



A Deweyan Method of Teaching Genetics to Integrate Science and Ethics with Student-Centered Problem Solving

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1. Introduction

If you owned a small insurance company that covered health policies, would you decline an applicant who was diagnosed as having Huntington's disease, assuming that you also knew that treatment bills over a ten year period would bankrupt you? As it happens I have a friend whose father started such a company when it was illegal for an African American to own an insurance company. How would you advise him when faced by this situation? All my students had just watched Barbara Walter's documentary, PERFECT BABY, and had seen her interview with Woody Guthrie's son and family, none of whom have been tested for Huntington's disease and any one of them could have the genetic disease. With few exceptions, all my students are African American, yet almost all of them would advise my friend to give the health coverage even if it meant certain bankruptcy for him. Their reasoning was that the applicant had the right to insurance regardless of consequences.

A similar situation occurred in another class. On this occasion the content of the class had been the consequences of overpopulation to organisms in general and then to humans in particular. Students were distressed by the information they learned but when asked whether there should be a limit to family size, again almost all of them thought that everyone had the right to as many children as they wanted.

My concern on these and similar occasions was not with student's values, but that in every case their decision making by-passed what was in front of their noses. It seemed to me that, in fact, they were not acting ethically at all since their heads and their hearts were in no way connected. They expressed no compassion in their decision making and cut the connection between deed and consequences. Understanding had no part to play. My role as educator was pointless because the answers were given *a priori*. The loss of a person's livelihood, global devastation, misery and suffering apparently did not enter in to their ethics—only the rubrics of a religion or rule book.

1(a) How to integrate science with ethics?

The problem of this unit is to find a way of presenting ethical issues in such a way that the teacher does not simply elicit responses pre-determined by home, peer group or religion, but provides a process of decision making that is intrinsically ethical, i.e. it connects values with facts, feelings with data, and deeds with consequences. The problem was directly addressed by John Dewey so his philosophy will first be examined for

help in finding a concrete answer. He conceived of the problem as fundamentally the problem of the relationship of science to morality and considered the resolution of the problem the primary task of a teacher. A practical method of implementing his ideas follows the theoretical analysis.

1(b) How to teach student-centered problem solving?

The following unit was originally inspired by the need to solve the problem of how to teach genetics that was student-centered and inter-disciplinary. A practical method is given that I think achieves this and provides a suitable context in which to locate student bioethical problem solving in a scientific manner. It offers a Deweyan pedagogy in which the teacher “directs the child’s activities, giving the exercise along certain lines, and (that) can thus lead up to the goal which logically stands at the end of the paths followed.” ¹ It breaks with traditional education that was characterized by Dewey for:

“its passivity of attitude, its mechanical massing of children, its uniformity of curriculum and method. It may be summed up by stating that the center of gravity is outside the child. It is in the teacher, the text book, anywhere and everywhere you please except in the immediate instincts and activities of the child himself.” ²

It was of course Dewey’s aim to bring about a revolution in teaching in which, “the child becomes the sun about which the appliances of education revolve; he is the center about which they are organized.” ³ The following unit has taken the above criticism to heart. Students are “given a motivation to demand the information.” It was tried out and had pleasing results.

2. Dewey’s Theory of Science.

The genius of science is not in its method but in its insistence that mind is subject to experience. Mind is not allowed to think what it pleases but must discipline itself by the hard knocks of experience, the center piece of the laboratory. By experience, Dewey means what he claims it has always meant—simply what is experienced.

“The existing experience holds us for its own sake, and we do not demand that it takes us into something beyond itself. With the child and his ball, the amateur and the hearing of a symphony, the present object engrosses. Its value is there, and is there in what is directly present.” ⁴

Over against rationalists he asserts that reason is subjective and prejudiced if it acts independently of experience and that experience in the first place is a matter of feeling (sensuous awareness). Mere reason is empty. The real is in the experience that we as reactive organisms must respond to and objectivity comes from the consequences of acting in response to that environment. Hence the name for the philosophical movement of which he was a prime architect—pragmatism. The central tenet is often thought to be that of learning by doing but this is only a partial and misleading characterization. The artist is Dewey’s hero, such as Emerson, because the artist begins with the immediacy of experience and then finds a path in and through that immediacy. The role of reason is the practical one of finding a path through an uncharted territory. Scientific knowledge is thus not about universal truths for all time but truths in the sense of sign posts that help us get around with minimal disaster.

Over against empiricists or idealists of the Kantian sort, Dewey rejects any kind of transcendentalism that implies a mental *a priori* decision making mechanism that is the deciding arbiter between truth and illusion. Dewey can agree to having a set of rules for “constructive synthesis in a differential sense” but not to a static endowment lurking in the brain that provides a “law for the determination of every experienced object”. ⁵ The

problem that empiricists inherit is the simplistic notion of experience given by John Locke. It is assumed that experience consists of small frames of experience that are pieced together like frames in a film. For Dewey the mind is an active exploratory experiencing entity that follows its feeling awareness of the environment in which it is set. Reason only abstracts partially out of this continuum and must remain all too human and is fundamentally time bound and developmental. That we can make generalities and express them as laws does not alter the condition upon which these laws are based. It would be rather like splitting written music from the instrument that makes the sounds. As transcendental as music may be, it does not detract from its time bound materiality. Dewey's passion for philosophy was directed in many respects from a desire to overcome the split ways of thinking that characterizes modern thought, and science in particular.

