Education in America: science for survival

Part 2, by James W. Frazer, Ph.D.

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This is the conclusion of Dr. Frazer's two-part article. It begins with the continuation of his discussion of the sixth through tenth school years.

The editors find Dr. Frazer's proposals for curriculum reform in science and technology to be very exciting and thought-provoking. While we do not agree with all of his suggestions regarding music, history, and literature, we are publishing the article in full, in the interests of sparking debate. Further contributions and responses are welcome.

Genetics, growth, and development

The chicken project, started by the sixth graders, is continued through the production and study of fertile eggs. Growth and development records are kept, along with notes on the amounts of food and water necessary for that growth and development.

Some of the possibilities for the teaching of genetics using these student-raised chick embryos include study of the developing chick embryos, including blastoderm and gastrulation discs when the embryo is carefully lifted off the yolk sac for study; candling and timed incubations; use of the photometer previously used in the study of plant leaves to now study the development of the cytochrome system; both DNA and RNA can be isolated and quantitatively estimated for a series of discs, up to the 96-hour chick; the increase in dry mass, protein content, and lipid content can also be estimated.

Some representatives at different developmental stages can be dehydrated, oil-clarified, and mounted permanently in balsam. Drawings made from the whole mounts can be transferred to computer graphics to aid in demonstrating organ system changes during development. If TV photogrametry is available, such a transfer could be made to three-dimensional reconstruction.

Meanwhile, with proper care, the chicken flock is growing and producing eggs, fertilizer for the garden plots and, eventually, hatching new chicks for the upcoming class's chicken genetics projects.

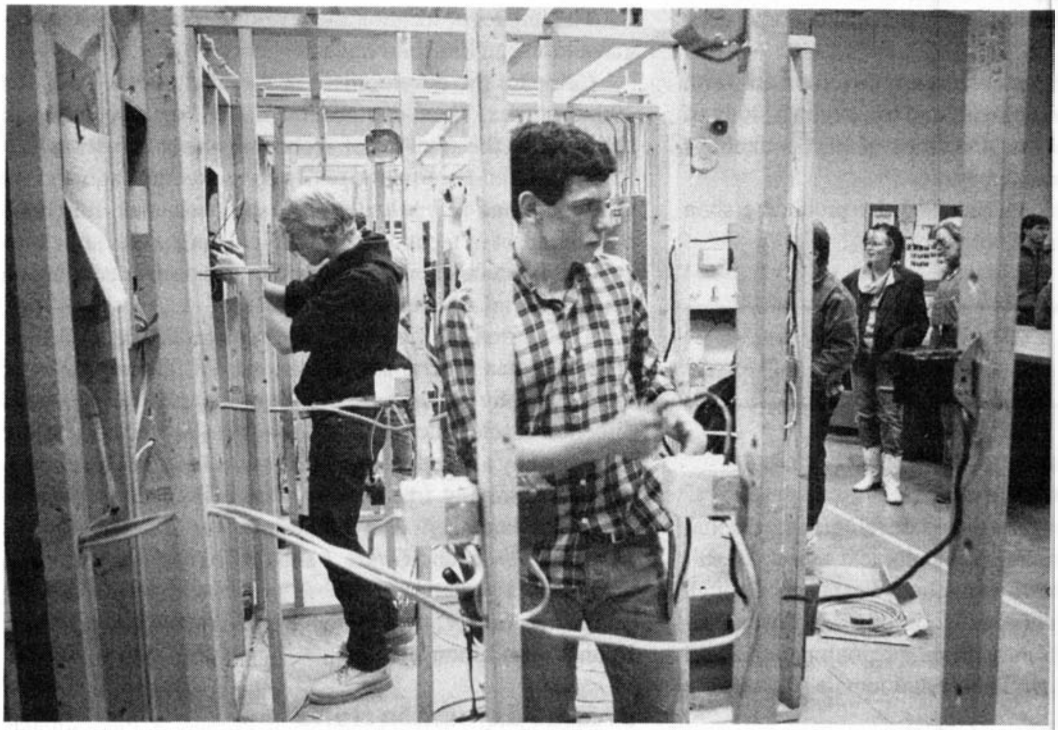
Mice, kept and carefully tended in the classroom, have uteri that can be studied by transillumination, if carefully done. The number of embryos per mouse and the rate of growth of the embryos from fertilization (vaginal plug) to delivery can be studied. This really is an extension of things the students already know, since birth and development of farm animals would already have been observed during the use of this park/orchard concept laboratory.

