DOCUMENT RESUME

ED 097 417 CE 002 114

AUTHOR Hambleton, Ronald K.; Olszewski, Francis
TITLE Woodworking Objective and Test Item Bank: Appendix J. Final Report.
INSTITUTION Massachusetts Univ., Amherst. Center for Occupational Education.
SPONS AGENCY Massachusetts State Dept. of Education, Boston. Research Coordinating Unit for Occupational Education.; New York State Education Dept., Albany. New York Research Coordinating Unit.
PUB DATE Jun 72
NOTE 92p.; For related documents see ED 060 218, ED 085 541, CE 002 111-117

EDRS PRICE MF-$0.75 HC-$4.20 PLUS POSTAGE
DESCRIPTORS *Behavioral Objectives; *Criterion Referenced Tests; Curriculum Development; Educational Objectives; Industrial Arts; *Item Banks; Measurement Techniques; *Performance Based Education; Test Construction; Trade and Industrial Education; *Woodworking
IDENTIFIERS ESCOE; Massachusetts; New York

ABSTRACT

This is one of the outcomes of the work of the Massachusetts Evaluation Service Center for Occupational Education (ESCOE). The purpose of the work described in this report is to provide a set of specific behavioral objectives for woodworking teachers to use in the development of their high school curricula. Special emphasis is given to a discussion on the rationale behind criterion-referenced testing. The remainder of the document is devoted to a description of the development of the objectives and the test item bank for woodworking, and gives the following information to the teacher: objective code (block/unit), objective number, objective, final product, evaluation criteria, and a description of the operation. Also included is a detailed list of materials needed to test each objective and a 25-item bibliography. The document concludes with two appendixes on pretest materials and block and unit breakdowns. (BP)

ED 097417

FINAL REPORT

BEST COPY AVAILABLE

Evaluation Service Center for Occupational Education

APPENDIX J:

Woodworking Objective And Test Item Bank

by

Ronald K. Hambleton and Francis Olszewski

Submitted To:

Commonwealth of Massachusetts
Department of Education
Division of Occupational Education
Research Coordinating Unit
Boston, Massachusetts

State of New York
Department of Education
Bureau of Occupational Education
Research Coordinating Unit
Albany, New York

Evaluation Service Center for Occupational Education
Center for Occupational Education, School of Education
University of Massachusetts, Amherst

June 1972

This test is one of four tests published as separate appendices to the Final Report of the Evaluation Service Center for Occupational Education, Center for Occupational Education, School of Education, University of Massachusetts, Amherst, Massachusetts, June 1972.

TABLE OF CONTENTS

OVERVIEW OF THE PERFORMANCE TEST DEVELOPMENT PROJECT

Background

The 1968 Amendment to the Federal Vocational-Technical Education Act mandated the development of state-wide evaluation systems for the administration and operation of federally supported vocational education. Parallel to this mandate the Research Coordinating Unit director for the Commonwealth of Massachusetts was in the process of completing some predesign activities for the development of a vocational-technical education management information system. By 1969 the predesign of this system had moved into the feasibility stages and specifications of the system were being developed.

At this stage of development New York State, which already had a fine centralized testing program, became interested in the philosophy espoused by the Massachusetts system and joined in the funding of a more intense feasibility test, which eventually became the source of the Performance Test Development Project. The Evaluation Service Center for Occupational Education (ESCOE) was funded in July 1971 and was housed in Amherst, Massachusetts, to test the feasibility of systems development based upon the principles of (1) local control and development of vocational curricula, (2) data-based feedback based upon tailored performance tests, and (3) curriculum description through terminal behavior objectives. The following report deals with a subcomponent of the ESCOE system which was designed to develop performance tests as software support for the ESCOE program.

Whats and Whys of Performance Testing

Performance testing is more a new reality as opposed to a new concept in educational testing. The concept grows out of the need felt by educators to sample actual performances of trainees as opposed to merely measuring symptoms of desired (or intended) competencies through paper and pencil tests and then relying upon the predictive powers (i.e., previously established associations of paper and pencil test scores to some hypothetical or observed criterion of competency in performance) of the test to infer competency acquisition. The felt need has grown in part from the inability of standardized achievement tests to deal with the unique objectives of a specific educational program, in part from the reportedly low correlations between measured skills and on-the-job (or in-the-shop) performances, and in part from the lack of realism involved in the paper and pencil testing situation.

