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ABSTRACT

The major and current findings of Project IMPACT are summarized in this report on the status of metric education at the elementary, secondary, inservice teacher, and preservice teacher levels. Each of the following major components in metric education are discussed: metric knowledge, measurement skill, estimation skill, attitudes toward changeover, curriculum development, instructional strategies and materials, and monitoring the move to metrics in departments of education. (CS)

Project IMPACT, An Overview on Preservice and Inservice Teachers and Administrators

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Introduction

The metric system has been a legal system of measurement in the United States since 1866. In 1922 the American Association for the Advancement of Science adopted a resolution affirming the desirability of adopting the metric system for use in published scientific materials. In 1944 the National Science Teachers Association adopted a resolution favoring legislation dealing with conversion to the metric system. Science educators are familiar with the famous process goals of science teaching, including the goal of developing the process of measurement. Finally President Ford signed the Metric Conversion Act of 1975 which committed the United States to the use of the SI Metric System.

The authors became involved in metric education concerns in 1971. They found evidence suggesting the adult population (including teachers) in the United States was not well informed about either the customary or the metric measurement system. For example, the 1971 Gallup Poll revealed that 56% of the persons surveyed did not know what the metric system was.

One thing the poll did not reveal was the percentage of persons who knew what the metric system was and could also effectively use the units

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to make accurate estimations and measurements. Corle (1963) and Swan & Jones (1971) found inservice and preservice teachers were inadequate in their ability to use either customary or metric units of measurements. The authors also found there was a lack of quality instructional materials and measurement instruments in teacher education and public school classrooms. This lack of knowledge, skill, and instructional materials is seen as a crucial problem which is exacerbated by the realization that the changeover to the SI Metric System will result in one of the most significant nationwide curriculum changes to impact the schools of the United States.

Project Design

The authors would argue that the changeover effort will be best served through the efforts of cadres of trained leaders. The research, development, and dissemination thrusts of Project IMPACT should be viewed as a concerted effort to identify, train, and support leadership cadres. From the above findings and from their personal experience, the authors concluded that a comprehensive research and development effort was needed in order to attend to the major components related to providing quality metric education through a cooperative public school and community effort. The matrix (see Figure 1) shows the relationship between the major components and the research and developmental efforts completed by the metric education project (Project IMPACT)[1] at Penn State.

Project IMPACT Summary

The vertical column at the left in the matrix (Figure 1) lists the Project's seven major components. The heading at the top of the matrix

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1. This project, Instruction in Measurement Processes for Action Classroom Teaching, was funded by U.S.O.E. Grants #G007603523, 1977; #G007700162, 1978; and G007902321, 1980.

identifies which levels are currently under study. The number(s) in the cells of the matrix refer to the curriculum publications, research studies, and instructional materials for a given component that have been completed by Project IMPACT to date (see References at the end of this paper).

The purpose of the remainder of this paper is to summarize the Project's findings for each of the major components shown in Figure 1. Hopefully this will help you put the studies presented by the other panel members in proper perspective.

Research Components	Levels K - Adult			
	Elementary Students	Secondary Students	Preservice Teachers	Inservice Teachers
1. Metric Knowledge	6	14	1, 4	11, 15
2. Measurement Skill	6	14	1	11, 15
3. Estimation Skill	14	14	1	11, 15
4. Attitudes Toward Metric Changeover			5, 13	11, 15
5. Curriculum Development	14	14	12	7, 8, 9, 10
6. Instructional Strategies and Materials	14, 16	14, 16	17	7, 8, 9, 10, 17
7. Monitoring the Move to Metrics in Departments of Education	2, 12	2, 12	2, 12	2, 12

Figure 1. Matrix summarizing the completed research and development efforts for Project IMPACT.

Metric Knowledge

As indicated in Figure 1 beside component #1 (Metric Knowledge), Project IMPACT has focused primarily upon the preservice and inservice teachers' knowledge of the SI Metric System. Project IMPACT has developed a valid and reliable (KR20=.79) test of metric knowledge. The components of knowledge measured are listed in IMPACT Volume I, (Szabo, Trueblood and Nippes, 1977).