Other genetic teaching is by study of plants raised from fertilized seeds during earlier years.

During these grade years, both sexes of the student population are reaching the beginning of sexual maturity. The mood swings and hormonally dependent changes occurring in the students should be discussed and explained quite thoroughly, including information about sodium retention producing pre-menstrual syndrome.

In turn, the subject of genetics can lead to discussion of the brain and nervous system. The developing embryo is a good takeoff for the early development and structure of the brain, and the CIBA books, especially the diagrams by Netter, together with models and cross-sections of plastic-embedded human brains, can be studied.

Neural function can be studied using the earthworm ventral nerve cord with shop-constructed stimulators and FET



An eleventh grade class learns how to wire a house, in a school in northern Virginia. In the proposed curriculum reform, students build electric circuits and become familiar with the use of computer graphics to design wiring systems. In the high school years, they also begin to help teach the younger grades.

input DC recording. By using different types of electrodes (potassium, sodium, calcium, or some of the more recent calcium-chelate-filled electrodes), an idea of the different types of ion fluxes in nerves and muscles can be obtained. The deep tendon reflexes of the students themselves can be studied. Each student should be able to make measurements of temperature, pulse, respiration, and blood pressure (with the manometers made in the shop, probably also the stethoscopes).

Watchful parents will probably become concerned during this period. Contention should be expected and quietly prepared for, but if the parents are drawn in and included in the accomplishment of some of these projects, serious opposition should not be a problem.

In some states (e.g., Ohio) it is illegal to approach even the fringes of a discussion of sexuality in a science classroom. This subject is reserved for health class. This barrier between subject classes should be removed.

Study of growth and development of mammals, other than by non-invasive means, is essentially forbidden to students in the United States and Britain. Magnetic resonance imaging could be used to advantage, but it will be some years before commercial instruments are available within the economic constraints of public schools. An alternative does exist, however. Transillumination of the mouse uterus (a unit for which can be constructed by senior students), growth of body mass, dielectric constitution, and fat/lean ratios can be obtained by use of 13.65 mHz carefully tuned inductive coils and antennae. One such system is commercially available, but a basis system could be student-constructed at little cost.

Summary: fifth through ninth years of school

During this period, the student has built several electric circuits, including small computer circuits and AC wiring circuits. He has learned of dynamos, auto generators, and alternators, and has become familiar with the use of computer graphics to design wiring systems. He has used self-constructed tools to measure solar events and has analyzed several biological specimens.

A heavy emphasis has been placed on the passage of wisdom from prior generations to his generation throughout all of his studies. He has continued his studies of plant growth and ecology and has used some of the product from the park/orchard as classroom material.

He has learned a little of several languages and has studied the geographical surroundings of language groups. He has studied the results of "cultural collision" and has hopefully developed an idea of different philosophical systems represented by present-day cultures.

He has been intensively exposed to various 1-, 2-, 3-, and n-dimensional geometries and has constructed them. From them he has been given trigonometric identities and has used those identities in quantitative shop practice and as exercises in computer modeling.

He has studied bioenergetics and early development, with reference to his own development, and has begun a study of neural function as part of explanations of his/her feelings during development of sexual maturity.

He has begun educational pay-back by producing shop products for use in earlier school years.

Tenth through twelfth years of school

Preparation for primary grade instruction duties and school service duties

1) A course in human growth and development, emphasizing neural development and psychological aspects of students expected in preschool and school years one through three (ages 4-10). Students may begin one day a week assisting in first and second school years, beginning in the third quarter of the tenth year. Both male and female students are to participate.

2) A course content review of school years one through six. All students must participate. Together with the course content, the students should discuss the history of U.S. education and comparative educational philosophies of present national systems. Both male and female students must participate.