Hence the performance test can be conceived of as a criterion-referenced test, in that (1) it is objective or criterion-centered (in one-to-one correspondence with the extant component of a stated objective); (2) it seeks to ascertain a subject's possession of a specific competency rather than to complete a comparison of the subject's competency level to a previously measured norm group; and (3) it usually requires a dichotomous decision as to whether the competency has been demonstrated. The performance test can be construed to be a special case of the criterion-referenced test in that there is a definite attempt to establish fidelity between the sample observation of the performance test and the performance being sampled.

In the evaluation of instructional programs in vocational-technical education, the concept of performance testing is especially appropriate for several different reasons. First, performance tests can be hypothesized to produce more relevant and valid date concerning the instructional program output. Vocational program objectives tend to deal with competencies which require concurrent behavior changes across several domains of instructional objectives.

Hence the accomplishment of a vocational objective may depend upon the development of a psychomotor skill, the mastery of a cognate process, the acquiring of some fundamental facts, and the development of a particular attitude. Unlike paper and pencil tests, which emphasize the measurement of the cognitive aspects of the performance or observations which emphasize process and action components, performance tests possess the potential to measure the mixture of behavior domains appearing in the desired performance. The performance test can therefore be argued to offer a valid means of measuring intended outcomes.

Second, performance tests produce product records which can be studied by teachers to diagnose the place in the instruction where a weakness may have occurred, aiding considerably their ability to analyze their instructional methods. Since the teacher can determine what aspects of the competency are missing, he can trace the point in his instruction where his objectives were not met. Also, since the product is concrete it can be kept longitudinally to analyze pupil growth at different stages of a multi-year program.

Third, the nature of the data produced by performance testing contains the flexibility demanded by the information needs of an evaluation system. The tests are constructed in one-to-one correspondence to stated objectives, thus enabling selection of test components from a data bank situation in such a manner as to tailor the testing to the measurement of a unique set of program objectives. Since the tests are objective specific, comparisons of small aspects of an instructional program are possible. Since the tests are criterion-referenced, skill attainment in a particular area of interest can be ascertained; hence output of instructional programs can be described relative to percentage of skill development.

Restraints on Test Development

The design of the performance tests had to take into account both the philsophical and the operational structure of ESCOE. At times both of these structures served as restraining and occasionally frustrating hurdles for the test development team.

The philosophical nature of ESCOE provided the foundation of principles which are believed to have caused the performance tests to be unique. Since the objectives were generated by each local school, several very similar objectives appeared for a single behavior within a subject. Dr. David Berliner, now with the Far West Laboratory for Educational Research and Development, invented a process to state these similar objectives into a synthesized form accompanied by item changes providing for the unique characteristics of each objective. Thus, if enough objectives from different schools were collected to represent the curricula, by synthesizing those objectives one could arrive at a statement of all desirable behaviors within one curriculum.

The raw objectives based upon the curricula of each of the participating schools were synthesized to identify the major behaviors within a curriculum area. Hence, if the process worked ideally withi a curriculum area a linear set of behaviors was produced. The degree to which this process failed to produce such a linear array of behaviors comprised the first major restraint. If a singular listing of behaviors could not be gained. then singular test items could not be written.

A second philosophical principle which developed into a restraining factor was the decision to test only locally-maintained objectives within a specific program. This principle actually involved several implications for testing. First, a student would be tested only on the objectives maintained by the curriculum he was receiving. Therefore, the test items had to be described in a form indicating one-to-one correspondence with the synthesized objectives so that the local teacher could select only those items maintained for his course. This selection pattern, however, did increase the logical assumption that the tests possessed high validity in regard to the courses for which they were designed to measure outcomes. Second, each item had to be independent in its ability to be administered, since previous or adjoining items would not necessarily be administered with it. This item independence served as a restraint to test development in that objectives could not be clustered into tasks involving several test items.

