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ABSTRACT

A study was conducted to determine the feasibility of using proficiency modules (PMs) to instruct students in an elementary science education class. A PM entitled "Magnetism, Electricity, Heat and Microscopic Viewing in Science Instruction" was prepared which described performance behaviors and a variety of learning activities that would enable a student to acquire them: a laboratory practicum, attendant readings, individual and small group instruction sessions. The 17 senior student subjects were given copies of the PM and of a laboratory handbook written to guide them in the laboratory practicum. Each was responsible for selecting the learning activities that would best help him to acquire each performance behavior. Subjects evaluated the program by answering six specific questions regarding number of activities completed, amount of reading, number of small group sessions attended, size of learning stations, and organization of the handbook and of the program. Analysis and interpretation of the data led to these conclusions: (1) all students in the trial group reacted positively toward the program; (2) interest was generated in the laboratory practicum, 15 of the 17 completing all activities described in the handbook; (3) the PM permitted students to work individually, with indication that individual differences were met as students worked at a rate according to their abilities and desires. (Student answers to questions are appended.) (JS)

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REACTIONS OF COLLEGE STUDENTS TO A SCIENCE EDUCATION PROFICIENCY MODULE

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Note: This bulletin reports one of a series of investigations designed to develop, evaluate and implement a model teacher education program for the preparation of elementary teachers. This report was prepared pursuant to a contract with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy. This bulletin may not be reproduced without permission.

The Problem

The purpose of this study was to determine the feasibility of using proficiency modules (PMs) to instruct students in a science education class. Feasibility in this instance is defined as "the extent to which college students can adjust to the system and achieve at higher levels of quality with greater efficiency".

Procedure

In the summer of 1969, a PM, patterned after the prototype contained in the Georgia proposal for the feasibility study (Johnson, 1969), was prepared to instruct a section of senior students enrolled in ESC 399, Elementary Science Education. The title of the PM that was tested was "Magnetism, Electricity, Heat and Microscopic Viewing in Science Instruction", one of the topics normally studied in the course.

In the PM performance behaviors were listed under the headings: Magnetism, Electricity, Heat and Microscopic Viewing. A variety of learning activities that would enable a student to acquire these performance behaviors were also described in the document: a lab practicum; attendant readings; and individual and small group instructional sessions. A laboratory handbook was written to guide the students through the laboratory practicum part of the PM.

Seventeen students were given a mimeographed copy of the PM and a copy of the laboratory handbook. Three ideas were emphasized in the explanation of the module to the students: (1) Each student was responsible for acquiring each performance behavior specified in the PM if he did not already possess the performance behavior. (2) Each student was to select the learning activity or combination of activities that would help him acquire the performance behaviors in an efficient and effective manner. (3) The instructor would be available to assist any student in identifying learning activities that would assist him to acquire specified performance behaviors.

In addition, the students were given the following information:

1. The laboratory schedule, or times during which time the laboratory would be open and materials available for the students to work individually or in small groups.

2. The schedule for three small group instructional sessions or times during which the instructor would be in the lab to work with small groups of students on problems of common concern.

3. The schedule for individual student assistance or times during which the instructor would be available to work with students who wished assistance.

4. The lab handbook which described activities that could be completed with materials available to them in the laboratory. The handbook was composed of two Parts, A and B. In Part A the activities were introduced and directions for completing them were described. Part B contained supplemental information for each activity. The students were encouraged to try to complete an activity described in Part A before turning to the related section in Part B. After they completed an activity and read the appropriate section in Part B, then they might wish to repeat part of the activity or re-examine the equipment.

Findings

Since this trial of the PM was designed to test only psychological feasibility it was decided that detailed objective data collection would be delayed until better controls could be placed on the subjects of the study. Therefore, only subjective evaluations were requested from the participants.

Reactions were obtained from each of the seventeen subjects. Each was provided three, four by six inch cards and asked to respond specifically to the following questions:

1. How many of the laboratory activities described in the handbook did you carry out?
2. How much reading did you do?
3. How many small group instructional sessions did you attend?

In addition, the students were asked to respond freely in writing to three questions which were designed to provide their attitudes toward the procedures. These questions were:

1. What do you think of this means of organizing an instructional program? What are some if its advantages and disadvantages?

2. What do you think should be the size of a learning station? Why?

3. What is your reaction to the organization of the laboratory handbook?

Table 1 presents a summary of the extent to which these students completed the activities described in the laboratory handbook.