3) Students are to be introduced to other school service functions: cafeteria duty—food preparation and clean-up duties. In addition, students are to be introduced to financial aspects of cafeteria support: federal programs, procurement of materials, food laws (state and federal), and means of food preparation. All students must participate. Starting in the third quarter of the tenth year, one morning per week is to be spent in the cafeteria facility as workers.

4) Custodial duty. Students are introduced to heating and cooling systems, electrical systems, lighting, floor maintenance, auditorium facilities, parking lot and playground maintenance, and window care.

5) Shop supervision and instruction. Review of course content, years seven through ten, emphasizing shop practices. One afternoon per week spent in assisting, beginning fourth quarter, tenth year.

Continuation of the philosophies of societies

Review of Margaret Meade, Melville Herskowitz, and other readings of the social makeup of primitive societies in relatively modern times and the consequences of the collision of those societies with western civilization. Comparison of this collision with the changes in Europe, Britain, the Americas, and the Russian Federation as a result of the growth of industrial states.

The impact of technology development on industrial organization and its social impact.

Compare the development of Germany in the 18th and 19th centuries. Then, compare the rise of Japanese industrial ability with the transfer of technology to a society which retained its feudal structure until a calamity, then adopted the techniques and technologies of western societies. Emphasis on the impact of technology on pre-existing social structures and the directions in which technology is used depending on existing social structure.

The period of Leninist communism in the U.S.S.R. (1922-88) has several social features, but a comparison of the philosophy of the state, impact of that philosophy on the direction of scientific effort in a top-down direction, is clearly illustrated by a comparison of the results of Lysenkoism with the comparatively free development of molecular genetics during the same period in the western world. Solzhenitsyn's *The First Circle* and *Gulag 1* should be read. Compare this picture of a society with those presented by Machiavelli, Smith and, finally, the biographies of Truman, Eisenhower, Kennedy, and Johnson.

Present-day nation states

Some of the ancient civilization of China was alluded to in the seventh year. Here the development of China, her political struggles, the impact of the West on those struggles, and the impact of China on Southeast Asia and the Pacific islands should be thoroughly examined.

Using Chinese history as a time base, the class should construct a "Simulchart" outlining the major events of the Balkans, Caucasus, and Greece, the emergence of civilizations in Egypt, the Middle East, Africa, Europe, Scandinavia, and the Americas.

This kind of project allows the use of class group cooperative projects for different area specialties which, after instructor editing, should be copied and disseminated to the class as additional material. In subsequent subsequent years, the material of the previous year should be reviewed, then added to by the new group. Thus, use of ponies won't be of much value.

During this project, it is important to remember *why* this exercise is undertaken. At each point in the Chinese timeline, an emphasis and extended discussion should occur as to the evidence on which our knowledge of those times is based. This entails a review of the meaning of geological strata, methods of isotopic dating based on our current understanding of nuclear physics and current measurements of the rates of isotope decay, and the contents of cultural *desiderata*. The Scandinavian Runes, Pliny, Plato, the Biblical books of Moses and other writings should be consulted to try to outline the lives of common people at each one of the times and places reviewed. Similarly, in more modern times, an intensive effort should be made to try to outline the living conditions of common people during the times allocated and in different global locations.

A "big picture" overview of this kind of history of human kind should show that the lot of the common person has gradually improved, not so much by changes in political systems, but by the gradual, painfully slow, accretion of knowledge about human environments *and the uniquely human ability to pass this knowledge from generation to generation.*

If this passage of knowledge had been completely successful, the history of the 20th century would have been much different. The student should be led to the perception that increase in the knowledge of the physical universe does not, *pari pasu,* indicate a maturation of the human thalamus freeing it from the dictates of lust, avarice, and covetousness, but rather gives that thalamus ever more sophisticated tools to use in the student's own destruction.

Applied mathematics and physical sciences

These studies are keyed to critical experiments, from which mathematical treatment, physical intuition, and chemical intuition are nurtured. For each of these experiments, the student should draw data graphs, then graphs of interpretation based on corrections to the measured data based on thermal diffusion, environmental temperature and pressure, light, ionic strength, and other experimental conditions that require data adjustment. From adequate treatment of data, a thorough familiarity with algebraic and numeric treatment should result. In some cases, e.g., Fourier diffusion, an introduction to differential calculus is afforded.