The third restraint involved both philosophical and operational aspects in that two forms of scoring were preferred by the two cooperating states. Philosophically, the state coordinators differed on the location of scoring; this disagreement became a restraint to test development in that the items developed had to be scorable both in the local school and at a central test center. Three forms of scoring meeting this restraint were adopted, with choice of scoring form depending upon the nature of the individual item. Two of the forms are based upon meeting the restraint with a single scoring process. The third form requires two different processes in order to meet the dual scoring restraint.

The scoring approaches requiring only one process are (1) the caliper or mechanically scored form and (2) the selection of correct response form. In the mechanically scored approach, several measured settings can be placed in a test scoring kit; the student or teacher records by label which of the settings fits the final product. A key of correct setting labels can then be referred to, producing a dichotomous score for the product in terms of size tolerances. In the selection of correct response approach, ~~correction keys~~ can be applied directly to the students' responses. In both cases either a central office or an individual classroom teacher can use the keys.

The third scoring form is not as simple, since two types of scores are required to meet the dual-use restraint. This scoring form is necessitated by the many tasks in the vocational curriculum which require expert observer judgment for the determination of performance quality. The two types of scoring needed for these items are (1) structured criteria for observation, and (2) pictorial records (color-coded to facilitate central scoring). The structured criteria for observation communicate to the teacher what aspects of the product to check in order to judge the performance successful. These criteria would be used in class. In the pictorial scoring process, camera angles have been described which would allow Polaroid pictures to be taken as records of the finished product. Color-coding the criteria checks would enable observers in a central location to determine the quality of the performance.

Each of these three approaches provides a means through which credible and unbiased scores can be obtained. All of the processes can be scored by individual teachers and used within a classroom setting without the aid of a central scoring station. The fourth restraint to test development arises at this point, since it is impossible to arrive at an immediately usable set of norms through the current scoring system and the dichotomous item response without implementation of a program designed to gather enough data to norm the tests.

Two other restraints were present throughout the test development project, both operational in nature. First was the quality and quantity of the behavioral objectives themselves. Few if any of the curriculum areas were fully described, and the tests developed are limited to described curriculum. In two test areas, more items were developed and the synthesization process was repeated in order to sharpen the synthesized objectives. In these cases much curriculum had been left undescribed and the fill-in process aided considerably in explaining the descriptions. However, complete and multiple sets of items were not available from each school; therefore the test items may be lacking in content validity in cases of consultant-written items, may be representative of several behaviors, and may hence be difficult to test or represent only a small segment of the previously unwritten curriculum.

The second operational restraint was that of time. Although the budget was small, the seriously close deadlines in development work made time an even greater restraint. Creativity is sometimes especially evasive under deadlines and within the constraints of administrative conflict. Still, the time dimensions were met in terms of design. Since schools were closed during the critical month of June, illustrations of some items of the tests could not be produced; therefore only plans, item descriptions, materials descriptions and administration instructions could be developed.

A final restraint can be observed in the language in which the proposal was written. First, several terms apparently changed in meaning or in relevance to the project once development began. One apparent change occurred in the description of sixteen tests for four areas. One test for each level of a curriculum area cannot be developed so as to be equally relevant to all schools. Since the schools maintain different objectives, different items must be assigned to each school, even on the same level. Hence a more appropriate process becomes the development of an item bank from which tailored tests can be developed for each individual program. Second, the time restraints and the differences in nature of curriculum required different kinds of tryouts, making the language of the proposal seem sometimes inappropriate.

Purposes of the Test Development Project

The design of the test development project included not only the goal of producing tests as products but also the goal of establishing feasibility of the test development effort across a broad spectrum of vocational-occupational curricula. For this reason four different areas of vocational curricula were selected for test development. These four areas differed in hypothetical difficulty of test development. The areas chosen were machine shop, woodworking and carpentry, electronics, and automobile mechanics. The automobile mechanics area was hypothesized to be the most difficult since manufacturers determined the curriculum, which therefore differed across competing manufacturers.

