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A survey, a questionnaire, and a literature search were employed to determine what would be the implications of the adoption of the metric system for the education of exceptional children. Current experience of exceptional children with the metric system and problems associated with the use of the English system were determined. The needs of exceptional children in a learning experience are enumerated (clear presentation of concepts, sequential presentation from the concrete to abstract, apparent functional relevance of new learning). Exclusive use of the metric system is recommended. A rationale for its adoption for exceptional children is presented. Recommendations for facilitating the adoption are made in terms of classroom stratagem, educational personnel preparation, community responsibilities, and time considerations. (KW)

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# KEY ISSUES CONCERNING THE ADOPTION OF THE METRIC SYSTEM AND IMPLICATIONS FOR THE EDUCATION OF EXCEPTIONAL CHILDREN

A Position Statement Prepared at the Request of the U.S. Department of Commerce

Compiled and Edited by the Information Utilization Unit of the CEC/ERIC Information Center of the Council for Exceptional Children

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The Council for Exceptional Children submits the enclosed position statement regarding some of the key issues of the U.S. Metric Study as they relate to the education of exceptional children. The Council's statement incorporates the results of the following activities:

A hand and computer search of the literature was conducted to cull all pertinent information on measurement systems, arithmetic characteristics, and exceptional children.

A list of outstanding math theorists, teacher educators concerned with preparing teachers to teach math, math supervisors in the public schools, math teacher specialists, special education instructional materials specialists, and special class teachers was compiled. This list was generated by surveying the CEC professional staff for recommendations and then spiraled as the respondents indicated new resource people within this spectrum of disciplines.

The telephone survey revealed that seven university and Special Education Instructional Materials Center Network personnel were conducting summer workshops and conferences for math and/or special class personnel. In order to get a flavor of the practitioners' views, the basic issues set forth in the Bureau's guidelines were incorporated into a questionnaire which was distributed to workshop participants. Only eight responses were received on time for inclusion in our statement.

A preliminary statement was reviewed by the Council's Executive Committee.

I. Current Experience of Exceptional Children with the Metric System.

Respondents' major concerns. The following concerns emerged from the survey:

- Most exceptional children (except the gifted) are not introduced to the metric system at all.
- Where they are, the system is presented on the fourth or fifth grade level as an enrichment experience to support the primary English system.
- Metric units are sometimes introduced on the fourth or fifth grade level as an enrichment experience only.
- Metric units are most often used pragmatically in auto training, vocational programs, and business laboratories.
- Metric tools have recently been used to teach linear concepts to blind children.

Most of the respondents were more often and more deeply concerned about how well exceptional children understood the *current* measurement system than how well they would adapt to a *new* one. Undoubtedly, there are serious deficits in arithmetic learning today. There are researchers and practitioners who feel that these deficits are direct results of the complexity, diffusiveness, and inconsistency inherent in the English system of weights and measures. Because exceptional children present a variety of learning problems with symbols and concepts, CEC's commitment is to find and support systems which, as much as possible, remove confusion and distraction.

Problems associated with the exclusive use of the English system. The major problems which emerged were as follows:

1. Excessive loss of class time in teaching the 53 denominate units and all of the complex fractions needed for computation.
2. A widespread difficulty among all pupils and some teachers in quantitative appraisal, (Murphy & Polzin, 1969).
3. A basic confusion about equivalencies between units.
4. An absence of clear understanding of the number system which prohibits further math learning, and then predisposes the child to failure experiences.

From teacher to theorist, each respondent supported a shift from the English to the metric system so that children with learning, health, and behavioral problems might be relieved of the disabling chaos now experienced. The respondents felt that only the simpler, more orderly metric system will accomplish this.

## II. Trend Patterns for Use of the Metric System with Exceptional Children.

Although there has been a decided increase in societal use of the metric system, there appears to be a discrepancy of its use in classrooms (Helgren, F. J. 1967). Data on use patterns with gifted children were not available. However, if instruction for them is tailored to their competency, they would be receiving as early and thorough an introduction to metrics as do their "normal" peers.

Queried about use patterns, many special educators replicated the response of "regular" educators by indicating that they too had not even considered teaching metrics. An interesting by-product of the survey was the unsolicited statement from many of these same educators that they should be teaching metrics and would plan to.

They agreed that there would be increased use now not only because of their own awareness, but also because our nation and the world have so moved.

## III. Needs of Exceptional Children in a Learning Experience.

Before we can evaluate learning systems, we must know a good bit about a principal in the system. The learner. His needs and characteristics are primarily determinant of system success.