Experiments to be performed:

1) Work equivalent of heat, using friction clutch submerged in water. Accurate thermocouple temperature measurement and force/distance measurement. Thermocouples are to be fabricated by the students. Dewars are to be constructed by the students using a silver plating technique on glass jars. This requires use of the aldol reaction and is also an introduction to organic and inorganic chemistry as well as electrochemistry.

2) Electrical equivalent of heat. Ohm's law is implicit in this experiment, as well as second order equations. Students measure the electrical resistance of resistors, then measure the heat generated when electricity is passed through the resistor while it is submerged in water and the Dewar made in part 1, above.

3) Polarographic determination of oxygen and several ions in aqueous solution, using the Heyrovsky dropping mercury electrode. This experiment introduces the student to the following concepts: half-cell potentials; formation of the electrochemical series of the elements; atomic ionization potentials; the Nernst equation; exponential equations; types of glass, ways to shape and polish glass capillary electrodes; construction of half cells; ratios of ionic diffusion rates; activity at electrode surfaces (looking at the mercury surface during a redox reaction). The student should be made aware of the relationship between his data and the construction of semiconductor devices.

4) Amperometric titration followed by determination of mass of plated metals. From a synthesis of these four experiments, the student should have derived an idea of the electron flow in circuits, the reductions at electrode interfaces, and an idea of valence, transfer function, and an introduction to thermodynamics. He should have the definitions of the units for heat, work, and energy well in hand.

5) Hemoglobin spectra during polarographic determination of oxygen consumption by yeast. Human blood diluted 1:100 with well-oxygenated Krebbs ringer phosphate containing 1 mg glucose per milliliter, is placed in a spectrometer cuvette (constructed earlier) and absorption spectrum run. Cake yeast of about 1 gram per ml Krebbs ringer is made up; 0.1 ml of this suspension is added after the dropping mercury electrode is inserted, so that both a constant voltage polarogram and the spectra of hemoglobin can be obtained simultaneously. Repeated spectra are obtained at noted times to include 400-427 nM and 550-640 nM.

The Beer-Lambert law, hemoglobin O_2 affinity, yeast metabolism, and oxygen-carrying capacity of human blood all can be explored by this simple experiment. Data should be stored on computer disc and a curve of PO_2 and Hgb reduction made using Lotus Works or a similar program. Since there are repeated experimental runs, experimental statistics can also be introduced. A single finger stick, 0.05 ml blood, should suffice for at least 10 determinations.

6) Earthworm surface coat is prepared in a flat holder held in front of the spectrometer beam. Wavelength is set to scan 400-640 nM, a spectrum is run in well-oxygenated Ringers solution, then oxygen is allowed to deplete in a sealed cell, and the spectrum is re-run. The two spectra are subtracted by computer. The "difference spectra" resulting should show in approximately the band 420 nM. Flavins 475, cytochrome C approximately 550, and cytochrome oxidase 610. Muscle myoglobin and hemocyanin will contribute large parts of a properly run difference spectrum.

7) A 10-liter respirometer is constructed in the shop, preferably from knurled aluminum plate formed on a Collet lathe. Alternatively, aluminum can be rolled and heliarc welded to form two concentric cylinders. Individual respiration and respiratory quotient are determined using CO_3 gravimetry for CO_3. These determinations are made at complete rest, standing, and after running in place. Data are entered into the computer and the energy cost for different amounts of exercise is calculated. Each student group (three students) should perform the entire experiment. The experiment should also produce separate data for determination of gas law constants and the gas law $PV = nRT$ derived from data. Historical review should include at least Lavoisier, Boyle, and Charles.

8) The apparatus of "7," above, can also be used to form a Watt steam engine by adding a steam jet and water coolant.

This allows introduction of Carnot and steam efficiency, leading to a discussion of entropy.

