the cultivation of these new principles and skills.

In Nigeria, science teaching has remained didactic for many decades now. Excuses ranging from inadequate equipment and facilities, poor teacher pedagogic content knowledge, low job motivation, examination-centered evaluation, and a host of others have been given for the lack of innovation in curriculum implementation by teachers and the concomitant inability of learners to lift the country into scientific and technological glory. Today, the country with a great human, natural, and materials potentials has remained a ready market for substandard goods from less endowed, less gifted, less populated nations of the world. This paper as such studied the possibility of prompting science students' decision-making capacity through the application of problem-solving heuristics in the science classroom.

Decision-Making and Science Learning

The whole essence of acquiring science knowledge is that young people should be able to utilize the intellectual benefits f science in their own interest and that of improving their communities. Science and technology are not only shaping our environment but also influencing our decisions (Umoren 1991), helping us to either improve our environment or destroy it.

The present vision of the New Partnership for Africa Development (NEPAD) and the Millennium Development Goals (MDG), lies in the empowerment of individuals for optimum wealth creation and reduction of poverty.

Gosling and Musschenga (1985) had earlier conceptualized empowerment as the ability to make decisions, wise decisions which are based on well-reasoned ethics and pertinent knowledge. Hurd (1988) in the same light believes that productive science ventures are linked to the ability to interpret and decide on the human and social forces that generate and sustain scientific endeavours.

Thoughtful decision-making in Aikenhead, (1985) are:

1) Predisposition to reason critically
2) Guided by an explicated set of values
3) Informed by pertinent scientific and technological knowledge and.
4) Informed by the epistemological and social status of that knowledge.

The last of these is thought by Aikenhead to be most vital to decision-making since it is permeated by critical reasoning. The implication or signal sent by this understanding is that the previously artificially perceived boundaries between science, management, and social life are gradually dissolving as all knowledge are interwoven and a prerequisite to optimum achievement in all domains of knowledge. Education should presumably prepare students to function effectively and independently in society. It should endow them with the cognitive and problem-solving skills necessary to deal with assorted daily life problems in their professional and everyday life. It should also teach them skills on imaginative thought because they are not only preparing to pass the examination but also to become future decision-makers. It is presumptuous to expect that students can acquire such complex skills automatically and intuitively without targeting it through efficient instruction.

A major criticism of science and schooling (Hurd,1984; Doyle and Hurtte 1985) is that students do not learn to reason and think critically in the face of problems. A problem-oriented society context for science courses provides the framework essential for the development of such intellectual skills as problem-solving, decision-making, and synthesis of knowledge. These according to Umoren (1991) are among the intellectual skills required for effective participation in the information age in which we now are. Today, knowledge, skills, networking, and effective decision-making from proper situation analysis rank above the endowment will beauty, natural resources, and industrial products. Nations in which citizens lack these attributes irrespective of natural endowment remain second class in world affairs.

The act of making a decision lean towards events such as context and questioning issues, determination of, drawing conclusion and making a judgment; taking a resolution, and making up one’s mind among alternative situation. It is the point in the thinking process when the mind resolves all controversies, excludes confusion, and cuts off alternatives by taking a side or making a choice in the face of two or more inviting offers. It marks the end of giving thought to other possibilities.

Juniper (1976) identified types of decisions to include:

- Considered decision, usually limited by time and opportunity.
- Scientific decisions are usually considered decisions.
- Impulse decision which relies more on emotion instead of facts. They only superficially anchor on information and are biologically triggered.
- Forced decisions and traps in which the individual's power of choice is subjugated by the influence of some other more significant powers through

imposition. A Trap is an end in the continuum in which there is no identifiable way out due to the absence of alternatives.

- Deferred decision which may be deliberately a strategy, a habit or a gesture indicating desperation. Reasons for deferred decisions may range from the triviality of such decisions to indiscernible contradictions that prevent people from deciding to decide.
- Collective or group decision in which the weight of consequences of the decision is shared by a group. The eye of the deciders is on the penalty of a wrong decision. It is done by collective bargaining which is a major element of scientific discourse and negotiations.