The starting point for thought then is experience and for science this means the experiment. It is not one experiment but one continuous multiplicity of experiments that are part of an on-going journey of thought. To understand his philosophy one has to appreciate that what is first grasped is not an idea but a feeling for qualities that are present. Secondly, Dewey cannot be understood if one forgets that the mind does not seek abstract truth but solutions to a problem, in particular how to realize the object of its desires—the fulfillment of its feelings. The invention of a telephone was an ongoing interplay of envisioning, feeling, testing out a practical solution, thinking and 'seeing' facts in a new light that then led to more tentative ideas, actions, feelings, ideas, actions and so forth. Knowledge is thus an interplay of feeling (the aesthetic), action (conation) and thinking (reason). Science (knowledge) is thus an organic process in which feelings lead the way.

What Dewey has in mind as he developed his philosophy was a reflection upon the role of mind in human evolution that he himself called a genetic way of thinking. Mind developed because of its power to help our species negotiate the environment. When the brain was set free from simply following behavior patterns given by coded instructions in DNA, it could start acquiring knowledge (science) that could be passed on to following generations through culture. The role of philosophy is to facilitate that process, i.e. to assist in solving problems and only in this respect could it justify itself (pragmatism!). Hence Dewey's preoccupation with science and science education but the science he has in mind is not split from the arts or morality. It is not to be found in some esoteric method, but "a way for getting at the significance of our everyday experience of the world in which we live" and education is "a continuous process of the reconstruction of (that) experience".⁶

To illustrate what he means we may use an example from genetics and quote the inventor of the modern plum, Burbank.

"I wanted to get a plum that would ship.....a plum that would be beautiful and delicious, a plum that would be large, a plum for canning, a plum with a small pit or none at all, and so on. My designs were pretty carefully worked out. For instance, as regards the shipping plum. The plum developed to be picked from the tree and eaten right there, or within a few hours in the house was quite a different thing from the plum that could be picked, packed, shipped, delivered may be thousands of miles away, unpacked, sold, carried home, and finally eaten fresh And this couldn't be acquired by accident or chance—it had to be studied and the specifications pretty carefully written."⁷

The experience of the plum was in the first place a matter of the senses—greater and larger than the cognitive reflections. Actively reflecting within the experience, the mind started wondering about possibilities. A number of questions were posed by that experience. A future objective was posited that would ultimately provide a conclusion to a rational study. Thought was future oriented, visionary and a social enterprise. Truth and values were relative to the inquiry from the outset to the consummation of the experiment. Truth did not concern eternal forms but about something new that in turn provided the starting point for acquisition of

future knowledge.

“There is only one sure way of deciding whether a plum can travel a thousand miles, be stored on a grocery shelf, brought home and remain not merely edible but tasteful: send some of the new varieties on just such a journey. The problematic situation arose within a context and the success or failure in resolving it will be judged by a return to that context Success in inquiry is inextricably connected to interactions between humans and their environments.”⁸

3. Dewey's Theory of Science and Morality

Once we understand John Dewey's theory of Science, it is not such a big jump in the imagination to realize that there is no necessary gulf dividing science and morality. If science was independent of feelings then clearly we would have an inherent break that was unbridgable. If science was independent of action, then morality that concerns actions would have no connection. If morality was necessarily irrational and had no interest in cause and effect then there would be an impassable gap. If morality could not create universal generalizations out of particular experiences or science did not have an ability to make judgments on particularities or arrive at some universals we might decide *a priori* that Dewey was being fanciful. If science could not be visionary or future oriented there might be an impasse but as the example of Luther Burbank's plum illustrates, the future is implicit in experiment. It required vision for the mind to set up its experiential procedures. If either morality or science were not inherently developmental in history and culture there might be a case to reject the impossibility of a logical analogy between the two. Clearly, however, the very same human qualities are required in making scientific judgments as are required in moral judgments. Indeed, both begin with experience and a feeling response to a specific and actual situation demanding action and rational judgment.

Dewey was concerned not to reduce morality to science but rather to show that logically they are parallel activities of the conscious mind. Morality follows on the results of scientific inquiry and its method of problem solving parallels that of the sciences. After all, in Dewey's philosophy, feeling awareness is the real, guiding the mind and confirmed by consequences from action.⁹ Is not a morality based in love not one that begins with a feeling awareness guided by the mind and testing itself by consequences of its actions?

Arguments against Dewey assume a transcendental bases for ethics that is independent of experience. They assume a conscience that acts according to judgments “in terms of itself “ independent of time and place. An example of this is intuitionism. Here there is a belief in immediate intuited judgments, not conclusions, having no logical relations and “not amenable to intellectual supervision” In such a belief system, morality is about future ends and values. Science is simply about causes and reflections on the past and what has happened. Values are unconditioned and science is conditioned. Morality is subjective and science objective. What we find though is a split way of thinking characteristic of past philosophies and idealisms that perpetuate its dualisms into the present. In Dewey's philosophy of science such a split is quite unnecessary.¹⁰

What then is the difference between science and morality? Morality passes a judgment upon an experience. It poses questions about what we should do with the information that we have gained through science. Martin Luther King and his associates strategized politically in exactly Dewey's manner. In the morning they would meet to morally reflect upon what had happened the day before and then would decide upon some action for that day. They then would act upon that decision and from that experience make further judgments from which to determine how they would act on the following day. Dewey writes that only the living can make moral judgments and that these must be in terms of time and space—of antecedents and consequences. The

rational component must take into account psychology and sociology.