The performance tests were hypothesized to be sufficiently flexible to fulfill many purposes of a comprehensive evaluation system. Because of their proximity to the desired outcomes, performance tests were hypothesized to serve as (1) student diagnostic and prerequisite instruments, (2) diagnostic instruments for the analysis of instruction, (3) criterion instruments, (4) measures of classroom achievement, and (5) program success indicators. Each of these uses has already been piloted to some extent.

The performance tests as developed have several application conveniences. First, since the test items are paralleled to synthesized objectives, computer selection of test items or "synob" comparison of items can be used as a methodology for tailoring tests to instruction. Second, since the conceptual frames of the tests can be described, each test has built-in potential updating or extension by the classroom teacher.

Problems Encountered

Problems occurred from three viewpoints. First was the problem of lack of known direction, a handicap which often occurs in the area of development. Second was the problem of lack of perfection or completion of the objectives used as raw materials for the development of test items. Third was the problem of contending with dual scoring requirements and with several different kinds of program emphasis and structure.

The first problem has been emphasized recently with the development work done on criterion-referenced testing. From a conceptual point of view, the criteria previously used to determine the quality of norm-referenced tests can no longer be used for criterion-referenced tests. Since the measurement strategy of the criterion-referenced test and the performance test is to determine the possession of either a skill or the capability to carry out an activity or process, the degree to which the test differentiates between subjects taking the tests does nothing to indicate test quality. Unlike the norm-referenced test, in which measurement strategy is to distinguish between subjects, the performance test cannot be hypothesized to produce large differences across subjects nor can any specific level of difficulty be expected. Hence, average levels of difficulty and large differences between subjects do not indicate quality of the performance test.

In performance testing, some concepts of reliability still appear useful, while others appear to have lost their relevance. Reliability over time, or test-retest reliability, is still meaningful as long as the time between tests did not include opportunity for the subject to acquire the skill in question Since performance tests are designed so that each item does not necessarily refer to the same skill or activity, reliability indices dealing with homogeneity of the test no longer appear to be relevant criteria for test quality.

The degree to which the items of a performance test cover the skills of an area and approximate actual required performances operates in a similar relationship to the performance test as that of a prediction index to a norm-referenced test. This degree of similarity might be compared to the concept of fidelity so often used in the recording industry.

The second problem area involved the quality of the raw materials used. As should be expected, the synthesis process does not apply evenly to all areas and was not applied with the same consistency to each set of objectives. In the machine shop curriculum area, between 70 and 80 percent of the content was described by the objectives. These objectives possessed adequate depth across skill areas to enable the synthesis process to produce clear synthesized objectives describing unique performances. The creation of items parallel to the synthesized objectives and possessing the independence and flexibility required by the philosophy of the system was a straightforward process.

In the woodworking area, between 60 and 75 percent of the content was described. Unfortunately, the synthesizers of the raw objectives failed to produce synthesized objectives which dealt only with single performances. Instead, the raw objectives were synthesized by similar or related behaviors and the product of this process was a matrix of similar performances (rather than a single performance) with several form changes denoting differences in conditions and extents across schools. Since these products seemed usable, the decision was made to produce a matrix of test items generated in one-to-one correspondence to the performances included in each synthesized objective.

This decision was the source of some time lost due to the expanded number of test items which had to be written; however, this increase in items was accompanied by a large increase in test specificity, which increases the degree to which the performance test can be tailored to fit a given instructional program without any noticeable loss of efficiency of the item banking process.

Due to the variance of material and the limited scope of the objectives developed for the electronics curriculum area, a decision was made to rewrite many of the synthesized objectives. For more than one-half of the contract period two of the test development team members struggled to find a format within ~~which~~ the scope of the electronics curriculum could be described. By expanding the number of conditions it was found that classes of performance could be described by synthesized objectives. Hence, through considerable redesign and a small set of compromises of the synthesis process involving uniqueness of performances and allowance of performance form changes, subcollections of electronics objectives could be written which would allow test development along similar conceptual lines as those followed in the development of the machine shop test. Results of the test development effort again produced item banks, as in the two previous test areas, with the items possessing similar relationships to the synthesized objectives.

