A Summer Institute in Microcomputer Applications for Secondary School Science Teachers

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Introduction

Last winter, the Indiana Consortium for Computer and High Technology Education announced its support of 1984 summer institutes for Indiana teachers. The institutes were to provide computer-related training opportunities related to the teachers' professional interests and local curriculum requirements. Teacher training institutions in the state were invited to submit proposals for such institutes.

The Consortium approved Manchester College's proposal for a two-week institute in microcomputer applications and interfacing for secondary school science teachers. This institute was to be aimed at teachers who already had some programming ability and who desired to increase their capabilities for utilizing the microcomputer as a science teaching tool. Participants could earn three semester-hours of graduate credit for the concentrated two-week experience.

Sixteen participants were selected, with the requirement that they already have at least a year of experience in using and programming microcomputers in science teaching. Teaching areas of the participants included physics, chemistry, biology, and computer science. Geographically, their schools were distributed over the northern part of the state, as far south as Indianapolis.

Nature of the Institute

It was planned that participants would work on projects which would be related to their own teaching areas for the ensuing school year and which would run on microcomputers available for use in their local schools.

Because interfacing and graphical procedures are quite hardware-dependent, it was important that participants work on computers of types available to them in their schools. To supplement the microcomputers available at Manchester College, participants were invited (but not required) to bring microcomputers with them to the institute. It turned out that 12 of the 16 participants brought microcomputers; some were from their schools, and some were the individuals' own computers. A few of the participants brought two different types of computers, as they expected to utilize them for different purposes in their schools.

It was made clear to the applicants that the hardware-dependent parts of the work would be planned for Apple and Commodore 64 and VIC-20 computers. It was explained that some users of other types of computers would be accepted as participants in the institute, if they were willing to devote some of their efforts to making the necessary adaptations to their computers. Several participants did at least part of their work with Radio Shack and Atari computers, and they were generally able to make desired adaptations to those computers.

Though the participants all had prior experience with microcomputers, there was considerable variation in their areas of competence. Some were not very confident of their abilities for ordinary programming in BASIC—such things as using data arrays, getting data in and out of disk files, and performing string operations. On the other hand, several of the participants were able to write machine-language subroutines to perform such things as high-speed data moving operations.

The teaching staff consisted of the three authors of this paper, representing the disciplines of biology, chemistry and physics. Each of us has worked for several years on computer-related projects in our disciplines. We believe that the interdisciplinary composition of the institute—both the participants and the teaching staff—was an important factor in the value of the experience. In most high schools, the science teaching and learning are not highly specialized along the lines of traditional science disciplines. Many problems encountered by science teachers in learning how to use the microcomputer are quite similar, regardless of which science discipline is involved. Throughout the institute, it was clearly a meeting of science teachers, not of computer game players.

Topics and Projects

The institute emphasized use of the microcomputer as:

1) A computational tool for problem-solving, laboratory data analysis, simulation, and modeling.

2) A graphical medium for plotting functions and displaying spatial relationships.

3) A laboratory instrument for interfacing with experimental apparatus.

The daily schedule of the institute involved morning, afternoon, and evening sessions, with the evenings somewhat optional, depending on interest and stamina. Evening participation was often about 80 percent.

Approximately one-third of the institute time was devoted to lecture/demonstration presentations by the teaching staff and two-thirds to work on individual projects.

Presentations by the instructional staff centered on:

1) Programming techniques for science teaching applications—e.g. computation, graphing, sorting, storing and retrieving data.
2) Interfacing of microcomputers with external apparatus.
3) Transducers for physical measurements.
4) Demonstration of applications developed by the instructional staff.
5) Demonstration of software from various sources.

Hands-on experiences of all the participants included:

1) Assembling and testing of an interface board (the MIA, or Manchester Interface Adapter) designed for use with Apple or Commodore computers.
2) Assembling and testing of accessories for use with the MIA—pushbutton switches, thermistors, light sensors, and connecting cords.
3) Sharing of science teaching ideas and software and hardware ideas among the participants.
4) Trying out and adapting ideas from various sources—from the instructors, other participants, reprints of published articles, and commercial software.
5) Becoming acquainted with the various types of microcomputers represented in the institute.

Beyond these common experiences, there was much variation of individual experiences. Some of the participants worked on improving their general programming skills in areas related to science teaching. Others used their previously acquired skills to develop particular applications in their teaching areas. Some worked mostly on software development; others also did considerable work on apparatus for particular experiments.

The following summary gives an idea of what was done:

7 participants centered their efforts primarily on physics-related projects, 3 on chemistry-related projects, and 3 on biology-related projects.

All 16 participants successfully completed the assembly and testing of the Manchester Interface Adapter and its accessories for timing and for measurement of temperature and light intensity.

7 worked on temperature calibration and measurement procedures for use with thermistor temperature probes.

3 worked on applications of light intensity measurement with photosensors, e.g. observing the progress of chemical or biological processes in terms of the light transmission through a test tube in which the process is occurring.

6 worked on various motion timing experiments—e.g. timing of pendulums and freely falling objects.

5 worked on other timing experiments—e.g. pulse-rate timing, animal activity, strobe light calibration, and stop-watch type of computer applications.

3 used the computer to control external devices—e.g. controlling a strobe light, or controlling an electromagnet in a release mechanism for motion experiments.

5 developed instructional programs other than direct laboratory measurement programs—e.g. simulations and demonstrations.

6 developed various utility programs for doing useful tasks related to science teaching—e.g. graphic routines, data collecting and analysis, record keeping and grading.

8 worked on various kinds of hardware development—devising apparatus for experiments, adapting the MIA to other computers than the Apple and Commodore for which it was designed, making a voltage analog-to-digital converter, etching circuit boards for additional MIA's, etc.

4 did some work which involved creating machine-language subroutines to achieve precision of timing or increased speed of certain computer operations.

Evaluation

Evaluations were obtained from the participants on the appropriateness and quality of the instruction, the value of the projects on which work was being done, and the degree to which individual needs were being met. Predominantly good-to-excellent ratings were given in all of these aspects of the institute.

Because the institute was aimed at the needs of science teachers who had already achieved "computer literacy" and wanted to increase their ability to program and use microcomputers as regular teaching tools, we were very interested in gaining ideas about factors in the secondary school teaching environment which would favor the effective utilization of microcomputers in science teaching.

One factor which came through very strongly was that integrating the powers of microcomputers into science teaching depends strongly upon having the computers available in science classrooms and laboratories for everyday use—not just occasionally getting the use of a computer borrowed from a central computer room. Many important uses of computers in science teaching depend upon the creativeness of teachers and students to grasp the opportune occasions for applying the computer to those tasks for which it is especially suited.

The institute participants quickly grasped the values of laboratory interfacing to achieve microcomputer-based systems for experiments, demonstrations, and simulations. The direct hands-on student involvement in such activities requires ready availability of multiple microcomputers.

Many of the institute participants have had experience with various under-$300 microcomputers—e.g. several models of Commodore, Radio Shack, and Atari computers—which have really fine computational, graphical, and interfacing capabilities. It seems likely that this can be an important key to making it feasible for science teachers to have multiple computers for laboratory use—if school systems do not insist that more expensive computer systems are the only ones which are worth buying.

If we have an opportunity to run a similar institute again next summer, the most likely improvements to be achieved would be: 1) more effective adaptation of interfacing techniques to several different types of inexpensive microcomputers, and 2) more effectively air-conditioned working space for the institute.