Moral terms like freedom, responsibility, ideals, duty have no meaning except in the actual context. The need to abstract in both science and morality is to assist in making further judgments. However the fact that we can abstract does not alter the fact that all judgments are necessarily contextual whether scientific or moral.

Given that there is compelling argument, according to this author, for a parallel logic between and science and morality, can we find a parallel method of solving ethical problems that can be taught, rather as the scientific method is taught?

In reality the two processes of thought and judgment go hand in hand but because of how we think of science and morality as polar opposite activities, we tend to circumscribe out procedures of thought, feeling , activity and judgment that are coterminous with both science and morality. In other words, for Dewey, we need more awareness and clarity about what we do, rather than do something new. Before developing strategies for thinking through some classic ethical problems in genetics along Deweyan lines, it is necessary to outline an overview of method for the unit, in particular to set up instruction so that it is student-centered.

4. A Method for Teaching Ethical Problem Solving in Genetics.

If Dewey is correct, that science and morality are parallel activities involving the same skills, the only difference being that morality involves a higher order of judging, then perhaps we could teach moral problem solving in an analogous manner to teaching scientific problem solving. Logically it would seem that this is a possibility and what follows is a proposed adaptation of the scientific method to ethics.

I. Defining the problem.

To concretize my thinking I will use the ethical problem this paper began with. Should an insurance company run the risk of bankruptcy or major loss in order to cover an applicant with the genetically terminal illness, Huntington's disease?

We have a presenting problem but we need to look more deeply to find what really is at stake. Upon careful reflection and analysis, we find two basic needs.

- 1) All people need health care and the resources to pay their bills.
- 2) All companies cannot take risks they cannot honestly cover.

II. Generate hypothetical solutions.

One needs to envision and brainstorm possible solutions to the problem. For assistance, one needs to research how others have previously dealt with this problem and take reasonable effort to consult with journals, experts, the WWW etc. We will assume that the following are an exhaustive list of hypothetical solutions.

- 1) Insurance companies charge realistic premiums and the government will pay over and above what the applicant can reasonably afford.
- 2) When the insurance company has paid out a reasonable amount of money on health bills, the government then pays all further bills.

- 3) The government, state or federal, implements either a national insurance plan or a national health plan.
- 4) All the above—1 and 2 being steps towards 3.
- 5) Government or/and insurance companies have pre-set limits on liability that is conducted upon medical advice, so that life support can be withdrawn or unduly expensive treatment be denied at a certain point in the progression of Huntington's disease, for example, when mental faculties have been lost.

III. Determine what criteria would be used to deem plans/solutions as good/bad or better/worse? (Controlling variables)

The task is now to anticipate consequences of the hypothetical solutions that have been imagined. In this case we are interested in:-

- 1) outcomes for the parties involved—material and non material
- 2) outcomes for the government, state or wider community -material and non material.
- 3) outcomes for dependents, family or friends—material and non material.
- 4) anticipate unintended outcomes, particularly in light of research into past experiences of comparable situations.

IV. Procedure/Materials/Presentation of Data.

Choose the best hypothetical plan and fully write out how it would be implemented with list of resources and costs incurred. Plan data tables, graphs and so forth to determine how outcomes can be measured and presented. Implement the plan if it seems that the more detailed plan appears to continue to offer the best outcomes.

The only way to be sure that one has made the best decision is to carry it out. The test for ethics must be ultimately come from a judgment based upon action and consequences. That ultimate test is our conclusion that will carry with it the full weight of ambiguity, presuming that in the real world, choices rarely lead to unambiguously good outcomes.

V. Conclusion

The hypothesis must be judged in terms of the data or outcomes. How good was our hypothetical solution to

the problem we began with? Given our analysis of the data and the experience in implementing our planned solution, how could we refine our problem, hypothesis, procedure, materials, data collection and so forth. Ethical judgments become the basis for further research and starting point for developing better judgments and solutions. In a way, Dewey proposed no more than what is carried out in the social sciences all the time, and in deed he thought that sociology and psychology were inseparable from the process of ethical decision making.

Perhaps the above is all too simplistic, but it would seem to me that it is reasonable to make the demand on those who think that intuitions or revealed morals are the proper basis for ethics that they justify their metaethical stances in terms of actual contexts and actual consequences. No ethical stance can claim to be called ethical if it ignores the fullest use of human feeling, action and thought applied to all too human problems.

Dewey is also surely correct in saying that a public school teacher has only done half the job of teaching genetics if only facts are presented. Students are being cheated if they are not allowed to make moral judgments about the import of the information they have learned. Scientists may not hide behind science.

To show the feasibility of using this as a teaching method for High School students, a series of representative real life type situations that demand ethical problem solving are described below and worked out in the Deweyan manner. The simplicity of the method is captured in the `Life Skills' poster used in New Haven for its Middle schools (see adaptation devised below). High School teachers are asked to use it in their respective subjects. As it happens, the correspondence is so close that the method used here can be articulated in terms of this hand-out.

