Institute for Christian Teaching
Education Department of Seventh-day Adventists

HABITAT RESPONSIBILITY: TEACHING STEWARDSHIP THROUGH CHEMISTRY

by Gloria A. Wright

Department of Chemistry
Caribbean Union College
Maracas Valley, St. Joseph
Trinidad and Tobago, West Indies

Prepared for the
18th International Faith and Learning Seminar
held at
West Indies College
Mandeville, Jamaica

June 16 - 28, 1996

270-96 Institute for Christian Teaching
12501 Old Columbia Pike
Silver Spring, MD 20904 USA

HABITAT RESPONSIBILITY: TEACHING STEWARDSHIP THROUGH CHEMISTRY

Introduction

When God created the earth, He proclaimed it "very good". He then created human beings and assigned them the privilege of taking care of it and using the resources for the mutual benefit of all who would share this space.

Unfortunately, as we prepare to usher in the twenty-first century, it is clear that this planet is in anything but a "very good" condition. Any assessment of the state of our terrestrial home will reveal a planet reeling under the ravages of over-exploitation and waste accumulation. To a great extent, this present state of the earth is due to developments that unfolded during the twentieth century.

Although Chemistry is a relatively young science of some three-and-a-half centuries, the practice of Chemistry has been important since prehistoric times. The Egyptians and the Assyrians processed ores to produce metals for ornaments and weapons and produced very effective embalming fluids; then, closer to our times, the alchemists of the Middle Ages exerted much time and effort looking for methods to turn cheap metals into gold. All these activities produced by-products but at a manageable level. It was not until the nineteenth century, with the dawn of the industrial revolution, that the equilibrium shifted toward production of a greater proportion of unused or unusable by-products as opposed to intended or useable products. The accumulation of scientific knowledge was accompanied by development of associated technology and in the area of Chemistry it was no longer enough simply to discover what chemicals existed in nature, but to isolate them for study and for use, then later to synthesise them. This latter proved to be a blessing to the extent that many health-promoting and health-restoring products became available in large supplies and at affordable costs. In addition, new materials and substitutes for natural substances were created, most of which were intended to make life easier for mankind.

By far the most significant event in the development of science and technology has been the discovery of petroleum and the industries it has spawned. Both the primary and the secondary products of the petroleum industry dominate our lives -- from basic fuel to the ultimate in state-of-the-art paraphernalia, and everything in between. Other new discoveries, such as nuclear science, also have far-reaching effects on our lives, but the most pervasive is, without a doubt, the "oil" industry -- black gold. Trinidad and Tobago, the site of Caribbean Union College, is an oil-producing country and so a course such as Chemistry In Society provides an appropriate arena for students to practise informed decision-making based on their knowledge of chemistry.

The Problem

It must be emphasised that Chemistry, like any other area of scientific knowledge, is neither good nor bad. Chemistry seeks to understand the composition and properties of the substances that are present in the physical universe, and the changes they undergo, thus discovering laws God put into effect in His acts of creation. It was God's intention that human beings should take the "talents" that were presented to them at their creation and "multiply" them by using their God-endowed abilities to uncover and to create.

But like everything else that was marred by the entrance of sin, man's ability to manipulate his environment has led to misuse. This is now endemic in his thinking and is reflected in the use of certain value-laden words: a place is considered "developed" to the extent that grass and trees have been replaced by steel and concrete; "refined" foods have been robbed of their most crucial nutrients; "progress" is reflected in a shift away from physically demanding occupations, or in carrying out the same tasks using methods that require less physical exertion.

The unfortunate truth is that many Christians have bought into this value system, at both the individual and the corporate levels. Thus they are found among the consumers of our society who are caught up in the whirlpool of conspicuous consumption: the advertiser raises the expectations of the consumer with a promise of the "better life", the consumer in turn increases her demands of the manufacturer who seeks to satisfy the consumers who then come to expect more -- and so the spiral continues. In order to cater to today's consumer, the resources of the earth are being exploited at an ever-increasingly rapid pace, leading to extensive depletion of our non-renewable resources and a scarcity of precious materials. They are caught in a trap which Brown[1] refers to as "quantitative thinking", mirrored in his country's wasteful life-style. He welcomes a return to "old-fashioned virtues of thrift and simplicity" for, says he, "thriftiness is next to godliness".