In the area of automobile mechanics, less than 50 percent of the content was described by the raw objectives. Many of the subdivisions of content were too sparse to allow for the development of synthesized objectives. In addition, the synthesis process applied seemed irregular across blocks and units. The level of abstraction of behaviors described by the raw objectives and the interdependence of the performances raise questions concerning the appropriateness of the synthesis process in this area. Certainly, the limited number of usable synthesized objectives and the necessary revisions of the existing objectives made the decision to rewrite the objectives essential. Revision of the curriculum descriptions were made in relationship to the job orientation of the curriculum. Test items were written around standard mechanics tasks as described in the automobile mechanics curriculum. In some of these items, synthesized objectives are tested in a format which includes a cluster of the objectives provided by the ESCOE system. In other items, only parts of ESCOE-produced objectives are included in the new synthesized objectives being tested. Once a test item has been constructed, the process can be reversed so that system capability as achieved in the other three test areas can be gained. Because of their time-consuming nature, tasks in the curriculum such as disassembly or reassembly of a motor or transmission were not included as complete test items. Instead, either sample tasks extracted from the large unmanageable task or written or pictorial selection items were generated to test these phases of the curriculum.

The third problem area encountered was the difficulty involved in the existence of two separate scoring requirements and in the time limitations of the test development project. It was not always possible to produce useful in-class scoring of the performance item and credible, objective centralized scoring of the performance through application of the same scoring process. Therefore some items are suspected to produce more useful scores in the classroom than in a central scoring situation, while the reverse is suspected of other items. Only time and study of the tests can alter or affirm these suspicions. It is unfortunate that systematic refinement of the woodworking, electronics, and automobile mechanics tests is not planned to occur along the same lines as those applied to the machine shop test.

The following report includes development and field testing procedures, item bank descriptions, recommended analysis procedures and uses for one of the four test areas briefly described above.

I. RATIONALE FOR DEVELOPING THE OBJECTIVE AND TEST ITEM BANK

One of the things which is badly needed in the area of vocational education is the availability of behavioral objectives with which teachers can systematically construct their curricula. In addition, testing materials are needed in some flexible format such that teachers and/or external examiners can assess the extent to which individuals and/or groups are achieving the specific course objectives. The flexible format is necessary so that the testing materials can be used for individual assessment as well as program evaluation on any specified subset of objectives from the bank. Individual assessment takes the form of providing information to the individual and the teacher on the particular objectives the student has mastered that appeared on the test. Program evaluation would consist of reporting, in part, the proportion of examinees in the student population of interest who have mastered each of the specific course objectives covered on the test.

The availability of an objective and test item bank would facilitate teachers and evaluators making criterion-referenced measurements to assess students and programs (Hambleton & Novick, 1972). To do this the test score information should relate to specific program objectives and be interpreted relative to prespecified performance standards. (In a later section of this report we will discuss additional features of criterion-referenced testing and measurement. Also we will contrast norm-referenced tests with criterion-referenced tests.)

2. PURPOSES

The purpose of the work described in this report is to provide a set of specific behavioral objectives for woodworking teachers to develop their high school curricula, and to provide materials necessary and guidelines for teachers and evaluators to construct criterion-referenced performance tests. The objective bank is complete to the extent that it covers synthesized objectives previously developed by the ESCOE staff. (However, it is well-known to all involved in the ESCOE project that many woodworking areas are not covered. It is expected that as these objectives become available in the future they will be incorporated into the materials described later in this report. Fortunately, this can easily be done with the system we have developed.)

Basically, what we have attempted to do is specify what an examinee has to do to demonstrate mastery of specific objectives. For each task, examinee performance is graded as either acceptable or unacceptable by referring to the evaluative criteria. We have provided guidelines for doing this and reported on ways to do both individual assessment and program evaluation. A special feature of our material is that all testing consists of students completing performance tasks. Also, the flexibility of the testing materials should make them more useful to teachers in the schools. It should be noted that little attention in our performance testing has been directed toward process. This clearly has nothing to do with the importance we attach to it since we consider process extremely important. Rather, in this first stage of test development we preferred to restrict our attention to product evaluation. Future improvements to these materials will undoubtedly focus on the processes involved in conducting certain performances.