SCENARIO 1

As a College student, you successfully use recombinant DNA technique to produce a new bacteria that can rapidly convert cellulose into glucose. You are approached by a giant international corporation that promises you power, fame and fortune if you will allow them to market your biological creation. The corporation anticipates that the bacterium will provide a cheap and easy way to dispose of garbage and recycle paper into edible sugar. It will solve a global ecological problem and provide food for a hungry world. There is one problem that you feel the corporation minimizes. These bacteria, if released into the environment, might destroy anything made of cellulose—such as all plants and wood products, houses and furniture. How would you solve your dilemma?

(figure available in print form)

Adapted from Weissberg and Caplan—'When you have a problem'.

(a) Defining the Problem

1. Self-interest in power, fame and fortune—for oneself- for the Corporation
2. Possibility of destroying the world.
3. Saving the world ecologically
4. Feeding hungry populations.

(b) 4 Solutions

1. Destroy the bacteria
2. Accept the terms of the Corporation and trust their judgment.
3. Donate your work to UNESCO that will conduct an international symposium to debate the issue.
4. Start your own biotechnology business and invite experts in genetics, economic development, environmental protection management, international investment and a New York City banker to be on your board of directors.

(c) Consequences for solutions 1-4

1. The bacteria were too great a liability so their destruction gives you peace of mind and the world is saved. You stay poor and you become a school teacher.
2. The corporation makes you rich, famous and powerful, but you have no control over what happens to your bacteria. The fear of global disaster continues but research is being funded to find a virulent virus that can destroy the bacteria in the worst case scenario. A minor accident occurs. The bacteria is banned by the government.
3. The UN debates the issue—the entire development becomes international and gradually new biotechnology is put into effect that has adequate safeguards. It takes thirty years before you get any financial return. However you have friends around the world and you are well respected.
4. Initially your company is enormously successful, however, it is bought out against your will by the original company that wanted to market the bacteria. You retire early with plenty of money but with serious health problems due to the exhaustion and anxiety of being an entrepreneur.

(d) Plan and measures uses to make a conclusion.

Choose solution 3

1. Make an appointment with UNESCO at their New York offices.
2. You meet with the UN General Secretary and advisors.
3. Your proposal for an international symposium is accepted.
4. You lose control over your bacteria, but you are employed by the UN to assist in the development of the commission's work.

Measures of success

- cheap disposal of garbage occurs

- cheap production of sugar occurs
- adequate safety precautions against disaster are implemented
- your life is fulfilling

SCENARIO 2

A single woman in her late thirties seeks a husband who is a tall muscular blonde blue-eyed, white male who is also aggressive, handsome, highly intelligent and rich. She fears she will never be able to marry such a man of her dreams but learns that a reproductive technology company in California has in its sperm bank, sperm for a male who perfectly matches her Mr. Right. Furthermore, they guarantee successful fertilization of one of her eggs and will perform the embryo transplant for her. The total cost to her will be \$50,000 which could be finance through a bank loan. You are her bank manager. What advice would you give?

(a) Problem definition

1. Does she understand the Mendelian Laws of Genetics of Independent Assortment? The return on her investment is highly improbable. Some of the desired traits, such as intelligence may come from developmental influences or events over which she has no control.
2. The loan is highly profitable for the bank. However she seems emotionally unstable and may well default on repayment, especially if the baby does not have the expected traits.
3. The woman's motives seem racist. She has a right to her values but does the bank need to get involved or associated with eugenics?
4. Could she consider adopting a baby or become a foster parent?

(b) 4 Solutions

1. Advise client on the risk of the investment. Make loan available if client seems to understand

the genetics of inheritance of traits

2. Make the loan conditional on an interview with a genetics counselor and family planning agency.
3. Refuse the loan on ethical and business grounds.
4. Make the loan conditional on her finding a loan guarantor.

(c) Consequences for solutions 1-4

1. Client's baby is a brunette white male but mother is extremely happy. She had her fantasy and loves her baby regardless of what the future brings. She pays off the loan.
2. Client is depressed. Her child is eventually taken from her by the Child Protection Agency because of negligent abuse. She defaults on her loan—her guarantor pays the amount outstanding. The bank makes a reasonable profit.
3. After an interview with the genetics counselor and family planning agency she abandons her fantasy, becomes more accepting of males, and gets into an affair with her male beautician. She becomes pregnant and goes back to the bank manager for a loan on a Dodge Grande Caravan.
4. The bank manager is fired by the bank's owner for refusing the loan. The Reproductive Technology company arranges credit for her.

Plan and Measures of Success

Choose Solution 3

1. Make an appointment with a genetics counselor and family planning agency.
 2. Follow through on counseling. Dream of the baby and not of the husband. Relax and be open to wider possibilities and expectations. Look for trusting intimacy with a male and not appearances.
- Measures of Success.
- minimal financial loss and or at least financial security
 - frustrations resolved
 - has a baby

SCENARIO 3

The Lesh-Nyhan syndrome is a genetic disorder leading to mental retardation, cerebral palsy, self-mutilation, uric acid build up and early death. Only females can be heterozygous carriers. Assume that it is now the twenty-first century and recently you have learned a safe procedure to alter genes on the egg chromosomes (germline therapy) and on a fetus (somatic gene therapy). A woman comes to you having inadequate health insurance and no financial resources, but she has been diagnosed as being a carrier for the Lesh-Nyhan syndrome so there is a 50-50 chance of her baby having the disease. You are also aware that a fellow doctor has recently been successfully sued for professional negligence for failing to properly diagnose a genetic disorder in a fetus. What would you do for your patient?