In general, the authors found that the typical inservice teacher and school administrator demonstrates a low level of understanding of the SI Metric System. This conclusion comes from the data collected on the pretests administered during the 1977 and 1978 project years. On the other hand, these data show science and mathematics teachers are well informed and given appropriate leadership training have provided the Project with a pool of knowledgeable leaders who have provided effective staff development programs and metric workshops in school districts in the nine Northeastern states. Houser and Trueblood (1975) and Attivo (1979) found that preservice elementary teachers also demonstrate on pretests a low level of understanding of the SI Metric System. After approximately two days of instruction the preservice and inservice teachers' knowledge significantly improved.

Based upon the above findings it appears that given about two days of training preservice and inservice teachers can become knowledgeable about the SI Metric System. In addition, since science and mathematics teachers are usually well informed they can be used to help instruct their colleagues.

Measurement Process and Estimation Skill

As indicated beside component #2 (Measurement Skill) and #3 (Estimation Skill) shown in the Figure 1, Project IMPACT has also studied the process of measurement and estimation skills of preservice and inservice teachers and primary grade children. The pretest data show almost all inservice and preservice teachers, including science and mathematics teachers, need instruction and practice making estimations using the basic metric measurement units. The posttest data show that after two days of hands-on instruction the estimation skills of the preservice and inservice teachers significantly improved. For example, estimation error rates quickly drop from ±200% to ±20%. From this experience and data the authors believe the typical inservice and preservice teachers' ability to make reasonably accurate estimates can be significantly improved in a reasonably short period of time.

Science and mathematics teachers, as you would expect, already know how to make relatively accurate measurement using metric measurement instruments. Therefore, their time is best spent working on their estimation skills. The other teachers, however, need practice making measurements and estimations.

The research with young children (Smith, Trueblood, and Szabo, 1980) show that, after hands-on instruction on how to manipulate and read a metric ruler, children can make accurate measurements to the nearest cm. The most difficult task for children was interpreting the results of iterative measurements.

Based upon the above findings the authors recommend that inservice and preservice training of teachers should focus primarily upon developing teachers estimation skills. For most teachers, the authors found that their measurement skills can be improved through properly constructed

estimation skill exercises. This means having teachers check their estimates using appropriate measurement instruments. This procedure saves time and seems to give more meaning and purpose to the estimation activities.

It would appear that manipulative activities should also be used to teach young children to use metric measures. Their instruction, however, should give special attention to developing the concept of iterative measurement.

Attitudes Toward Changeover

Shrigley and Trueblood (1979) developed a valid and reliable (KR20=.90) attitude measure for use with teachers. The authors found that inservice teachers' attitudes toward metrics and the changeover process can be improved by using a non-threatening hands-on approach to teaching the process of metric measurement and estimation. They also found that most mathematics and science teachers have a positive attitude toward metrics and that school administrators tend to have lower attitude scores than their teachers. This latter finding lead the authors to adopt the practice of providing school administrators with hands-on awareness workshops before or at the same time they provide training for their staff. This practice has helped Project IMPACT gain support for follow-up activities such as:

1) Purchasing appropriate metric measurement equipment.
2) Including metrics in the districts' long-range plans.
3) Obtaining inservice time for curriculum development projects.
4) Obtaining school district funds for additional metric training.

Curriculum Development

Project IMPACT developed instructional materials and tests which reflect teachers' and school administrators' knowledge of curriculum. These materials reflect the point of view held by the project relative to what teachers and school administrators should know and be able to do relative to metric curriculum development. For example these materials include:

1) Using developmental psychology to sequence metric curriculum objects (Szabo and Trueblood, 1977).
2) Evaluating and selecting commercially produced instructional materials (Szabo and Trueblood, 1978).
3) Designing metric games (Szabo and Trueblood, 1974).
4) Preparing a long-range metrication plan for a school district (Szabo and Trueblood et al., 1978).
5) Producing and evaluating self directed learning activities (Szabo and Trueblood et al., 1978).
6) Competencies for preservice teachers (Szabo and Trueblood, In Press)

It has been the experience of the authors that teaching curriculum development skills are as important to implementing the metric system in schools as those related to becoming knowledgeable about the skills in using the metric system itself. This is important to remember because our data show there is a low correlation between knowledge of metrics, estimation, and measurement skills and curriculum development skills as applied to metrics.