Making decisions is a regular feature in life. In essence, every major life activity centers on proper decision-making. The capability of making vital decisions is a human quality that could be improved or enhanced by instruction. It is on this premise that this study is posited.

Statement of the Problem

The present democratic awareness calls for the active participation of citizens in collective decision-making. Good governance hinges on effective decision-making that emanate from an appropriate knowledge base. Our students of today will form the manpower, administrator, legislators, politician, etc. of tomorrow. Developing their skills and competence in decision-making through instructional principles could help individuals choose the path of peace or war, productive or unproductive, developmental and useful or destructive and useless ventures. The importance of the process demands that decision-making skills development should not be left to chance and spontaneous attainment.

Apart from laying the foundation for functional science practices and industrial decision-making, emphasizing decision-making skills acquisition through science instruction will enable science students to make sensible and reasonable real-life decisions (Zoller,1982), drive the functional aspects of society, enrich the individual reasoning effectiveness and evaluate the sensibility, credibility or otherwise of other people's decisions. It is in this premise that the study asks thus: will the application of problem-solving heuristics in science teaching prompt science students to develop decision-making abilities about science society problems? What other variables influence the development of decision-making competencies of science students?

Research Questions

The following research questions guided the study.

1) What is the effect of using science problem-solving heuristics (PSH) in science teaching on students' development of decision- making skills?
2) Will there be differential effect of PSH on male and female science students' ability to make decisions.
3) Will students' background characteristics affect their decision-making ability?

4) Will students' religion influence their ability to make decisions?

Research Hypotheses

The following null hypotheses were tested in the course of the study:

1) There is no significant effect of the PSH on students' decision-making ability.
2) There is no significant difference in male and female students' decision-making ability after the PSG.
3) There is no significant influence of students' background characteristics on their decision-making ability.
4) There is no significant effect of students' religious beliefs on their ability to make decisions.

Design of the Study

The dependent variable in this study was students’ scores in the decision-making test while the independent variables were the instructional model (Problem-solving heuristics), sex, religion, and students’ background characteristics. A factorial design (nonequivalent pretest post-test control group) was adopted as it enabled the study of the effect of the treatment within the various groups. A 2 x 2 x3 x 3 factorial design was found appropriate for the study.

Method of the Study

Senior secondary school II students from three schools in Agbor metropolis in Delta State were used for the study. Senior Secondary II students were used because they are judged to possess enough school experience, and maturity and have undertaken a full course in integrated science in junior secondary school. Six intact classes were selected from the three schools (two intact classes from each school). Each school thus produced an experimental and a control group. A total of 520 students made up of 288 males and 232 females started the study but attribution reduced the number to 480 (240 & 250) the study. Of this number,240 students received PSH as treatment while the remaining 240 in three intact (control) classes across the three schools did not receive any treatment (zero treatment). However, all classes received general orientation before the administration of the pretest. Treatment lasted for five weeks during which the experimental group was presented with some science-related everyday problems on combustion, pollution, predation, vaccination and communicable diseases as well as some useful tips for resolving problems associated with these areas.

Data for the study were collected using a 36-item decision-making ability test (DMAT) adapted from Umoren (1991) test of the science-technology society (TOSTS). The DMAT was the D segment of Umoren (1991), TOSTS instrument which was modified into three parts. Part I consisted of students' background data relating to sex, age, parental academic and economic background. Part II consisted of four historical situations in which the subjects were expected to make decisions of such world issues that had great implications for science. Each of these four questions provided multiple dimensions for assessing subjects' positions.

Part III Consisted of seven case models in which subjects were presented with science background cases with health, safety, religious, social, and political implications. The aim was to determine subjects' authentic views about such cases and their likely science-informed decisions. The reliability coefficient of the DMAT in the present circumstance was found to be 0.68.by KR 21

Results

Table 2 showed that the experimental group which received the PSH treatment produced a higher mean gain (24.54) over the control group (11.02). The difference in the mean may not have occurred by chance but as a result of the experimental treatment since the two groups did not differ significantly at the pretest.