(a) Problem definition

1. The law requires that you only have to provide a medical consultation.
2. Your HMO policy is to give minimal services, which in this case can include a genetic diagnosis of the fetus.
3. The HMO has private charitable funding for somatic gene therapy since this procedure avoids abortion of the fetus.
4. The HMO has government funds to provide germ therapy without cost since this will remove the defective gene for all time.

(b) 4 Solutions

1. Give the medical consultation only.
2. Diagnose the genes of her fetus. Refer her to an abortion clinic if the baby has the defective gene and recommend her fallopian tubes be tied.
3. Offer the option of somatic gene therapy but make clear that the procedure is not risk free. The fetus may not develop normally once returned to the womb after therapy.
4. Offer free abortion, provide either the option of tying her tubes or the option of having germline therapy now or at a later time.

(c) Consequences for solutions 1-4.

1. Following the consultation, she carries the baby to term since she has no resources for an

abortion and cannot face harassment from anti-abortion protesters. Her baby turns out to have the Lesh-Nyhan syndrome and dies four years later. The mother is left with large bills incurred from treatments and death of the baby.

2. The baby was found to carry the defective gene. Your HMO director is prepared to unofficially waive expenses for an abortion because of the circumstances.

3. Somatic therapy was not successful in the long run. The baby dies shortly after birth. The HMO does not cover all the expenses of her pregnancy.

4. Germ therapy is postponed. Despite the inconveniences involved, she eventually gives birth to a healthy baby who grows up to become a genetics counselor.

(d) Plan and Measures of success.

Choose solution 4

1. The patient has an appointment with a genetics counselor so that she can fully understand what is involved in germline therapy, including the abortion.

2. Appointment made for abortion and tubes to be tied.

3. Patient returns in two years to begin the medical process leading up to successful fertilization of a normal egg.

Measures of success.

- mother understands and supports the therapy.

- baby is born healthy and lives with no negative consequences from the therapy.

- society is saved from the ravages of this disorder

- cost of the federal government funding is less than the cost of ignoring the problem.

SCENARIO 4

Imagine you have been watching a program on CNN in which scientists announce that they are on the brink of finding a cure for AIDS but their success is dependent upon a five year extension of a major government genetics research grant. A debate follows between politicians running for an imminent election. How would you vote if the crisis requires that 3 of the following six programs must be eliminated in order to bring the federal deficit under control.

1. The newly successful space program that promises technological progress and jobs.
2. Tax credits for family child support.
3. Teenage job training.
4. Genetic AIDS Research.
5. Health coverage for genetic medicine
6. Foreign aid to starving refugees.

(a) Problem definition

1. The federal deficit is increasing so fast that the future of government programs in general is being bankrupted. Action is essential now.
2. The Federal government is obligated to deal with disasters at home before it takes care of disasters abroad.
3. Issues of pain and suffering leading to death take precedence over tax credits.
4. Chronic unemployment in youth is shown to lead to virtual unemployability in later years. The financial consequences of ignoring this are worse than loss of high tech jobs created by Space programs. Social instability and a massive jail population are unacceptable.

(b) 4 Solutions.

1. Declare a national emergency. Cut back interest payable on government loans to an amount equal to that needed for the essential programs.
2. Cut foreign aid, space program and tax credits.

3. Pay for programs by declaring foreign aid to refugees and the space program wholly the responsibility of the Pentagon and refuse increase in funding to the Pentagon. Require insurance companies and HMOs to cover genetic medicine by law.
4. Institute progressive taxation to the level that existed in the pre-Reagan era so as to pay off the federal deficit and maintain essential programs.

(c) Consequences for solutions 1-4

1. The value of the dollar plummets. The federal reserve is forced to drop its interest rates too. Inflation dramatically increases but it solves the short term crisis.
2. Initially there are reports of increase in child and infant mortality at the refugee camps but Japan asserts itself as a global power and gives massive aid. The loss of tax credits has no immediate impact and the space program becomes totally international.
3. The Pentagon finds ways to administer the refugee problem and the space program. It has to cut back on its research and development into new weapon capability.
4. The return to pre-Reagan tax causes a right wing populist revolt that leads to a change in government so that all federal programs are canceled except for the military.

(d) Plan and Measures of success

Choose solution 1

1. Declare a national emergency.
 2. Create an independent commission to supervise the negotiation of government loans so that loss to small investors is minimal and loss to major investors is mostly in terms of projected long term profit based upon recent interest rates.
- Measures :—Federal deficit is managed so that essential humanitarian government programs are not threatened.
- Loss to investors in Government bonds does not destabilize companies and citizens on fixed incomes.
 - Inflation is temporary and the federal reserve agency is authorized to take those steps needed to control inflation.

SCENARIO 5

A religious Korean couple with four healthy daughters (and no sons) desires a son. They request prenatal diagnosis solely in order to learn the fetus' sex. They tell you, the doctor, that if the fetus is female they will abort it. Further, they say that if you will not grant their request for prenatal diagnosis they will have an abortion rather than risk having a fifth girl. Because the mother is in her late forties, you agree to the genetic diagnosis. The child turns out to be female and has the Down's Syndrome extra chromosome. What genetic counseling would you offer them as a friend and doctor?