Table 1. The Extent To Which Students Participated in the Laboratory Practicum

Extent to which Activities were Completed	Number of Students
All the activities	15
Most of the activities	1
Some of the activities	1
None of the activities	0

Every student participated in the lab practicum. Fifteen students completed all of the lab activities; one completed most of the activities; and one completed some of the activities.

The students were not required to do the activities in the handbook, but they were required to acquire the behaviors specified by the PM. Whether the high proportion of students completing all the lab activities was due to the students' enthusiasm, their uncertainty while participating in a new program, or simply their desire for this kind of learning activity is a moot point.

Table 2 indicates the amount of reading done by the students in completing the PM, other than the reading done in using the laboratory handbook.

Table 2. Amount of Reading Done by Students

Amount of Reading	Number of Students
Much	3
Some	9
None	5

About 70 percent of the students found it necessary to read material other than the handbook. Three students read extensively; nine students read some; and five students found it unnecessary to utilize this learning activity.

Table 3 presents the number of small group instructional sessions that the students attended. Students were not required to attend these sessions, but the sessions were provided for those who may have felt that they needed them.

Table 3. Number of Small Group Instructional Sessions Attended by Students

Number of Sessions Attended	Number of Students
Three	10
Two	0
One	7
None	0

Every student attended at least one small group session. Ten students attended all three sessions, while seven students attended only one session. Apparently, almost half of the students felt that they could successfully complete the module without the aid of more than one small group session.

Seventeen combinations of learning activities were identified: one combination for each student. Table 4 lists the combinations that were identified and the number of students that utilized each combination of learning activities.

Table 4. The Combination of Learning Activities Utilized and the Number of Students that Utilized Each Combination

Combination of Learning Activities			
Lab Activities Completed	Reading Done	Small Group Sessions Attended	Numbers of Students That Used the Combination
All	Some	Three	5
All	Some	One	3
All	None	One	3
All	None	Three	2
All	Much	Three	1
All	Much	One	1
Most	Some	Three	1
Some	Much	Three	1

Almost 50 percent of the students selected a combination of learning activities that consisted of doing all the laboratory activities, some reading, and attending either one or three of the small group instructional sessions. About another 30 percent of the students used a combination that consisted of doing all the laboratory activities, no reading, and attending either one or three of the small group sessions. It is interesting to note that the two students who did not complete the laboratory activities attended all three small group sessions and did some or much reading.

As regards the questions which were designed to provide students' attitudes or impressions of the procedures complete responses of the students are given in the Appendix. The responses for each question were categorized for tabulation purposes.

Table 5 presents the responses of the students in reference to the organization of this instructional program.

Table 5. Distribution of Student Responses Regarding the Organization of the Instructional Program

Kind of Response	Number of Students Responding
Favorable	16
Neutral	1
Unfavorable	0

Sixteen of the students were impressed with the organization of this instructional program; and one student considered the organization acceptable, but felt they should have more things to do. None reacted unfavorably toward this pattern of organization.

Table 6 summarizes the responses of the students in regard to the desirable size of a learning station.

Table 6. Distribution of Student Responses to the Size of a Learning Station

Number of Students a Learning Station Should Accommodate	Number of Students Responding
None to Two	2
Two	14
One	1

Two students felt that a learning station should be designed to enable more than two students to work together; fourteen students suggested two student learning stations would be best; and one student expressed the desire for individual learning stations. Apparently students believe learning stations designed for two students would be more beneficial than stations designed for individuals or for groups of more than two people.

Table 7 presents the students reactions to the way in which the lab handbook was organized. Since all seventeen students used the handbook there were seventeen responses categorized for this table.

Table 7. Distribution of Students' Reactions to the Organization of the Lab Handbook

Nature of Response	Number of Students Responding
Favorable	17
Neutral	0
Unfavorable	0

All the students felt the way in which the laboratory handbook was organized was good. At the same time many of the students were able to give very constructive suggestions by which this means of organizing the handbook could be accomplished more effectively. These suggestions may be found in the Appendix.

Conclusions

The analysis and interpretation of the data in this study seem to warrant the following conclusions:

1. All of the students in the trial group reacted positively toward the program presented.

2. The program generated interest in the laboratory practicum, in that fifteen of the seventeen students completed all of the activities described in the laboratory handbook.