The most conspicuous evidence of the low value that today's occupants of planet earth place on its resources is the landfills outside of cities. Our throw-away generation leaves behind a tell-tale trail of cast-offs, mostly made from a variety of plastics. Less visible, and therefore more insidiously deadly, are the pollutants of air and water which issue forth from industrial towers, from our domestic havens and from transportation systems. The culprits span a wide range of chemicals, but they all share one common fate -- they end up in the wrong place. In the same way, radioactivity has become a concern, because although none of the Caribbean countries uses nuclear sources of energy, or is heavily involved in the use of radioactive isotopes, the politicising of several recent attempts

to transport nuclear wastes through and near Caribbean waterways highlighted the fact that the use of earth's resources in one part of the world affects life in all other parts.

The Solution

All over the world people are concerned about the state of the earth. The accompanying desire to get back to basic qualities of life, this yearning for a more pastoral lifestyle, is a phenomenon found among Christians and non-Christians. But whereas for the latter it may simply reflect a disillusionment with the "rat race", for the former it should represent growth in the recognition that "God values quality over quantity of life.[1]

The concept of STEWARDSHIP is a hallmark of the American version of Christianity, in contrast to the European brand.[2] This followed from the fact that European churches were usually supported financially by the state, whereas in North America the congregations had to provide for their expenses. As a result, there is the unfortunate perpetuation of an understanding of stewardship which limits it to money. Not withstanding attempts through books and articles in Christian journals to broaden the scope of Christian stewardship in the minds of modern Christians, the association of stewardship and money is still extremely strong. The Seventh-day Adventist church, having been cradled in the United States of America, still carries vestiges of this distortion. We still have a narrow view of stewardship, reducing it to money.

To be true to the biblical concept of a steward (Gen 43, 44; 1 Chron 27, 28; Dan 1:11, 16; Isa 22:15; Matt 20:8; Luke 8:3; John 2:8), it is imperative that our definition of a steward encompass the broader view of "one who has been given the responsibility for the management and service of something belonging to another",[2] that other being God the Creator of this earth who at creation gave man dominion over the earth and all that is therein (Gen 1:28-30) and through redemption made us "stewards of the manifold grace of God" (1 Pet 4:10). God requires His stewards to be faithful (1 Cor 4:1,2). The Seventh-day Adventist statement "Caring For God's Creation"[4] that came out of the 1992 Annual Council begins

> 'The world in which we live is a gift of love from the Creator God, from "him who made the heavens, the earth, the sea, and the springs of waters" (Rev 14:7, NIV; cf Rev 11:17, 18). Within the Creation He placed humans, set intentionally in relationship with Himself, other persons, and the surrounding world. Therefore, as Seventh-day Adventists, we hold its preservation and nurture to be intimately related to our service to him.'
>
> Being cognisant of this relationship to God and to His

creation, Seventh-day Adventists must be proactive both as individuals and as a church in contributing positively to the state of the earth. We recognise our special relationship to God both by creation and by redemption (Ex. 31:13, 17). "Humanity-to-nature relationships were also a casualty of sin....The quality of life for the human family has been degenerating ever since. The state of humanity in sin is a condition of alienation from God, from one another, and from nature. Broken relationships are both the cause and the result of the Fall."[5]

To the extent that man's Fall brought destruction and decay to nature, man's redemption should be accompanied by some measure of respite for nature from the ravages of unregenerated human beings. The exploitation of nature's resources will be in the spirit of the God-given mandate to subdue and have dominion over the earth and all that is therein; it will be a series of interrelated and responsible actions in which care is taken to maintain the necessary balance between short-term and long-term concerns. Need, not greed, will be the watchword.

Responsibility of Seventh-day Adventist Education

God commended Abraham for his willingness to pass on His values to the generations following, (Gen 18:19) and today He is just as anxious that all our children be taught "of the Lord" (Deut 6:7, Isa 54:13). This task is a three-pronged one, involving home, church and school.