(a) Problem definition

1. All life is sacred so abortion is not to be taken lightly.
2. Girls are equally precious as boys.
3. In traditional patriarchal cultures, boys are strongly favored over against girls. Such a value is offensive to egalitarian sentiments!
4. Down's Syndrome babies and their families need a lot of support and assistance. If the parents are not highly motivated to do all they can for their child, the prospects for the Down's Syndrome baby to have a happy life is remote.

(b) 4 Solutions

1. Explore reasons for their objections to a female child. Abort baby if hostility to a female baby is deep seated.
2. Reject abortion option.
3. Accept abortion option on condition they discuss the issue first with a clergy person of their religious persuasion.
4. Accept abortion option on condition that they first meet with a Korean genetics counselor at the nearby university to clarify all the issues for them before making a final decision to abort the fetus.

(c) Consequences for solutions 1-4

1. The couple are even more determined to have the abortion.
2. The couple go else where for an abortion. They try a traditional Korean methods of abortion

that is successful but caused the mother later need surgery to save her life.

3. The couple reluctantly had the child. As was traditional in their culture, the child was never taken out doors or seen by anyone outside the immediate family.

4. The child was not aborted but given to a unique couple who were prepared to adopt a Downs Syndrome child. The child grew up to work happily sweeping and cleaning floors at the local McDonald's restaurant.

(d) Plan and Measures for success

Choose solution 4

1. Approach charitable funding agency to pay couples' bill for the genetics counseling.

2. Adoption agency approached to search for suitable adoptee parents.

3. The adopting mother plans to give up her job to give the needed parenting.

Measures:-No child abuse.

-Downs Syndrome child happy and lives to its highest potential

-Community resources support the family so the marriage is not threatened

5.Lesson Plans to integrate Science with Ethics in the Curriculum

We want to achieve the Deweyan goal of taking the formal syllabus and restructuring it so that students can choose a problem that is their own, have "a stimulus to attention..... to discipline to control(and) a habit of considering problems". What follows is "a working model (that) is not something to be copied; it is to afford a demonstration of the feasibility of the principle, and of the methods which make it feasible". It was planned and taught while I was reflecting and reading for this unit. It differs only in that ethical reflection now plays an important role in the unit.

a) Devise a lesson that lasts one week.

For several years now I have taught classes that are designed to last a week. Monday is for introducing the theme or topic and includes review of key vocabulary, drawings, photographs, artifacts and a video. On Tuesday, Wednesday and Thursday, activities or experiments are planned that teach the content of the class. Students are given readings from the textbook that highlight important informational content by answering review questions at the end of three sections of reading. On Friday the class is concluded by checking for understanding of content and students are given "CAPT" type questions that use the content they have just

reviewed but applied to real world situations and that test for higher order thinking i.e. are generally open ended questions. These are too difficult for most of my students to do on their own so they are done as whole class activity. Students practice writing whole sentence or paragraph answers. Their motivation to apply themselves is that they know that a selection of these questions will appear in an examination and that they are the kind of questions used by the State to test for mastery of thinking skills. An example of 10 questions is as follows:

1. The cat shelter advertises free shots to hybrid cats. How do you know if your cat is a hybrid?
2. Why is it that in “mixed marriages” the children will never be pure Caucasian or pure Negroid?
3. Why are your sex cells (sperm or egg) the only cells in your body to have only one set of chromosomes?
4. If you are tall but both your parents are small, what does it say about your parent’s genotypes?
5. What do gambling and genetics have in common?
6. Your mother planted a variety of red and white flowers. The flowers self-seed and next year you have red, white and pink flowers. What does this say about dominance in this flower’s genes?
7. Genes for blood immune type consist of three alleles A, B and O. What do doctors mean by the word allele?
8. How is it that doctors can study genetic diseases in your body just by looking at some of your white blood cells?
9. What is different between the genes of the sperm cells as they leave a man’s body every day and the skin cells he shaves off every day?
10. What would you tell your friend who asks you to explain what happened to her child to cause the child to have Down’s syndrome?

b) Devise a lesson plan that integrates evolution, genetics and sexuality

The themes and textbook readings are given at the outset for the whole marking period. Your curriculum might look like the following. This is just an example based on the particular texts that I feel are suited to my students needs and recent texts.

SEXUALITY, GENETICS AND EVOLUTION

THEMES: READINGS:

1. Evidence for Evolution	BSL ch. 28 Globe ch. 33
2. Theories of Evolution	BSL ch. 29 Globe ch. 32
3. Mendel's Genetics	BSL ch. 25 Globe ch. 29
4. DNA	BSL ch. 26 Globe ch. 30
5. Human Genetics	BSL ch. 27 Globe ch. 31
6. Sexuality in the 5 Kingdoms	BSL ch. 22 Globe 11: 3, 4 18: 3
7. Human Sexuality	BSL ch. 23 Globe ch. 25
8. Development through the life cycle	BSL ch, 36 Reading Project

Because genetics is intimately bound up with a modern understanding of evolution and what sexuality is about, it seemed natural to combine these three important components of sophomore curriculum together. Students could easily select activities or projects out of the topic order during the middle of the week and be able to see the connection to the unfolding development of content and concepts given in the readings, videos and so forth.

c) Plan instructional activities that have a wide amount of choice

The grading policy outlined below appears complicated but was necessary to accommodate a wide range of student abilities and to be responsive to the range of student interests. Non-academically achieving students generally do best on small scale activities that are concretely structured, last a day or two at most and do not require a lot of reading or writing. Some of these appealed to brighter students and were combined with bigger projects on the same topic. As it turned out, there were students who would do a minor project with a great deal of care and those who would speed through it and move on to another activity. Both had educational value—the more careful work usually ended up being the model piece that was put on the display board. Their work would be the examples from which to teach and explain important concepts to the class, such as the three dimensional structure of DNA. In a number of instances the outstanding work of the student or small group that worked on a project acted as an inspiration to many more students. Those who copied their work either were able to complete their project much faster or as occurred in the case of a project on meiosis, led to a simpler way of solving the problem of how to model chromosomal reduction division.