3. DESCRIPTION OF MATERIALS

One of the major stumbling blocks in developing woodworking performance tasks from the synthesized objectives was that in many cases the synthesized objectives covered several different skills. Hence it was impossible to develop only a single performance task to cover each synthesized objective. While it would have been possible to write several tasks, the mapping of each task to the particular skill within the synthesized objective would not be clear. The best solution seemed to be to rewrite each synthesized objective into as many specific skills as necessary.

Other problems included that synthesized objectives were not written as carefully as they should have been, so that much time was given to rewriting them. After several "poor" synthesized objectives were removed and many others rewritten, 165 specific objectives were written to replace the 32 synthesized objectives. Writing a performance task to measure each of the 165 objectives then became a fairly straightforward task.

Our task included the development of the objective and test item bank for woodworking, presented in Section 7, with the following information: objective code (block/unit), objective number, objective, final product, evaluation criteria, and description of operation. The information was collected on each objective.

The resulting materials were read by five woodshop teachers on two different occasions and many of their suggestions were used to modify our materials. In addition, a representative sample of 54 objectives was pretested with more than 60 students, and here the results were encouraging. Details on the pretest are presented in Section 5.

4. USING THE OBJECTIVE AND TEST ITEM BANK

The objective and test item bank can be used for: (1) individual assessment, and (2) program evaluation.

Individual Assessment

It is possible for a teacher to select any set of objectives that he desires for testing. (The teacher may select common objectives for students or different objectives, depending on his goals.) Then the list of objectives that an individual can do and/or cannot do can become part of his record and the information can be used to effectively monitor the student through the program.

Program Evaluation

If the list of objectives on which we desire information is small enough, then it may be possible to administer each objective to all students and by summing across individual reports we can calculate the proportion of examinees who perform each objective correctly.

In the more typical case, we desire information on all course objectives but the time required to test all students would be prohibitive. In this situation, evaluators should resort to the technique of an item-examinee sampling. Such a technique has been used successfully to evalwith instruction (e.g., Comprehensive Achievement Monitoring uses the technique (Hambleton, Gorth & O'Reilly, 1971)).

The psychometric technique of item-examinee sampling (perhaps better known as multiple-matrix sampling) for estimating test score parameters has recently become very popular with researchers and evaluators. Item-examinee sampling could be described as a technique where, according to Lord and Novick (1968):

> M nonoverlapping random samples of n binary items each are drawn (without replacement) from an $\bar{n}$-item test and treated as separate subtests; it is not required that $m = \bar{n}/n$ or that $M = \bar{N}/N$. A different subtest is administered to each of M nonoverlapping random samples of N examinees drawn from a population of $\bar{N}$ examinees.

Lord (1962) was the first to estimate the test parameters (mean, variance and frequency distribution) for a population by utilizing an item-examinee sampling design rather than administering the total test to a sample of examinees. More recently, different researchers have investigated various item-examinee sampling designs to determine the "optimum" number of items and examinees to use in different testing situations.

Curriculum evaluators are presently using item-examinee sampling designs to collect more information on a program than would be available if all examinees in the population of interest took only a subset of the total number of items in the "pool." Item-examinee sampling is particularly applicable for curriculum evaluation, where information about the group is usually of more interest than information on individual examinees. Lord and Novick (1968, pp. 252, 257) report on several other situations where item-examinee sampling would be useful.

Final result includes a set of proportions to indicate the proportion of examinees who successfully completed each objective.

In the next four pages we will describe one model that has been used successfully to evaluate instruction and seems applicable in vocational education.

Comprehensive Achievement Monitoring (CAM)

Hambleton, Gorth and O'Reilly (1972) describe a model for the evaluation of student achievement in classrooms and for curriculum evaluation called Comprehensive Achievement Monitoring (CAM). All of the decision-making is done on the basis of criterion-referenced test results. The CAM design includes the following components:

1. The definition of a curriculum with behavioral objectives;
2. The writing of test items to measure student performance on each objective which are criterion-referenced test items;
3. The organization of a set of randomly parallel tests, where each test is made up of items measuring all of a sample of all of the objectives in the curriculum and therefore represents item sampling;
4. The design of longitudinal, usually every three or four weeks, schedule of test occasions throughout the course;
5. The analysis of the test data and the reporting of results by computer, usually within a couple of days;
6. The interpretation of the results by evaluators, teachers and students as a means for making better decisions about their instruction and curriculum; and
7. The modification of curriculum, instructional activities and the CAM design based upon the results.