9) The physics of solutions

a) Osmotic pressure and the Van't Hoff equation are studied, using sucrose solutions and silastic membranes, then advancing to calcium, sodium, and potassium electrodes; and selective membranes. Boiling and freezing point effects of solutes, volume—volume changes with water—methanol solutions, and heat of solution are studied by constructing an isolation colorimeter in shop (practical applications to automotive cooling systems). Refrigerant and gas expansion leading to the Joule-Thompson effect are studied using natural gas or propane expansion and a burn-off candle.

b) Further studies are made with ascending paper chromatography using commercially obtained nucleic acids as markers, spraying paper with phosphotungstic acid to develop spots (the meaning of RF and the effects of solvent are examined).

c) The study is continued by use of an electrophoresis apparatus. A shop-constructed 50V, 10A DC power supply, lucite strip carrier, and solvents are required.

Electrophoresis of plasma proteins derived from a finger stick is performed. A capillary centrifuge (shop-constructed) is used to separate cells and plasma. Plasma protein is developed by Ninhydrin spray, the o.d. is determined by the spectrometer for each peak. A second run subjected to charring could give cholesterol readings.

10) The chemistry and physics of foods, food preservation

a) The storage and preservation of foods is part of the training in food service already outlined.

b) Bread is made in the classroom—both yeast risen and carbonate risen. The results should be edible and, with the addition of honey and raisins, should be the occasion for a class party.

c) By this time, fruits from the class orchard should be available. The fruits are subjected to a blender, the blended mix analyzed for starch (I_2 reaction), sugar (Benedict's reagent quantitative), fat content (extraction with either Bloor's reagent or $CHCl_3$-CH_3OH 3:1, followed by drying and gravimetry. The dried residue after extraction should be used to determine water content, total cellulose concentration can be determined by enzymatic digestion with commercial cellulase. From this digestion, or digestion of starch, Lineweaver-Burke plots of enzyme activity can be produced. Salivary amylase can be used as source enzyme for starch digestion.

Some of the blendorized fruit can be cooked, pectin added, and jams made. Some of the natural fruit should be canned.

Some of the natural fruit should be refrigerated, some left to rot, then both carefully examined with a microscope and with bacterial grow-out on Petri plates.

11) Introduction to computer architecture

In middle school years, basic DC circuits of diodes and electronics were explored. Now construction of etched, double-layer motherboards is undertaken using copper-plastic annealing and acid etching, computer chip mounting, computer chip analysis and high frequency circuit analysis. The student is given some chip design characteristics and is to construct power supplies and biasing nets to derive an output for simple ladder networks in adders or subtractors, multipliers, and LED displays. The structure of digital and analogue monitors is investigated. The physics of magnetic storage is brought forth. Simple optical readers are constructed. Fiber optic signal transmission is utilized and constructed. Some of the products of these constructions are to be used in primary years.

12) Introduction to radiowaves

The student already has studied optical propagation and should also already be familiar with Snell's law, dielectrics, and optical polarization. A high-frequency band oscillator and receiver is constructed and both omni- and directional antennae are used for quantitative radio reception and reflection studies.

While exact formulation of Maxwell's laws of propagation is beyond the usual student, they should be aware of his treatise on electromagnetic waves, and should have historical knowledge of the contributions of Gauss, Seber (note relationship to Einstein), Faraday, Henry, Poincaré, D'Arsonval, Marconi, Schotky. They should know the structure of Selenium rectifiers (the earliest solid state component), Schotky function diodes, and the characteristic layouts for solid state circuit designs and how they are manufactured.

Tenth through twelfth years

Arts development

1) Development of multiple-color (up to 32,000 at present and increasing) digital large screen monitors has allowed an art form not available to previous generations. Some of these have already been used in television commercials, and further use can be expected from present action of the Federal Communications Commission, which will allow higher-resolution television broadcasts.

As a result, there will be explosive effects on the requirement for TV tapes or CD recording resolution and content, and the resolution of TV cameras, optics, and home reproducing equipment.

The students should construct their own artistic concept on a high-resolution instrument, and transfer this to storage media. *Then,* reconstruct their image in oils, tempera, and synthetic media.

Particular attention should be given the types of pigment used historically, its durability, and the toxicity of pigments (Michelangelo's mercury, the arsenicals, copper salts, iron salts, etc.).