3. The module, as designed, permitted the students to work individually. There is an indication that individual differences were met in the trial and that the students worked at a rate according to their abilities and/or desires.

4. This trial program was well received by the students. Most of the suggestions made by the students are incorporated in the regular plan of total GEM program.

Finally, this trial run seemed to have provided what the GEM program is designed to provide -- motivation, individuality; success, and the desire to do further study without fear and frustration. The students in this group want more of this kind of curricular activity. They considered this way of learning was more beneficial than the traditional lecture - discussion - demonstrations made of instruction.

APPENDIX

Subjective Responses of Students

I. <u>What do you think of this means of organizing an instructional program? What are some of its advantages and disadvantages?</u>

A. "I am very impressed with this project. If the materials we were able to use were available in the schools then it seems to me that children would enjoy learning more and develop a more working understanding of the various concepts. However, since it is new and different I can see how children could have problems getting readjusted to the new learning situation. It seems to me that some children would take full advantage of free time to dig and learn on their own but some children would use the free time to goof off."

B. "This program is similar to one I experienced in botany at Columbus College last summer. I enjoy this type of student freedom especially in science courses.

A pre test would have been helpful."

C. "This approach to learning basic concepts of science is extremely beneficial in that the student finds out <u>why</u> a certain fact is true and can make other generalizations from it. To experience the force of magnetism reinforces the student's study of how a magnet works. Rote memorization does not induce creative learning or any sort of further inquiry in the approach to learning. A proficiency module promotes the learning of skills at one's own pace and enables the student to see how much he understands."

D. "This approach to science is probably the best I have ever experienced. As adults are often merely children at heart, I as an adult could see how a child would be fascinated with "seeing science in action" rather than reading about it. Children are natural manipulators of "things" - this approach comes very natural to them. As far as changing behavior is concerned, this is the way. One remembers best what he must figure out, and the mistakes he makes than he does what he is told. This, to me, is memory improvement and application of that learning - and this is teaching."

E. "Basically, this approach can be very adequate in that it is based on the individual. The individual should be left on his own as much as possible, but sources should be available for group discussion, instructor assistance, etc. I think the program far outdoes the classroom lecture type situation. Experiencing something is a definite pre-requisite for learning it."

F. "I thought that the basic approach was very good. I definitely believe that separate rooms for each section should be used to avoid distractions.

I found that the learning stations were very useful in giving experience. This type of set up would be very conducive to learning for the average child and the bright child it seems. The objectives provided goals without being pressured by the teacher.

The only fault I find is that we were told that we would work on our own and when we finished what we did was up to us. However, you seemed to feel a hostile atmosphere when you finished and had nothing else to do. As in any class I think when one has done their work they should be able to continue or go to another subject. Here we had nothing to do but waste time because we felt the instructor would be displeased if we left."

G. "I believe that this has been a very, very good approach to learning concepts in Science. I like to be given a "problem" and then <u>to choose</u> my own method of solving it as we have done in class for the past week. To me, the greatest part of this type of learning is that we were given the freedom to work on the problems as we wanted to and as we thought best. When I am given this freedom, I believe that it makes me want to learn more."

H. "I think the approach is very good. If a student already knows something he can move on to something else, rather than being held back by the rest of the class. He does only those activities that he needs to do because the student is active and knows what he has to learn. There is no problem of boredom like there is in so many lecture, teacher-oriented classes. The student knows ahead of time what knowledge he is expected to gain and what skills he is to learn. Therefore, he does not have to play guessing games with the teacher as to what he thinks is important."

I. "I think that the work the demonstrations or experiments, which we carried, were well planned by the instructor. This is essential. We needed a certain amount of guidance so that we would not bog down as we explored materials, etc. We needed to know what to look for.

I felt that I enjoyed and learned more from this method of exploration than I did from straight lecture.

I have experienced learning difficulties, even disabilities, in my previous work in the physical sciences. I have failed chemistry and geology and made D's in physical geography, with near failure.

I feel that preparation made in high school physical science was inadequate. I took a survey course which did not contain a laboratory. Then the college lab courses moved too fast for me.

I wonder if education majors would not profit from special science courses."

J. "I enjoyed the program very much. I was more involved in the subject matter itself, rather than the tedious "taking notes" process I usually suffer through. With all the talk of actively involving children in their classwork, I feel this would be an <u>excellent</u> method of teaching subjects such as science and perhaps social studies."