Grade Policy for the Third Marking Period: General and College Biology.

1. Tuesday, Wednesday and Thursday will be experiment/project days. You choose experiments/projects that appeal to you from a list below that relate to sexuality, genetics or evolution. You may create your own topics/experiments with approval from your teacher.
2. There are approximately 24 days (8 weeks) to this marking period. You will choose a combination of major, medium or mini-sized experiments/projects. A major experiment (science fair type) will take an estimated 6 days, medium (CAPT type) take three days, i.e. a week and a mini experiment will take 1 or 2 days maximum.
3. A recommended combination is 1 major report (24 points), 1 major experiment (24 points), 2 ethical problem solvers (12 points each) and 4 mini experiments/projects (6 points each). Any combination is acceptable but you need 100 points for 100% grade. 4 bonus points are given for students who work consistently at their work.
4. All your projects or experiments will be kept in your folder—both your rough work and your completed work. These will become a portfolio of your achievements in science for this marking period.
5. On Mondays, you will be assigned homework for the week, introduced to the theme in Biology for the week, and see a video related to this theme. There will be a video quiz.
6. On Fridays, we will review homework and then have a CAPT test based on the homework for that week.
7. Your final grade will be based on your grade point sheet and your portfolio folder of written up experiments and projects.
8. As projects or experiments are completed, they will be put on display and their content discussed with the class.

SAMPLE EXPERIMENT TITLES—see Globe Biology Textbook if G pages, Study of Life Textbook if S pages.

How does a human baby change during development? G 446

How can a model be used to illustrate recombinant DNA technology? G543

How do adaptations help an organism survive in its environment?

How is a bird's body adapted to its way of life? G 310

How similar are grandparents to grandchildren? **Major experiments** using a variety of types of Fast Plants that last the whole marking period and involves plant breeding. Also we should have

round worms to experiment with to trace genetic variation in offspring.
How do you read a pedigree chart? G 530
How can one make a realistic model of DNA? G 525 or S 533
Make a model of the movements of Chromosomes in making sex cells. S 423
What genetic variations exist in this class of students? S 562.
How useful is a thumb? G 585 or S 772
How does the stress of birth prepare babies for life? S 494 (also visit a hospital).
How similar is a human skeleton to other mammals? In what way is it modified to life in trees or on the plains?
Does the size the human skull correspond with school grades?
How similar is a chicken wing compared to a human arm? S 266
How is the relative age of a fossil determined ? G 574
How do fossils form? G 570
How does a chicken develop? Hatch a chicken using an incubator and describe the stages of its development using drawings.
How do plants have sex? Dissect a flower and make drawings of its parts.

PROJECTS IN GLOBE BIOLOGY see Globe biology book pages 519, 535, 547, 565, 581 and 595.

PROJECTS IN STUDY OF LIFE see College biology text pages 415, 439, 471, 491, 515, 547, 565, 597 and 625.

Example Projects (Adapted from Globe Biology)

1. Visit a nursery or botanical garden (example, Edgerton Park near East Rock). While there, find out which flowers are hybrids and which are pure breeds. Make a list of the varieties of flowers in each category. Take photographs if possible.
2. Present Mendel's experiments in the form of a Science Fair poster and accompanying short research paper. As far as possible, use your own words and keep it simple.
3. Find a genetics book or science fiction involving genetics (e.g. Jurassic Park), and write a book review.
4. Make a pedigree of your family for a specific trait, such as tongue rolling, nose size, blood type, cancer or longevity. Include as many generations and individuals as possible. Your older relatives may be a good source of information.
5. Interview a genetics counselor at Yale New Haven Hospital. Write up an account of your visit and describe how you feel about genetics counseling as a career.
6. Visit an agricultural research center (State, university or business owned). Find out how genetics is involved in their research. Describe these projects and how they are intended to be used.

(Adaptations from Study of Life)

1. Research the relationship of cancer to genetics and the impact environmental influences can have on whether one gets a particular cancer or not.
2. Write up an interview with a physician or nurse who specializes in genetic disorders and their treatment.
3. Using different colored pipe cleaners to represent chromosomes and copper wire for centromeres and asters, make models of the stages of meiosis (formation of sex cells).
4. Write an article for the science section of a newspaper describing the progress that has been made in genetic engineering with plants and animals and how this may impact the world in the twenty-first century.
5. Conduct library research on new kinds of reproductive technologies such as sperm banks and in vitro fertilization. Describe procedures involved and success of these techniques. Write it up as

a short pamphlet.

6. Write up your findings on causes of fetal abnormalities and deformities and present them in the form of a magazine article. Include implications for prenatal care and abortion.

d) Use both Performance Based Assessment (PBA) and a checklist method of evaluation. Include option of working in small groups.