The educational system followed by our colleges is very suited for passing on a true concept of stewardship to succeeding generations of Adventists. It is an extensive system, being the broadest operated by any protestant church and embracing schools all around the world. Students pursue a "liberal arts" degree, built up of components other than the student's narrow area of special interest. The components are chosen on the basis of the kind of outcome (graduate) desired. It is therefore possible to build into the general education requirements a component which incorporates true stewardship education. Ideally, all classes taught in Seventh-day Adventists schools should provide stewardship education. True education is more than a knowledge of literature and science.[6]

Chemistry lends itself very nicely to the awareness of our stewardship relationship to God. In the process of "peeking into the mind of God", the student of Chemistry has many opportunities to emphatically proclaim with the apostle Paul: "O the depth of the riches both of the wisdom and knowledge of God! how unsearchable his judgments and his ways past finding out!" (Rom 11:33). The more intelligent the Christian, the greater he or she can render praises to the great God of the universe.[7] Led by a teacher whose objectives include stewardship education, the student begins to respond to issues by asking at each stage,

"What are my responsibilities in this situation as a Christian steward?" The quest to understand more deeply the works of nature does not remain simply an end in itself. It carries with it an ethical and moral responsibility to seriously consider the implications of all personal and societal decisions, to seek to make the most balanced decision in each case, and in turn to try to influence others to do likewise. Decisions will not be made simply on the basis of expediency or convenience but on the effects on life -- plant, animal and human.

The Course: Chemistry In Society

CHEM 107, Chemistry In Society, is designed to give non-science students a knowledge of the chemical activities that occur in the course of daily living. The class meets for two hours each day, Monday through Thursday, during which time students are mainly involved in practical activities. Through this "hands-on" approach, the students investigate the properties of air, water, acids, bases, and various energy sources. In addition to that gained from their laboratory experience, they gather information outside of class. Class discussions provide a forum for sharing information and, more importantly, developing perspectives from which they will make decisions. They are able to give an example of this in the class project which consists of a written report on some aspect of the course content. A more desirable expression would be actual physical involvement in a project which leaves a community of their choice in a better state. Examples of such a project were those sponsored by a leading commercial bank in the country, and which involved fourth form students this year in projects such as cleaning up rivers under the Young Leaders programme.

UNIT I: SAFETY IN THE LABORATORY AND PUBLIC SAFETY

The first activity of the course is reading of the laboratory safety rules and the signing of an agreement to abide by them. One copy is kept by the student, one is turned in to the department. These rules outline safe conduct and attire, proper disposal of chemicals and immediate action in case of an accident. They then have to locate safety equipment and answer questions about their upkeep and use, as well as learn the meaning of relevant terms. They do simple glasswork and learn the names and appropriate uses of laboratory equipment. In regard to public safety, they examine labels of commercial products, list the active chemical components and identify their properties. With this factual information, they then go on to answer questions about their use of these products in the past and how they intended to use and/or dispose of them in the future. Under "garbology", information on solid waste disposal in Trinidad and Tobago and some other countries is discussed. The out-of-class activity involves each student measuring the garbage generated per person in their home or dormitory room over

a seven-day period, determining how much of it is recycled and comparing their results.

UNIT II: AIR AND GASES

In the second unit, experiments are carried out which investigate the composition and properties of normal air, and gases in general. For example, in the laboratory they prepare and test some properties of component gases and at home they make a simple barometer by which they monitor atmospheric pressure -- attention is turned to the topical issues of ozone depletion in the stratosphere and ozone accumulation in the troposphere; global warming and the "greenhouse effect" due to the increase of carbon dioxide and water vapour in the atmosphere, transportation being the main source; the fluctuation in the oxygen content of natural waters. The causes and the effects of recent changes in the atmosphere, their significance and possible responses that can be taken by individuals or communities, are discussed.