New concepts should be presented in a clear and simple manner. Like other children, all exceptional students function best when concepts presented are clear and simple. The orderliness a disordered child experiences tends to mitigate his own chaos. The earliest and most intimate encounter with numbers-- ten toes and fingers--reinforces comfort with the base ten. That concept system which provides as clear a relationship as possible between symbols and concrete objects would be the path of least resistance for our children. Many of our respondents endorsed the conversion so as to avoid "loading our kids down with archaic, useless knowledge." Human and conceptual models that are reasonable and stable communicate positively to the child, and aid learning.

Mentally retarded, learning disabled, and often neurologically impaired children have great difficulty integrating ideas. Although they utilize learning processes that are no different from those of other children, for many, these processes are often disrupted. In the conceptual stages of learning, abstractions are integrated and

systematized–not randomly, but in an orderly fashion. "Those functions that are not pertinent to the solution of present problems, can be easily avoided or eliminated by the child" (Kephart, 1968). If indeed a system for learning is clear and simple its avoidance is minimized and the probabilities of generalization are increased. Once the learning of concrete facts is integrated, then, and only then, can new learning be superimposed (Suydam, 1970). A child learning numeric concepts is expected to move from one stratum to the next, and, pressured to perform, he often goes on to the next step without mastering the present level of skills. Externally his behavior may attest to mastery, but really he has lost his way in the foundation. It would, therefore, behoove us to simplify this process, quicken learning, and thus facilitate the cycle of concept assimilation. Use of the metric system would in part serve these ends (Kephart, 1968).

Complex material should be presented sequentially - from concrete to abstract. Learning disabled children demonstrate a strong need to learn sequentially from the concrete to the abstract. "Concreteness is very important in building perceptual skills." (Homan, 1970) The base ten numbers concept, peculiar only to the metric measurement system, lends itself to easy concrete presentation. "Modern mathematics encourages the teacher to be concrete with examples and to present concepts in a practical, meaningful language–an approach especially helpful to the child with a learning disability." (Homan, 1970) The abacus (base 10) and Cuisenaire rods for demonstrating measurement in metrics can be succcessfully used.

Dr. Vincent Glennon (1968) has observed that disturbed children exhibit arithmetic disabilities more often than reading disabilities. He has also noted that the educable retarded and culturally disadvantaged youngster bring to school well-established misconceptions about numbers only to have them compounded later. It has also been observed that slow learners have difficulty remembering the names and equivalencies of the 53 denominate English units. Mentally retarded children tend to possess a poor concept in linearity, which, with the English system, is clouded with multiple unit names and measures. A UNESCO study of 13 European nations revealed that English and Scotch students (then using the English system) were less proficient in mathematics than were European children (Helgren, 1967). There are "known deficiences of American students on problems of measurement, so-called problems of denominate numbers." (Suydam, 1970) If the maze of units hinder learning in "normal" students, one might justifiably anticipate the same for "special" students.

Many exceptional children present distinct arithmetic deficits. Complex systems only further muddy the waters. Interestingly, researchers have noticed a companion rise of achievement in reading skills closely linked with arithmetic skills. Dr. William Fitzgerald of Michigan expressed great enthusiasm about metrics if for no other reason than to clarify measurements per se in the minds of special students. School psychologist Stanley Smith (1966) emphasizes that if disturbed children can "achieve grade level reading and arithmetic, they can accomplish other subjects too." Such ripples of benefits spread far wider than school work!

The functional relevance of new learning should be apparent. Fantasy is a favorite haven for children who experience failure in learning. Reality-based and relevant curricula reiterate the worthiness of the real world. What exceptional children do not need is a dual system of numeration--metric learned for enrichment and English learned for usefulness. "How can the child or the teacher realize that the system is important if it is given no part of the curriculum or only intermittent attention and study?" (Helgren, 1967) If metrics is only an academic exercise (now taught in 5th grade) and not the system valued and accepted in the child's life-space, we may increase his fantasy and frustration. "When the functional relevance of science, mathematics, and reading are incorporated...motivation and genuine student involvement are usually forthcoming. If the learning has meaning for the student then educational advancement will take place" (Martins, 1966). Dr. William Rhodes asserts that instructional preparation should include natural consequences which are relevant and immediately meaningful (Long, 1967). As a pragmatic tool, the metric system of measurement taught from the outset, without disturbing conversions, will be more acceptable cognitively.

The metric system now taught in some classrooms has not offset the confusion we ascribe to the English system. Introduced as an enrichment unit late in the elementary experience, it is perceived by students and teachers as:

1. Only tertiary to necessary skills since it is taught sporadically and poorly, often at teachers' whim (Murphy & Polzin, 1969).