In general a student's work was valued by the number of class days they worked on their projects. There was a day by day check given of on task performance. Absence or extended inactivity was noted on the 'hands-on' section of the course grade sheet (a student keeps a copy in his or her folder of work). Students expressed a lot of appreciation for the opportunity to go at their own pace. In consequence I had much higher quality work. The trade off was that they did less but because they saw other student work, they were exposed to what they missed and as theory was presented, that work was referred to.

For ethical problem solving, a PBA is devised below. It is the PBA designed for the genetic situations described above and requiring a Deweyan ethical problem solving technique.

e) Devise a lesson plan with minimal class room management problems.

How could students choosing their own activities from a list of a wide variety of projects not cause undue chaos in terms of providing materials and so forth? (For the list, see below—students also had a package of step-by-step 'mini' activities that they could choose from. It was particularly useful for getting unfocused or frequently absent students immediately working). As it turned out, there were no unmanageable problems. In fact quite the opposite happened. Behavior problems largely disappeared and my level of stress went right down to a healthy and enjoyable level. Trying to have all my students working on activities that I assigned was far harder and exhausting than having students work at what they want to do. Putting the responsibility on to students to choose their own work was hardest for the normally disruptive or non-achieving students. They could not get their attention the normal way. Good students could get their education without disruption. Some of the non-compliant only cottoned on to the idea that they chose their own work and that their grade was dependent upon them choosing to do what they wanted to do, at the very end of the course. Only a minority chose to do nothing and they, of course, received a failing grade, but then they were the same students that had failed previously. A few high achievers expressed unhappiness at having to choose—the few passive students that enjoyed following orders. From my point of view, the experience of students having real freedom within the curriculum framework was so good that I would never go back to how I taught before.

e) Link ethical problem solving to instructional activities

Tack on to each project a reflection on the possible ethical consequences of the information learned. Examples are worked out above but may be stimulated by showing such videos as Barbara Walter's ABC TV special, 'PERFECT BABY'. Though more than five years old, the video anticipates the most critical genetic issues that will be major problems in the twenty-first century as well as held students attention.

WHEN YOU HAVE A PROBLEM

1. STOP, CALM DOWN, & THINK
2. DESCRIBE YOUR SITUATION
3. WHAT ARE THE CAUSES OF YOUR PROBLEM?
4. THINK UP SOLUTIONS
5. THINK OF CONSEQUENCES
6. CHOOSE THE BEST ONE & PLAN YOUR ACTION
7. DO IT. ACT!

*DID IT WORK ? IF NOT, GO BACK TO STEP 1.

Adapted from Weissberg and Caplan- 'When you have a problem'.

Teachers' Annotated Bibliography

Bernstein, Leonard. *Globe Biology* New Jersey, Globe Book Company 1990

An excellent textbook for its readability for students and for its activities. At the High School level, it suits nonacademic students best.

Dewey, John. *Experience and Education* NY, MacMillan 1963

A short book that introduces a reader to some of the key ideas of Dewey.

Dewey, John. *The Middle Works* Volumes 1-14, Jo Ann Boydston (ed) S. Illinois Univ. Press, Lon: Feffer & Simons 1979

These volumes represent the mature writings of Dewey. Volumes 1-3 and 7 are sufficient reading to understand his theory of science and ethics. They are somewhat technical, dense and do not make easy reading, however, it is not that much and, in my view, worthwhile the effort. He is generally acclaimed as the United States most original thinker in classical, yet quite radical philosophy.

Genetics and the Law III (ed) Milunski, A and Annas, G. NY, Plenum Press `84

The proceedings of the Third National Symposium on Genetics and the Law, held April 2-4 1984, is at times rather dry for its understated mode of expression, but for the most part, in a single volume, it goes to the heart of a representative set of ethical problems in genetics that are far from resolved at the brink of the twenty-first century. All the scenarios, with the exception of the one dealing with gender issues (an adaptation from Susan Baserga's Genetics Seminar, 1995 at Yale University) were inspired by situations discussed in this

collection of papers.

Schraer, William and Stoltze, Herbert. *Biology: the Study of Life* New Jersey Prentice Hall, 1991

The book provides an excellent background for High School introductory biology students, assuming their reading skills are grade appropriate. Its photography and diagrams are much superior to Globe Biology, however it lacks the activities of Globe that academic students can benefit from.

Student Annotated Bibliography

Biology: the Study of Life and Globe Biology,(see bibliographic description above) are the texts that are used at the High School I teach at. The use of these two texts given in this unit is only suggestive and indicative of the feasibility of solving the problems that the unit addresses.

Materials List

The titles of activities given in this unit are intended to be suggestive of what is possible rather than prescriptive. One would need to consult the texts cited for lists of materials. All of these activities can be done with readily available, inexpensive and easily acquired materials.

Notes

1. Dewey, J . Middle Works 1 p.25
2. ibid p. 23
3. ibid
4. Dewey, J . Middle Works 7 p.163
5. Dewey, J. Middle Works 2 p.133
6. Dewey, J. Experience and Education p.87
7. Boisvert, Raymond. Dewey's Metaphysics NY, Fordham Press 1988 p.172
8. Ibid.
9. Dewey, J. Middle Works 3 p.4,5, 12-14, 25-28
10. ibid. p.7,8

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