UNIT III: WATER AND OTHER LIQUIDS

The first water activity involves producing a sample of "clean" water from "foul" water. As the students go through the water purification procedure, which is patterned after the process carried out in communal water treatment plants, they test the water by appearance and smell, learning as they see the transformation at each step, what each step accomplishes. Finally, a simple test is used to examine its chemical purity and they are taught to differentiate between chemical and hygienic purity. The importance of both production cost and health considerations in bringing water to this stage of purity and in choosing between the possible methods of further purification, is discussed. This leads very naturally into a discussion of the methods used to purify water in their respective territories, and a correlation evolves between the state of the natural waters and the type of economical activities in the countries or in different sections of the same country. This provides an opportunity for them to consider the availability of water and the cost of human activities on this life-supporting resource of nature. Activities are done to illustrate the meaning of "hard" water, its effects and causes, and methods of softening water. Tests for identifying the ions which cause hard water are carried out. Solutions, as distinct from colloids and suspensions, are identified by examination of some familiar liquids such as a starch-and-water mixture, a soft drink, and milk. The solvent properties of another liquid are experimentally contrasted with those of water. The "at home" activity for this unit requires each student to keep a log of water use by the occupants of the home or dormitory room for three days, specifying things such as number of baths, number of toilet flushes, number of times a washing machine is used, length of time water is run in the sink and number times the lawn is watered. The resulting data allows

for another discussion which focuses on the importance of water and responsible use of it.

UNIT IV: ACIDS AND BASES

Students are introduced to the concept of acids/bases by carrying out an activity which involves systematic dilution of an acid solution and of a base solution and, using indicators which by characteristic colours indicate how acidic or how basic a solution is (i.e. the pH of the solution), they determine each solution's pH. They first use commercially prepared indicator papers and solutions, then they prepare their own indicator solution from hibiscus petals and, noting the characteristic colour change of the solutions, compare the results. They then use their hibiscus indicator to classify as acid or base some commonly used substances such as tap water, vinegar, baking soda, shampoo, antacids, cleansers. At home they use their choice of indicator to determine the pH of other solutions, including dew, rain water and body fluids, and try to determine which component of the solutions account for the pH. They report on how specific products are advertised or promoted on the basis of pH. They learn the concept of "buffers" by carrying out experiments to see how an unbuffered solution's pH is more readily affected by acids and bases. For commercial applications of the principle as found in everyday life, they test and compare the pH of aspirin and bufferin and also carry out, in vitro, the reaction that occurs between an antacid and the acid in the stomach. Acid rain, an issue of current concern, is simulated and its pH is compared with that of tap water. Its effects on fruit, metals and minerals are observed. The effect of chemical processing on samples of human hair is investigated and in the process the students discover the relative pH's of chemicals used at various stages of the straightening or curling process. They learn about the composition of hair and put their own hair through some physical tests designed to determine its health. This section of the unit usually elicits concern and leads to questions on the part of both male and female students; some express definite opposition to chemical processing of the hair, others pledge to be more consistent about caring for their hair.

UNIT V: ENERGY: THE PETROLEUM INDUSTRY AND ALTERNATIVE ENERGY SOURCES

It is the availability of an abundant, clean and relatively cheap energy supply that has created today's way of life, and this is reflected in the fact that this unit is the most extensive. It begins by looking at petroleum (formed from heat and pressure effects on the remains of microscopic aquatic plants): its identity, composition, production; the uses of its primary products; the wide range of products that now exist because of it. Samples of petroleum in solid, liquid and gaseous states are examined, characterised and chemically

identified at the macro and micro level (using of molecular models.) The energy available per mass of a fossil fuel, in this case candle wax, is determined experimentally. Students have opportunity to synthesise examples of artificial flavours which they identify by chemical name and by association with a natural flavour. Plastics, synthetic products that result directly from the petroleum industry, and second in abundance (by volume) of the materials found in municipal solid waste, are next investigated. Samples of various plastics provide opportunities for learning the differences in physical and chemical properties which result from the differences in their microstructure and which determine their use. The properties also determine their classification and explain why some are recyclable and some are not. Samples of consumer products made of different plastics are classified and students practise interpreting the plastic recycling code symbols by identifying them on plastics in the laboratory and outside. In order to appreciate the "plastic problem", they bury samples of different types of plastics and after a week or more examine them for evidence of degradation. Similarly, they test samples of plastics for photodegradation by placing them in direct sunlight.