2. Only required course work and therefore an academic exercise (Murphy & Polzin, 1969). Increased use-patterns in commerce and commodities have not at all affected use-patterns in special classrooms and programs even though, as our respondents indicated, exceptional children involved in auto mechanic shops and industrial arts labs are quite capable of learning and using metric units well.

3. Unrelated to school needs and societal values.

4. Useful only for competent students. It is an abstract concept which slow-learning students find difficult to integrate and, while they reject it as useless, it reinforces their falure image. As only a minor system, it motivates minimally and serves no real consequences in the child's life experiences.

Teaching two systems for measurement is somewhat like learning to spell one word two ways; however, aside from the waste in time and energy, one system demands a jungle of fraction processes. Murphy and Polzin (1969) remind us that "weights and measures facts committed in anticipation of probable use will be forgotten; and that, therefore, teaching should be on the basis of general information, appreciation, and extension of experience." Bearing in mind factors like irrelevancy, uselessness, disorderliness, and confusion, it is not difficult to infer some very major implications for the educational needs of exceptional children.

## IV. Raticnale for Adopting the Metric System for Exceptional Children

In view of the problems which many exceptional children experience with certain aspects of the English system and/or the use of a dual approach to measurement, exclusive use of the metric system should be adopted. It would afford the following advantages:

1. The metric system is easier to calculate in, eliminating the need for teaching and manipulating "vulgar", complex fractions. Educable vocational education students have found calculators far easier to use with metrics.

2. It allows teachers to teach in ascending order from the concrete to the abstract more easily (unlike the English system which is more abstract).

3. It can be taught and learned early since it does not require knowledge of fractions. This, of course, provides learning-disabled children a headstart with number systems.

4. It is easier to read and remember. Weights are all one denominate unit (e.g., not 3 lbs. 12 ozs.) This reduces strain on dyslexic and "dyscalculic" (Homan, 1967) children.

5. It is more consistently graduated for quantity change. If conversion processes can be avoided, exceptional children benefit.

6. It can be used to teach the decimal concept showing its relationship to our own monetary system. In our present measurement system, we are running afoul of our own monetary practice. Children with learning deficits would more easily generalize if the two systems were based on 10.

7. It will save much classroom time releasing it to other learning tasks.

8. It will be used throughout the world and thus a reality factor for exceptional, as well as "normal" children.

## V. Recommendations for Facilitating the Adoption of the Metric System.

All of the respondents to the CEC questionnaire and most researchers urged the immediate introduction of the meter stick in all kindergarten or first grade classrooms. In time, the yard stick and inch ruler must be removed from upper classes and replaced with the meter stick and centimeter ruler. Level by level, gram weights, scale markings, and liter bottles should be introduced in upper primary grades. Since most equipment wears out in 20 years, replacement of older pieces will be quite natural. *Above all, laboratory daily use of the meter stick is essential.*

**Classroom stratagem.** The following suggestions were offered:

1. Parallel to society's use of metrics, schools must apply this one system in early childhood to reinforce the child's pre-school math experiences. Glennon (1968) asserts that 25% to 50% of the children entering kindergarten already recognize the yardstick, scale, thermometer or instruments used in measuring... Polzin and Murphy (1969) indicate that "recent research suggests that the metric system should be taught at the grade school level and doing this, the English system should be deemphasized."

2. Laboratory experiences will provide the only meaningful learning arena. Homan (1970) has suggested some strategem for discovery experiences that could be most effective in teaching metric concepts to handicapped children:

   a. Use Cuisenaire-type rods cut into 10, 20, 30, etc. centimeters to develop estimates of a meter and sharpen spatial relations, concepts.

   b. Place posters, around the room displaying items measured in centimeters, articles marked in grams for children to handle, and containers marked in liters.

   c. With tapes marked in centimeters, guide children in measuring each other's height, and later in measuring other items like ivy in planters, desks, and desk-row lengths. One special education teacher devised arts and crafts projects in which the children measured their craft in English units (Tudor, 1966).

      This can easily be done in metrics on the primary level and in both English and metrics on

the secondary level right now. To stimulate a better understanding of measurement units, Callahan and Jacobson favor the use of Cuisenaire rods with special children because rods permit children "to see the problem" (Callahan & Jacobson, 1967). Relay games can be run in metric-measured lanes. Chalk games and units can be marked off in metric units on the floor.

d. With older children, teachers might use a conversion number line or slide rule. This of course relates to the child's ability to conceptualize. Gifted students will be capable of abstracting techniques in early grades and make the shift quite easily.