K. "To me this approach was exciting, enjoyable, and informative. For once, I began to understand concepts that I had memorized throughout school years. Being able to work with equipment and demonstrate generalizations helped me to see the why of statements I had always just accepted. Moving at our own rate allows us to branch into new experiments by trying different things. It also avoids frustration from pressure of meeting a definite deadline."

L. "The approach to science study used here was probably one of the most effective I have used. I feel that exploration is the best way to get scientific material across to students and this module provided the opportunity for exploration. The skills acquired were ones gained through trial and error and will stick in my mind much longer than if they had simply been illustrated for me."

M. "I feel that the module method of learning is most effective in that I learned because I wanted to -- not because I was told to study. The fact that I was able to experiment with concrete objects stimulated my interest in the subject areas that had previously been boring to me. Since I was allowed to discover what the function of certain objects were, I desired to gain more knowledge in the areas. I also found out that I learned much from my partner. It was fun."

N. "This approach has many advantages. These are the aspects I am in favor of:

(1) the idea of working at your own pace.
(2) having the outline and lab manuel to refer to for information.
(3) definitely have the work stations and always have 2 students working together."

This module idea is very satisfying. It gives the student insight to many phases of learning. The instructor being available for extra help is a necessity though."

O. "I feel that this is an excellent method of teaching. It seems that I have learned so much more because I have worked at my own rate. Working individually or with a partner seems to be a great advantage. The actual experimenting with electrical circuits, magnets, etc. causes you to retain what you learn more so than if you merely read about it in a textbook."

P. "The GEMs project seems to be an excellent way for learning science. Children can progress at their own rates and can learn from their own experiences. Trying and experimenting teaches so much more than just watching and listening. For some children it may be the only way to get the concept across."

Q. "I feel the GEM Project is very effective. I feel it is very feasible for an individual to be able to work at his own rate. I find it helpful to work with someone as by doing this you can discuss why, or why you feel, your findings are what they are. I enjoyed working with the equipment and by letting the individual progress at his own rate. I found myself very eager to begin working on the module each day and I could re-do the test until I understood why the results were what they were.

II. <u>What do you think should be the size of a learning station? Why?</u>

A. "I think a learning station for 2 people would be much better. Very often when I put my ideas together with another person's then a solution can be reached much faster and easier."

B. "I think two students should be able to work together. It was helpful to me this time."

C. "The learning stations should be equipped for two people to work together. This way the students could profit from each other's ideas on the topic."

D. "For the best learning situation, I feel that the best set-up would be for the learning station to be set up for one person, but leaving it open for the students to move in and out of each other's learning stations."

E. "The learning station should be set up for 2-3 persons. A student benefits from mistakes and thoughts of other students, but if there are more than 3 in the group it will tend to lose its effect as a small group."

F. "I believe that learning stations for two would be better. In this I believe that the children together should be able to work at <u>about</u> the same rate and be fairly compatible. I believe that it is true that children learn best from each other. Also, this would teach social interaction and working relationships."

G. "I feel that it would be best for learning stations to be designed or set up so that two could work at them. This way, they could share ideas. However, it would be all right for one person to work alone in the station."

H. "I think that learning stations designed for one or two people is best. By working together you can help each other and learn from each other."

I. "I would like to work with another student such as a lab partner. I feel that the two students would profit from working together both academically and socially."

J. "In my opinion, the learning station designed for more than one person would be much more beneficial to the student. When students pool their ideas, they come up with even better ones nine times out of ten. They help each other and learn much from the interaction they experience."

K. "Learning stations designed to handle one or two students would be my preference. Being able to discuss with other students, have them see what you are doing, or work with other students would prevent one from feeling lost. Also working together leads to different approaches."

L. "I know for myself that I work better with someone else. A learning station designed for two students would be an ideal situation."

M. "There should be a station to handle at least two people! I enjoy working with another person. He or she may think of questions I wouldn't think of."

N. "Work station for 2 students would be best because one can help the other. And you could come to your station and work alone."

O. "Learning stations should be designed for at least 2 people. Of course, everyone learns differently, but in my case I seem to learn more quickly if someone is with me discussing what went wrong or why something turned out the way it did. We may not always come to the right conclusions but I always remember what we did and discussed."

P. "I think learning stations should be designed for two students to work together. Many times — peers can make very helpful comments that an instructor may not be able to make clear. If an individual wanted to work alone, he still could do so."