Table I: ANCOVA summary of the effect of independent variables on decision-making ability of subjects with pretest scores as covariates.

Source	SS	dg	Ms	F	P
Treatment method	18947.72	1	1894.742	1181.019	0.000*
Main effect	27463.628	3	9145.534	660.65	0.000*
Treatment	27200.278	1	27200.98	1930.89	0.000*
Sex	16.051	1	162.051	11.882	0.001*
Rel	174.312	2	87.252	5.430	0.004*
SBKGC	28.294	2	14.147	0.882	0.445
Treatment* sex	19.737	1	19737	1.448	0.209
Treatment * Rel	81.562	2	40.781	2.542	0.080
Treatment * SBKGC	4.084	2	2.0420	0.127	0.801
Treatment * sex *Rel	38.140	1	38.143	2.7980	0.090
Treatment *sex *SBkGC	41.324	4	10.331	0.646	0.601
Treatment *Rel*SBkGC	23.142	4	5.785	0.351	0.830
Error	46398.437	55	875.442	54.507	0.000
Corrected	53232.992	479	111.134		

* Significant at 0.05 level

Table 2: Pretest and Posttest means according to groups

	Exp. Group	Control Group
No. of subjects	240	240
Pretext mean	15.00	10.60
Pretext SD	3.10	3.16
Post text mean	39.54	21.62
Posttest SD	3.82	3.51
Means gain	24.54	11.02
Adjusted posttest mean	39.02	20.81

The F- value for the method effect in Table 1 was 1181.02 with df (1,479) Significant at 0.00 level of significance. Thus, the null hypothesis I that there is no significant difference in experimental and control groups in decision-making due to treatment was rejected (means = 39.54, 21.62). It was concluded that instruction significantly affected students' decision-making ability.

To determine the effect of the sex of students in decision-making across treatment groups, Table 2 showed the F value of 11.88 with df(1,479)was significant at 0.001 and thus significant at the set alpha level of 0.05. The null hypothesis 2 which stated that there is no significant effect of male and female students' performance in decision-making after PSH was rejected. This means that the performance of males and females deferred significantly in favour of male subjects.

With respect to hypothesis 3, Table I showed an F-value of 0.88 at df (2, 479), significant at 0.415 but which is higher than the 0.05 level set for this study. Null Hypothesis 3 which states that there is no significant effect of students' background characteristics on their decision-making ability was retained. This means that students' background characteristics such as parental economic status, number of siblings, and parental educational level have no effect on subjects' ability to make decisions.

On the effect of subjects' religion on their ability to make decisions, Table I shows an F-value of 5.43 at df(2, 479) was significant at 0.004 and as such significant at 0.05 level stated for the study. Null hypothesis 4 which states that there is no significant effect of subjects' religious beliefs on their ability to make science-informed decisions was rejected. This means that subjects' religion significantly influenced their decision-making ability in science-related society problems.

Discussion of Results:

A major finding of this study is that students taught with the problem -solving heuristics produced higher performance in decision-making than the control group which did not receive that treatment (experimental x=39.54, control x=21.62). This is in line with Onwu (1986) who stated effective problem-solving begins with the breakdown of the problem in bits and steps one of which include decision-making and decision implementation. It can be extra plated that since problem-solving skills are teachable using appropriate instructional devices (Moemeke and Omoifo 2003), decision-making can also be enhanced in learners through appropriate instruction. This study is however at variance with Anderson (1982) who did not find any significant effect of treatment on the problem-solving and decision-making skills of students.

The significance of sex on decision-making in favour of males corroborates Umoren (1991), who found a significant influence of sex in favour of males. It is possible to speculate that the cultural setting of the African mind places females in a position that makes them less enthusiastic to make decisions. This does not however suggest that females do not possess the capability to make an authentic decision but a reluctance to do so in the presence of male counterparts. This however is a speculation that needs to be investigated. The work of Atkin (1977) though disagreeing with any difference in the recall by males and females, agreed that any such difference could be as a result of differences in the application of knowledge to a problem situation in favour of boys. One could also speculate that Klahr and Dumbar (1988) and Ridley and Novak (1983) suggest that males persevere in science and as such develop a better working memory which is a necessity for decision-making and problem solving may account for the differences in this study. Bybee (1985) explained decision-making as a logical extension of problem-solving in a personal and social context.