Nuclear energy, although it is not an energy source in Caribbean countries, is none-the-less important for all members of the international community. Students answer a survey designed to test their understanding of nuclear-related phenomena, then administer it to three persons from different generations. The subsequent discussion of their findings and their opinions create the avenue for leading them to separate fact from fiction where this topic is concerned, and to respond to nuclear issues from a basis of factual information rather than fear. The last question on the survey which asks their opinion on whether the Caribbean should use nuclear power to generate electricity is particularly significant as this is a decision that they may have to contribute to after they have left student life behind. In any event, the debate over issues relating to nuclear energy has arrived in the Caribbean. In order to help them understand the concept of half-life, an activity which uses the shaking of coins in a box is used to simulate radioactive decay of atomic nuclei. They also learn other examples of beneficial applications of nuclear radiation, some of which are currently being practised in the region, as well as some destructive applications.

Whatever the source of energy, it is usually converted into electricity since, although expensive to produce, this is a clean, convenient, relatively safe and fairly efficient form of energy. Students make electrical circuits, and experiment with various circuit connections to see which work and which do not. They then discover what substances conduct electricity and which do not, and why. Finally, they learn how different types of batteries produce electricity by carrying out chemical reactions.

UNIT VI: DIET: ENERGY AND NUTRITION

Since our steward responsibilities extend to the care of our bodies, foods which provide energy and nutrition for human beings are also investigated. Different sugars and artificial sweeteners which are non-energy foods are compared for sweetness. Qualitative tests are carried out to identify carbohydrates, proteins, amino acids and iron in foods. A sample of milk is quantitatively analysed for protein, carbohydrate and water and the energy value calculated. Each student carries out similar calculations for their total food intake over a period of three days, determining their intake of energy, protein, carbohydrate, fat, calcium, iron and Vitamin C. They then compare their results with recommended daily allowances for their age and gender, and answer questions regarding the appropriateness of their diet. Finally, they compare their energy intake for one day with their energy output, based on their activities for that day and how long they engaged in each activity, and answer questions which relate to their personally achieving a balance between the two.

Throughout the course are interspersed opportunities for the students to learn the traditional skills of Chemistry: measuring in appropriate units with the appropriate apparatus, interpreting and drawing graphs, learning to write chemical formulae and equations. However, these skills, though taught deliberately, are presented as a means to an end, with the emphasis being on their usefulness in carrying out the practice of Chemistry .

Summary and Conclusion

As is the case with any area of knowledge, Chemistry provides an appropriate vehicle for passing on the values and virtues of Christian stewardship, indeed for knowing God.[6] This will only happen if there is a conscious and deliberate process of bringing to the attention of the students the reason these issues are important and the context in which responses to them are to be decided upon. The summary below shows how Chemistry In Society leads students into this experience.

	UNIT	STUDENT ACTIVITY	STUDENT RESPONSE
I	SAFETY IN LAB	Students receive rules for safe procedures in lab and locate first-aid equipment.	Students submit signed pledges to follow the safety rules and answer related questions.
	PUBLIC SAFETY	Students examine labels of familiar products to identify chemical content.	Students seek information on local public-waste disposal procedures.

II	AIR & GASES	Students investigate properties of gases normally present in air of those which cause pollution. Students make barometer and monitor atmospheric pressure.	Students discuss air pollution in the region and their island and its effects on quality of life. Students recognise some factors which affect climate.
III	WATER & OTHER LIQUIDS	Students carry out the steps of purifying a sample of foul water. Students test water purity and hardness. Students test solvents other than water for solubility.	Students evaluate the cost of a public water system and monitor their water usage over three days. Students learn to choose appropriate solvents.
IV	ACIDS & BASES	Students identify acids, bases using indicators and test their effects on buffers. Students test effect of "acid rain" on metals, carbonates, fruit.	Students identify acidic/basic properties of familiar fluids, becoming aware of the interactions between them. Students become aware of causes and effects of acid rain on the environment.
V	ENERGY Petro-eum as raw material	Students investigate gaseous, liquid and solid samples of petro-leum. Students examine the properties of dif-ferent types of plastics.	Students become aware of the wide range of compounds present in petroleum. Students become aware of the need to recycle non-degradable materials.
	Nuclear	Students do experiments simulating 'half-life'.	Students evaluate the pros and cons of nuclear energy sources.
	Electrical	Students try different electrical circuits to discover which work. Students test various chemical samples for electrical conductivity.	Students discover how electricity is accessed from a source. Students see that electrical energy can be produced from chemical energy.
VI	FOOD	Students record and evaluate their personal diets.	Students make decisions about their personal diet.