3. Response cues given by the child will be the best guide for pacing the change-over. Vigilance will permit us to revise materials to each child's changing needs. Although most respondents thought that all handicapped children would respond well to the conversion, special reference to the intensive language problem of the deaf was made. Teachers of deaf children will need to communicate a new vocabulary of units. In the upcoming issue of *Teaching Exceptional Children*, (Vol. 3, no. 1), Frank Franks, of the American Printing House for the Blind reports that a centimeter-inch ruler is being used quite successfully with blind children to develop concepts of linearity in metric units. Blind children can learn metrics with finger tip experiences. Measuring concrete objects in metrics will lead to generalizations re: numeration-the simpler the system, the quicker the integration (Dorward, 1968). Dr. William Rhodes cautions us that "learning should be an active process in which the child has to do something with materials, conditions, and surroundings. The more activity and manipulation required, the better the opportunity for a meaningful experience...engage as many sensory channels as possible (Long,1967)."

4. Faculty must remember to link experiences between home and school. Teachers should use supplementary materials from the community to reinforce metric learnings. Visits to stores, and from community-helpers could be planned. Parent workshops at school would prepare them for homework assistance as well as provide an adult education service. Link experiences will indicate to the students the global scope of this change. Professor Zoltan P. Deines of the Center of Psycho-mathematics Research in Sherbrooke, Quebec, recently brainstormed with his colleagues saying, "Each teacher should collect problems from the kinds of situations in the child's own environment

that really occur. Such problems will then have mathematical as well as social relevance to the children. I think it is extremely important to have mathematics regarded by the child as something that connects him to life and to his milieu, to his social being." (Suydam, 1970)

5. Metrics should be used daily in all subjects for transfer benefits. Teachers must feel comfortable with this system. As noted by Suydam (1970), "I think a kid who's around people who talk English will speak English. If you're around where people do a lot of mathematics, you'll learn to do mathematics. I don't feel much need to tell children to go drill...because I think they learn the things that are valued in their culture. Where they need to practice a specific skill they'll usually do it, the way kids will go and throw a football around." Biggs (1970) states "Teachers must have first-hand experiences of investigating mathematical problems for themselves at their level if they are to be convinced that active learning of mathematics is possible."

**Educational personnel preparation.** Teacher educators unanimously advised immediate preparation in metrics in training institutes. Many believed that teachers would represent the only force resistance to change and, therefore would require pre- and in-service *practice* with the metric system. Materials to be used in their classrooms could emerge from these workshops. In fact, all college departments should be using metrics exclusively as of this day. It was felt that teacher training need be no more extensive than student training. A laboratory experience where teachers discover, for themselves, the workability and simplicity of metrics will be the most transferrable learning experience for them and their students. Additional time for this should be planned into methods coursework on a regular basis. College math instructors might conduct a weekly session using liter bottles, gram weights and scales, and the metric stick—much as the teacher later will use in his classroom. During these sessions teachers should be given an opportunity to work comfortably with decimals, decimal fractions, and the new units vocabualry.

In-service workshops could offer the same enrichment. State, federal or local resource people might teach a weekly in-service enrichment course to teachers on all levels and in all subject areas. School districts should not only require at least this weekly session, but also be the responsible change agent in the conversion. Instructional materials centers and local libraries will need to stock an inventory of metric teaching aids and materials for exceptional children. Encouraged to utilize these local resources, teachers will be better armed as teachers and learners for this change.

**Community responsibilities.** Mass communication—i.e., media-television, radio, newspaper, public libraries, etc.—must play an active role in introducing and visually reinforcing these measurement units. Spot announcements of unit names and equivalencies or reading aides could be planned by television programmers. Non-school generated products can be provided by the commercial world and information disseminators for classroom use. Industrial measuring guides and video tapes could be donated. Community change agents can serve as resources for school enrichment programs. Writers of text books, above all, must be retrained so that instructional materials are quickly available. Textbook revision should initially display both measures and soon phase out the English markings. (Murphy & Polzin, 1969)

It would be most appropriate for the Department of Commerce to solicit from the major industries and agencies a concrete commitment for change so that a time line may be devised delineating what will change at given times. Communicated expectations structure choices for adults as well as children.

It would be helpful if the Bureau of Standards required that box and bottle manufacturers stamp metric and English markings with the English in a secondary position initially and soon deleted completely. Sensory reinforcement is a powerful ally. Because this is a national effort, the federal government should take the primary responsibility for providing funds, materials, and personnel assistance for this change. Training institutes and textbook purchases, it was felt, should be so subsidized.

**Time considerations.** An overwhelming vote of "do it now" and "do it quickly" characterized the responses and the literature. It was felt that a short term conversion would avoid the confusion of duality.

Most of CEC's respondents preferred a fixed date of 5 years for full use of metrics. This term would permit not only a comfortable transition to accommodate the inevitable "cultural lag," but also would establish a real limit, within which exceptional children seem to flourish.

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