Instructional Strategies

During the workshops and training session conducted over the past four years, the authors have found three instructional strategies which proved to be effective in motivating and helping teachers and school administrators to learn to use the SI Metric System. It should be noted that these strategies lean more toward an experiential learning structure than toward a didactic one.

These instructional strategies include:

(1) Using pre and post tests keyed to self-directed hands-on metric measurement and estimation activities (Szabo, Trueblood and Nippes, 1977).

(2) Developing and then using instructional activities in the classroom with students (Szabo, Trueblood and Smith, 1978).

(3) Playing and constructing metric games (Trueblood and Szabo, 1974).

These procedures were judged effective because the teachers and administrators significantly improved their metric knowledge, measurement, and estimation skills through the use of these procedures.

Role of State Departments of Education

The authors have conducted two national surveys (Chipley and Trueblood, 1976 and Szabo and Trueblood and Nippes, 1978) to determine what state departments of education have done to support the changeover to metrics. They have also spent the 1979-80 school year working with representatives of departments of education of nine states who are responsible for disseminating the metric system through a network of state, regional, and local school district metric leadersnip teams.

In general, they found that state departments of education can now provide:

(1) Instructional materials for training teachers in metrics.

(2) Instructional materials that illustrate how to teach metrics to students.

(3) Instructional materials for use in classroom K-12.

(4) Curriculum guidelines that show what metric content and competencies should be taught K-12.

The surveys also show that state departments of education have changed from 1975 to 1977 in several ways.

(1) Increased the number of personnel assigned to promote and assist in the changeover to metrics. The contact persons tend to be either the mathematics and/or the science supervisor. These key leaders are also helping school districts obtain federal funds to support local projects. The states where such funds have been acquired have made the most progress toward use of metrics in schools.

(2) Published state regulations supporting the change to metrics. However, these regulations do not specify dates when the changeover should be completed.

(3) Expressed mixed reactions to placing specific metric competencies in their state's teacher certification standards.

Finally, the authors' experience has shown that interest in metrics seem, in the nine Northeastern States, to be related to specific geographical areas in each of the states. The reason for this is not yet clear.

Future Problems and Issues

What problems will need to be addressed by those interested in promoting the changeover to metrics in schools in the near future? The authors have identified the following from their contact with schools now involved in the changeover process. These include:

(1) Developing acceptable indicators which can be used to determine when metric conversion has been completed by a school district, i.e., the ability of teachers and students to make metric estimations and measurements within prescribed limits.

(2) Providing classroom teachers with sufficient metric measurement equipment required to implement a hands-on approach to teaching metric estimation and measurement.

(3) Agreeing upon a coordinated set of K-12 curriculum guidelines which can be used to evaluate students' competence with metrics.

(4) Obtaining a clear/directive from each state department of education or the United States Metric Board that defines a realistic time line for converting schools and curriculum materials used in schools to the metric system.

(5) Supporting the efforts of school-based leadership teams as they work to disseminate metrics.

Conclusions

U.S.A. is quietly going metric, led by MNC's. Education will be the vehicle (as in Australia) vs. industrial conversion (Great Britain). Piaget Developmental Theory has implications for the teaching of measurement. To date, these implications have not been adequately tested. Attitudinal barriers are great and must be addressed in all metric instruction as changeover.

Future Directions

- Additional research on Developmental State Theory and its role in acquisition of measurement processes, estimation skills, and knowledge.
- Additional research on instructional approaches to imparting above skills.
- Expansion of above research into unexamined age, grade, and developmental levels.
- Design of curriculum material and instructional approaches consistent with our findings and those of the related body of research.
- Concerted effort to get the Federal and State legislature bodies to formally recognize the revolution and sanction the same.

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