The CAM methodology has been designed to work well with any grade level or curricular area. In fact, it has already been used successfully in more than 20 schools, with more than 15,000 participating students, and at grade levels from third to twelfth and in every academic subject area. (Hambleton, Gorth and O'Reilly [1971] provide a detailed report on one of the many applications.)

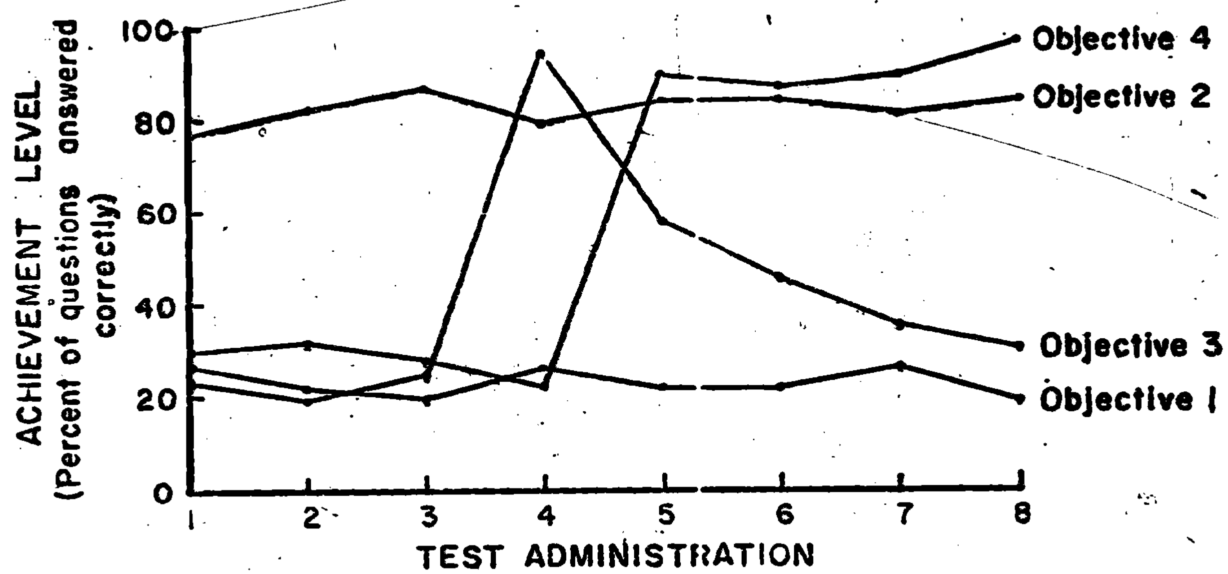
Particularly important to the success of the evaluation is the use of the computer. It alleviates the frequently encountered bottlenecks of most evaluations, i.e., the analysis of data and the reporting of results. The computer allows maximum freedom in the design of evaluation, which CAM has used by incorporating longitudinal testing with item sampling.

The information which is provided in the CAM system includes: (1) for individual students, (a) the total score on the current test and all previous tests, and (b) information on the correctness of their response to each item corresponding to course objectives on the current test; and (2) for any subgroup of students and any set of questions after each test administration, (a) the achievement level on each objective, and (b) achievement profiles which display graphically the level of achievement on all objectives on the previous test occasions.

The computer allows students' achievement to be plotted on any given objective (or group of objectives) for the entire course. This plot, called an achievement profile, gives a graphic presentation of the changes in group achievement throughout the course. Achievement profiles are a unique type of information available from the CAM model.