The significance of religion in determining science students' decision-making ability though unexpected, indicates that human decision is a product of intricately connected and complex thought processes. It also draws attention to the spirituality of scientific thought and scientific decisions.

The non-significance of students' background characteristics on their decision-making ability is quite informative. It draws clear sentiments that problems solving and decision-making are purely mental activities that are completely different from social characteristics and are thus unaffected by it.

Conclusion: Results showed that there exists a differential effect of treatment on student ability to take decisions. The study has shown that decision-making can be targeted and taught as an outcome of science instruction. This is because science generally involves the making of appropriate choices in the procedure, experimental techniques, and techniques for reporting and other science-related activities.

Subjects differed in decision-making ability along gender lines in favour of males. This may be connected with the social aspects of the classroom environment and calls for further inquiries into gender issues in the science classroom with Africa's cultural context of the school.

Religion was also found to be significant in this study. Though this is unexpected, it shows that irrespective of students' exposure to science and science thinking heuristics, students still hold tenaciously to their religious beliefs. One is tempted to state here that though some of the science-related problems had religious and moral implications, students considered moral and religious implications above scientific consequences.

Recommendation

Science teaching in Nigeria should target some other learning outcomes which are needed in effective science endeavours and in everyday life. Decision-making is a mental process and all-around learning must incorporate it. It should not be left to chance. Science teachers should utilize the ambits of science to develop and fortify learners' ability to make effective and appropriate decisions when faced with alternatives in the class, as practicing professionals, and in daily life and living. This is a more meaningful kind of all-round learning

REFERENCES

Aikinhead, G. S. (1985). Collective Decision Making in the Social context of Science. Science Education, 69 (4),453-475.

Alkin, J. A (1977). An information processing model of learning and problem solving Unpublished Doctoral Dissertation, Cornell University, Ithaca, New York.

Bybee, R. N .(1985).The restoration of confidence in science and Technology Education, School Science and Mathematics 85,95-108.

Doyle, D.P. and Hurtle, T.W. (1988). Excellence in Education: The states are in charge. Washington, D.C. American Enterprise institute for public policy research.

Gosing, D. and Musschanga, B. (Eds) (1985) Science Education and Ethical values Geneva: WCC publication.

Hurd, P. D. (1984). Reforming Science Education The search for a new version. Washington, DC. Council for Basic education.

Hurd, D.P (1988). The emergence of a new synthesis for Biology Education Bulletin of Science, Technology and Society 7(5/6).588-588.

Junniper, D. F. (1986). Decision Making for Schools and College. Pergamon Press Ltd. Headington Hill Hall, Oxford 30 Bw, England.

Klahr, D and Dumbar, K (1988). Dual search space during scientific reasoning. Cognitive science, 12, 1-48.

Moemeke, C.D. and Omoifo, C.N. (2003). The effectiveness of individualized, collaborative fieldwork and expository learning on Biology students ability to solve problems. The Jos Journal of Education 6(2), 84-94.

Onwu, G. O. M.(1990). Development of creativity and initiative in the context of African cultures. In African thoughts on the prospects of science for all UNESCO-UNICEF, Dakar 129-142.

Ridley, D. and Novak, J. (1983). The sex-related difference in high school science And mathematics enrollment. Do they give males a critical head start toward science and Maths -related careers? Alberta Journal of Educational Research, xxix,308-318.

Umoren, G. U. (1991). A science Technology-Society paradigm and cross River state secondary school students' scientific literacy, problem-solving, and decision making. An unpublished Ph.D. thesis submitted to the faculty of Education, University of Ibadan, Nigeria.

Zoller, U. (1982). Decision-making future science and Technology curricula. European Journal of Science Education,4(1)11-27.