Q. "I believe it would be more feasible to have learning stations designed for at least two people. It would be possible to work alone but in observing our group working on this module, everyone worked with partners."

III. <u>What is your reaction to the organization of the laboratory manual?</u>

A. "I think having 2 separate sections was good. It made me do the activities in A and try to think them through for myself before going to B for help or to see how my ideas compared with those in B. If B had been divided up and each "help section" had been with the activity then maybe I would not have bothered to think things through for myself. Some of the ideas in B were not clear to me but this only served to make me use more outside reading."

B. "I found the lab manual to be easy to follow. The arrangement of Parts A & B was helpful to me in that I proved some of my misconceptions wrong quickly after performing the experiment. If I were given all the information at one time I wouldn't have really thought through the experiment."

C. "The lab manual was very helpful in its synopsis of the topic in an introductory paragraph before the experiment. I liked the part A, part B division of the manual because it enabled you to do the experiment without seeing the results on the same page. This allows the student to generalize before he reads what is happening scientifically. <u>More diagrams</u> for how to set up the experiment are needed along with a few more extra activities for brighter students."

D. "I liked very much the Part A and Part B set-up. I liked to experiment and then check.

Another advantage of a separate Part B, is that it makes a wonderful review of the experiments.

I feel that it might be a good idea to have the following manual organization: Magnetism A
Magnetism B
etc., rather than all of B at the end of the manuel."

E. "I think that Part B should follow Part A in each individual activity. In other words, do the activity and read the explanation of it before you go on to the next activity. As it is set up now, there is a tendency to do all the activities and not take the time to read Part B.

I also think there could be some more diagrams. This would clear up some confusion in setting up the activities.

"A picture is worth 1,000 words."

F. "I liked the lab manual approach of A and B. I think that in A too many answers were given sometimes, especially in the section on heat. An explanation of the use of equipment before beginning would save time and interruption of the activity unless the unit is on only the use of equipment."

G. "I think that the set-up of the manual is excellent. It is good that the B Part (explanations or answers) was not written in the A Part. It was helpful for me to do the activities, ask myself questions about why a certain thing happened, answer them, then check the B Part to see if I was right."

H. "The "Part A-Part B" approach is a good idea. This way you can do the experiment and attempt to make your own inferences and generalizations without lots of facts getting in your way. However, when you have finished you can easily turn to Part B to check your ideas and to add to them."

I. "The manuel is excellent as it is. A table of contents would be helpful."

J. "The Part A, Part B approach seemed to me to be a very good one at times. Occasionally I looked at Part B prior to the experiment in order to more fully understand the experiment itself. I did feel that at times the manual contradicted itself by using different terminology for the same process or method in separate parts of the manual. (Ex. North - seeking and North Pole.) However, on the whole I thought it was well prepared and worth the trouble to go through every activity."

K. "I'm glad the manual was divided into Part A and Part B. That way before reading the answers on supplementary material or generalizations, I did the experiment, form ideas of my own, and then had a place that was convenient to find out more about the ideas I had begun to form."

L. "I think having a two part lab manual is the best. This way the student can read directions and follow them through before reading the expected reaction. This stimulates thinking rather than having an easy answer that might be read as part of the directions. I thought the lab manual was well constructed and organized and a good resource unit to work by."

M. "I prefer the approach Part A - Part B, simply because I didn't find myself looking at the outcome before the experiment. I felt like a true experimenter with Part A and that Part B was like research material."

N. "The lab manual approach with Part A - Part B is a good idea. It gave me the incentive to work the demonstration knowing that if I had any doubts I could refer to Part B for help.

Part B - was helpful in another way because the Generalizations told you what to look for.

The information in both parts was very helpful."

O. "This approach in the lab manual was very good. The only disadvantage of having a Part B to look at later is if you don't have enough time. This approach is fine as long as the student is allotted enough time to try the experiments by trial and error (especially those in electricity) a few times and then still have enough time to look back in Part B to read about what he has done. In my case, I had enough time, but others may work or read a little slower."

P. "I think the two section approach in the manual is good. It helps to do the activity before knowing the expected results. With the explanation immediately after the activity as in a regular text there is too much temptation to read the results and then hurry through the activity or skip over it entirely."

Q. "I found that by having the Lab Manual divided into Part A and Part B, it was a better learning experience for me for I drew my own conclusions and then checked them with Part B. Some of them did not correspond and then I asked and looked until I found the answer. I really think this is a better format than a regular textbook."

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