2) Artistic development in shop practices

The student has already been instructed in heliarc welding and a variety of metal-wood and concrete-shaping techniques. These should now be turned to a planned sculpture of the student's design. The design starts with a computer model, then progresses to a small mock-up, finally to a full-scale design and execution. Some of these should be kept in the school environment for 1-2 years.

3) Development of musical talents

In primary years, exposure to recorders, bells, and piano was begun. Some students will wish to continue these studies, others will wish to follow other pursuits. Every school, from primary grades through high school, should have facilities for concert bands, concert orchestras, pop orchestras, and associated sound recording and mixing equipment, so that both video and audio recordings may be made.

Instrument acquisition and training costs are a major problem for lower income families. A continuing shop project should be production of violins, violas, 'cellos, and string basses. Other major projects would be production of audio-equipped classical guitars with audio equipment constructed in electronics shop. This entails wood selection, techniques of "peeling" and steam-forming, cutting, then final assembly.

Brass instruments can also be constructed from tubing with appropriate bending, forming, soldering, and lacquering equipment, though these are time consuming and purchase options may have to be exercised, or some combination of construction and purchase option.

At least one piano or one harp per class should be constructed, using commercial strings, but the metal and wood sounding boards can both be locally constructed. Some students may wish to construct a synthesizer keyboard instead, using electronic shop for most of the work and plastic forming for the keyboard.

These are major constructions, requiring a very knowledgeable instructor, but can lead to the formation of student practice-rooms to further develop musical skills.

Other types of light or sound-producing instruments could also be constructed depending on a student's taste and abilities—thereons, percussion instruments, speaker enclosures—the list is endless.

During these constructions, the student should become thoroughly familiar with Hooke's law, sound propagation equations, wave propagation, sound pressure measurement, and electro-acoustic coupling devices.

Music theory, chording, sound vibration frequencies, and sympathetic vibration production should all be part of this instruction mode.

4) Music appreciation

Development of sound systems in electronics shop has already been mentioned. Some of the sound systems, with output to stereo headsets with instructor overrides, will be used to translate music theory into sound production by various instrumental combinations (some from local orchestra members) and fragments from classical, romantic, modern, neo-romantic, country, jazz, and popular music. The aim is to show the use of chord structure in orchestration from full symphony to combos. Musical history from simple chants and madrigals to baroque and more modern music can also be explored. Calypso and Middle African music offer special rhythm and harmonic exploration.

Middle Eastern and Oriental music offer a sound new to many children. The quarter- and half-tones, underplayed intent of passion and other nuances will have to be carefully explained.

The orchestras, group ensembles and choral activities are all parts of the "participate, then listen," type of exercise important to musical rendition. Group singing in many different forms should be recorded, listened to by the student, re-sung and re-listened to so that part harmonics and their purposes become edited by the student performer. Traditional Bach and baroque choral arrangements should be tried, then modern music should also be attacked, complete with lip cueing rapid sequences.

Physical development and sports

A few years ago, a small, quite poor coal-mining town built a beautiful football stadium and placed heavy emphasis on sports in the curriculum of its somewhat dilapidated school system. When asked about this type of investment, the mayor of the town brusquely announced that the stadium was built to afford student athletes a chance to get out of the coal-mining business, out of the area, and to make advanced education available to those students. The whole town council unanimously agreed. The community was doing its best to give the children a chance at a better life than their parents had to endure. A disproportionate share of the positions in present major professional sports is occupied by the kids who played in that stadium.

Obviously, only a few of the very best, most tenacious athletes will make it to the professional sports level, but the team work, social contact, and physical development afforded by sports participation are a very valuable portion of individual social maturation.

Every student should be involved in at least one team sport, with teams sorted by ability, matched by ability, but with access to all of the necessary instruction and practice equipment. Basketball, volleyball, baseball, football, field hockey, and tennis should all be available.

There should also be emphasis on participation in field and track events, to include running, high and broad jump, discus and shot put, and horseback riding.

In addition, starting in the second school year and continuing throughout school, there should be an emphasis on gymnastics, with equipment sizes graded to the size and ability of students. Balance beam, rings, parallel bars, chinning bars, horse, giant swing trapeze should all be available, but carefully coached and supervised. *All* students should participate, but they should be grouped by ability. The group compositions will change from year to year.