The class project as it is currently formulated allows the student to express his or her acquired awareness and concern as a Christian steward, or a serious intention to be part of the solution to the problems. For example, reports by the Environmental Management Authority that some popular beaches in Trinidad and in Tobago contain a high level of bacteria due to inefficient treatment of sewage and the presence of yatchs in the nearby marinas indicates the need for citizens, especially Christian citizens, to take more responsibility, individually and corporately, for what happens around them.

Instead of giving in to technicism, where technology sets the agenda for life on planet Earth, the ethics of the Bible should be the basis on which we make decisions on the value of life and on the conduct of life. Students will have been taught by their experience in the course Chemistry In Society, that

> "...human beings are to subdue and rule God's creation in such a way that they bring out the beauty and excellence God has placed in His creation; they are to allow creations's potential to flower."[8]

NOTES AND REFERENCES

1. Brown, L David Taking Care: A Guide to Responsible Living Augsburg Publishing House, Minneasota, 1978.

2. Hall, Douglas John The Steward: A Biblical Symbol Come of Age Friendship Press, NY 1982.

3. Illustrations of this fact abound: the book Counsels on Stewardship is a compilation of Ellen G. White quotations on our financial responsibility to God; stewardship workshops are really budget-planning tutorials emphasising "putting God first" in the "stewardship of treasures"; the stewardship director is usually someone trained in financial matters or someone who is considered to be successful in business; the point in our divine worship service where we sing "Praise God From Whom All Blessings Flow" is after the collection of the morning's tithes and offerings; a 'home' no longer needs people -- it is something one buys.

4. "Statement III -- caring for God's creation", Ministry Magazine, May 1993.

5. Nixon, John S. "The Mother of All Battles", Message, Jan/February 1996.

6. White, Ellen G. Education Pacific Press Publishing Association, Mountain View, 1952.

7. White, Ellen G. Counsels To Parents, Teachers and Students Pacific Press Publishing Association, Mountain View, 1943.

8. Sire, James W. Discipleship of the Mind Intervarsity Press, Downers Grove, 1990.

BIBLIOGRAPHY

American Chemical Society CHEMCOM: Chemistry In The Community 2nd ed., Kendall/Hunt Publishing Company, Dubuque, 1993.

Boughman, Larry W. Campus "Beautification: A factor in integration of faith and learning" (No. 190-94; 14CC: 39-58).

Bwana, Peter "Creativity and Responsibility in environmental transformation" (No. 081-90; 5CC: 257-270).

CHEMCOLOGY March/April 1995 Vol 24 No.3.

Fromm, Erich To Have Or To Be Harper & Row Publishers, 1976.

Holmes, Arthur F. The Idea of a Christian College, revised ed., William B. Eerdmans Publishing Co., 1987.

Kizito, Josiah "Environmental education: Caring for God's creatures" (No. 161-93; 12CC: 121-141).

Knudsen, Raymond B. Developing Dynamic Stewardship Abingdon, Nashville, 1978.

Lockton, Harwood A. "Adventists and the Environment" College and University Dialogue Vol 4, No 2 1992.

Longacre, Doris Janzen Living More With Less Herald Press, Scottdale, 1980.

Maiyo, Barnabas K. "Alienation, human values and ecology: The role of a Christian geographer" (No. 133-93; 10CC: 297-310).

Palms, Roger C. First Things First: Solid Guidelines for a Productive, Satisfying Life Victor Books, Wheaton, 1983.

Rein, R. C. Adventures in Christian Stewardship Concordia Publishing House, St. Louis, 1969.

Sider, Ronald J. Rich Christians In An Age of Hunger Word Publishing, Dallas, 1990.

Tyner, Kathy L. Exploring Chemistry In Today's World Wm C. Brown Publishers, Dubuque, 1993.

White, Ellen G. Education Review & Herald Publishing Assos., Takoma Park, 1940.

White, Ellen G. Counsels on Stewardship Review & Herald Publishing Assos., 1940.

Zuill, Henry A. "Expanding the garden: A Christian's view of nature" (No. 211-94; 14CC: 411-429).