This program requires a high degree of development of intramural sports competition.

Development of appreciation for drama, personal carriage, and speech

An adequate stage, props, and auditorium lighting system should be part of every school, including for years one through five.

In early years (starting the second year), topical plays for children, with costumes, should be a portion of the curriculum, but with emphasis on speech, placement, audience, and awareness of stage position. The student assistants are very necessary in this pursuit and they, in turn, must be adequately supervised by totally involved, imaginative instructors.

At the same time, introduction to rhythmic dance occurs, again with supervision in a play surrounding. In the fourth year, dance is slowly enlarged to include elementary ballet, standard ballroom, modern dance, and carefully supervised "RAP" dance. In the fifth and sixth years, the stories of ballet, the composers, and music are introduced, as well as more modern work—"Slaughter on Tenth Avenue," "Limehouse Blues."

Dances from ethnic groups are introduced beginning in the third year and continuing through the sixth year. Ethnic American square dance, shoddish, tap dancing, the Hebrew marriage dance, folk dances from Ireland, Scotland, Europe, Middle and Far East all should be seen and attempted. Some students will elect to continue this work throughout middle and high school years, others may not be so interested.

Management techniques for the home

One of the difficulties faced by many urban populations is lack of skill in the efficient management of limited resources. Balancing income and expenditures with a "long" view, knowledge of self-repairs for plumbing, heating, appliances, proper auto maintenance and budgeting. The knowledge required extends to food preparation and storage. Management of the produce from orchards, and of animals, introduces the student to some of the necessary skills, but a heavy emphasis should be placed on the "little economics" of family work and fiscal budgeting.

This sequence should begin in the sixth year and continue through the twelfth year. Participation is required for both male and female students.

1) Care of the physical home

Plumbing repairs (faucet gaskets, shut-off valves, valve seats, proper plumbing dressing, valve packing, sink drain trap replacement, toilet flush valve seats), house wiring (fusing, light bulb replacement, socket replacement), painting, wall refinishing, furniture repair, floor care, care of rugs, proper washing technique, care of heating and cooling systems, and lawn, garden and tree care (where appropriate) should all be included.

2) Maintenance of clothing

3) Cooking: storage and preparation of fruits and vegetables, meats, bread, pie, cookies, salads, fish. Upper years to include gourmet cooking. This activity requires coordination with food service activities and requires well-equipped multiple kitchens.

4) Family finances

Realistic estimates of income, realistic estimates of disbursements and checkbook balancing.

Investment managing, to include real cost of borrowing and its consequences, life insurance and health insurance, along with individual home mortgage types and costs, type of saving procedures (savings bank or savings and loan corporations, certificate of deposits, annuity and retirement funds, stocks and bonds). This should include answers to questions such as: "What are they? How do they work? What is a capitalist system as opposed to a socialist or communist system?"

Who manages the family finances? For a real family, *everyone* has input to major decisions, but husband and wife (or live togethers) *must* decide finances between them ahead of time, not at the end of the month or bill-paying time. Once commitments are made, they *must* be kept by all family members without exception. In a real family there is no "private" money. It is all in one pot.

5) Automotive and travel

The real cost of owning an automobile.

a) Initial purchase—borrowed money.

b) Cost per year amortized over probable useful life of the car. Expendables, repairs.

c) Insurance—equal to cost of repairs and more.

d) Fuel: miles per year divided by 20 miles per gallon times $1.40 equals approximate annual cost

For example: 12,000 miles per year divided by 20 mpg times $1.40 equals $840.00 per annum

6) Costs of apartment living: landlord responsibilities, tenant responsibilities.

7) Child care costs: single parent or two working parents.

1-4 years. Baby sitters or child care centers. Baby room setup or arrangement. Clothing and incidentals, diaper service or costs. Early age education, medical costs.

6-10 years. Clothing, school activity, training, special training equipment (sports gear, music, special electronics, advanced computer, arts and crafts, dance), driver education costs.

16-20 years. Advanced training selection (trade school, college or university, job corps, volunteer work, Peace Corps, armed services, dance, music, arts, academics).

20-24 years. Set up for life work (business, trade school, higher education).

8) Family social life

Togetherness is not just a word.

If both parents work, family life is only four to five nonsleeping hours per day. How does one plan enjoyable activity when everyone is already tired and frazzled?

Television: Do evening programs lead to individual isolation? Lack of family discussion, play and cohesiveness? (Note: Addicts may get defensive.) How are programs chosen? Should children have their own TV set?

Children's evening activities: How much should be allowed? Authority of the peers vs. authority of the parent—the dilemma of the teenager.

Family projects: furniture, books, museum, yard and garden, construction, library, family play (boats, sports, camping).

What if there were no family?

Institutional maturation. Peer-directed maturation (blind leading the blind). Substitute parents (child care, pre-school, school). Change in character of schools when parental influences decrease (socially maladapted children, violence, peer-directed anti-social activity). Violence may indicate failure of maturation beyond the fourth year.

Failure of passage of knowledge from generation to generation.

Failure of formation of the concepts of family and love. This failure can be passed to subsequent generations through ignorance.

Family community-related activities.

Church. Synagogue, mosque, community centers. All should tend to support the concept of family and are an important part of social maturation.

Political activities. What does a party meeting look like? Who are the local political prime movers? How do these people relate to municipal activities and county, state or national directions? What are parental opinions of these people? Where does one register to vote? Where does one vote? How important is a precinct vote?

What is the ideal family structure? Authority and physical size vs. reciprocal loving. Family schedule, family planning-meetings for the week (note the give and take, commitment). Bedtime without screaming, graded steps. Breakfast—a brand new day! No newspapers or TV allowed for 30 minutes.

Family financial meeting. No secrets.

Rate your own family. How can you make family life more pleasant?

This kind of family listing could go on and on but, without the central core of family love and respect, most such lists won't mean or help much. It is this central core which is lost in institutional maturation, and is passed on to resulting children.

Conclusion: toward a population of 'doers'

What we have presented is the structure of an educational program aimed at developing a population of doers who are well armed with basic skills and who have an appreciation of human history—the mistakes, blind alleys, and gradual accretion of successes.

The type of school suggested erases the schism between a so-called academic and vocational education. Homogeneous grouping (grouping by knowledge, maturational states, physical capability, artistic interests) is necessary in this type of environment. The aim is skill development in all the students.

Perhaps the most striking departure from present practice is the use of students in the tenth through twelfth year as paid assistants to classrooms in years one through nine, as well as in school service projects. This requires a much-altered orientation in the ninth through twelfth years.

The specifications of practical work in all school years require a heavier plant investment than most school systems contemplate. Much of the required plant equipment can be constructed by the students, but the tools, land, shop material, automotive repair shops, printing and electronic shops, computer systems are all expensive and lacking in most present schools.

The school systems at present are at the limit of their reasonable *ad valorum* taxation ability in most states. A federal to state income tax refund for educational purposes would be one way to finance the changes. Historically, federal refunds have been accompanied by federal requirements or guidelines, which, in this case, may be unconstitutional. Some effort would be required to show that money meant for education was actually spent on educational physical plant and equipment. Contracts with construction and equipment firms would have to be carefully monitored with adequate penalties for the inevitable wrongdoers.

The greatest demand of the proposed system is on teachers. At present, middle school science and mathematics teachers in many states have been promoted from elementary schools and have never had a course in college level science or mathematics! Obviously, before the proposed system could work, intensive teacher training would be a requirement. Much of this training would be shop- and laboratory-oriented, which might require refitting of colleges and universities!

The program would certainly require revision of present training sequences for elementary teachers, and a broadening of the education of middle and secondary school teachers.

As a matter of national policy, federal investment in education of the U.S. population is at least as important as investment in the Department of Defense, perhaps more important. With the present "three-year revision" attitude of elected officials and business leaders, return on this investment is hard to divine. With a longer view, however—10-15 years—it can be seen that U.S. competitiveness in a technologically sophisticated world is dependent on some system of education producing a socially coherent, technologically prepared society.