Figure 1 presents hypothetical achievement profiles for four objectives from a course. In this example, objective 1 was taught between the first and second test administrations, objective 3 between the third and fourth testings and objective 4 between the fourth and fifth. For the reason given below, objective 2 was not taught. On the pretest in the

Figure 1. Achievement profiles of a group of students on four objectives across eight test administrations.



example, all objectives except number two show achievement at the chance level or about 20% on the five-option multiple-choice items. Using the achievement profiles after the second test administration the following decisions might be made: (a) objective 1 was not learned and should probably be retaught in a somewhat different way; (b) since the performance level on objective 2 was high on both the first and second test administrations one could safely skip instruction on it. After the sixth testing, on the basis of the CAM data the following decision could be made: the performance level on objective 3 is slipping and since it is an important objective it should be reviewed. It is also noted that the performance level on objective 1 has not changed. One might postulate that the topic is just too difficult for this particular group of students.

In summary, CAM represents an application of criterion-referenced testing to program evaluation carried out using longitudinal testing and the notion of item-examinee sampling. Such a strategy might be applied to analysis of vocational education data.

Test Construction

Using the procedures described below performance tests can be constructed easily. Sample tests and evaluation sheets are reported in Appendix A. A test item, evaluative criteria and testing materials required corresponding to each objective are found in sections 7 and 8. The examiner prepares three lists. The first is made of objective statements to compose the test for the students. The second list is made up of evaluative criteria coded to the objectives in the test. The third list is made up of the materials required to conduct the testing. The last list, is of course, used by the examiner to set up his materials in advance of the test administration.

5. DESCRIPTION OF THE PRETESTING

In order to determine the feasibility and practicality of our materials, pretesting of 54 objectives was carried out in three schools in the Amherst area involving over 60 students in the ninth and tenth grades, during the latter part of May. Copies of the two forms of the test and the teacher evaluation sheets which were used are reprinted in Appendix A. To some extent teachers assisted in the selection of objectives to be covered on the tests.

It was found that the testing went most smoothly in the schools where the teachers were well-prepared. That is, in order for the test administration to run smoothly we found, and hardly a surprising result, that it was essential for the teacher to prepare materials necessary for the testing in advance. Also, it seemed to be important that students be informed of the purpose of testing.* Testing went more smoothly when this had been done.

The results of our pretest could be analyzed in several ways. For example, it would be possible to report the proportion of students in each class who had mastered each of the objectives on the test. Comparison of proportions on similar objectives across different groups could be done to identify the more effective teachers, schools, districts, etc. Of course, such checks as the similarity of students on other factors like intelligence, interests, etc., the appropriateness of the objectives for the different groups and the equivalence of grading standards in the different groups would need to be considered in interpreting the results.

The test results could also be used to diagnose specific disabilities of students. Students who have not mastered certain objectives could be assigned to remedial programs to bring their performances up to standard.

Final impressions of the pretesting include some concerns about setting tolerances, and whether "do-overs" are to be allowed. Whatever the decision, it should be standardized for any particular administration of the tests.

6. SOME BACKGROUND ON CRITERION-REFERENCED TESTS*

In recent years we have seen the implementation of many innovative instructional models such as Computer-Assisted Instruction (Atkinson, 1968), Mastery Learning (Bloom, 1968; Carroll, 1963), Individualized Instruction (Glaser, 1968), and Project PLAN (Flanagan, 1967) into our schools. Features such as the specification of curricula in terms of behavioral objectives, detailed diagnosis of beginning students, the availability of alternative instructional modes, individual pacing and sequencing of materials, and the careful monitoring of student progress, are common to most of the instructional models mentioned above and to many other instructional models to which we refer in this report. Programs along the same general lines are now being developed in vocational education. Within these instructional models, tests are used to establish an individual's achievement on specified content, i.e., instructional objec-

---

* Much of the material in this section is from an article by Hambleton, R. K. Assessing student progress: A criterion-referenced measurement approach. In R. DeLone, Controversies in education. New York: Saunders, 1973.

tives, and to provide information for making a variety of instructional decisions. Unfortunately, the most commonly known procedures for constructing, administering, and analyzing tests, and interpreting scores, are not as useful within the context of these new instructional models, and in some cases are completely inappropriate. This is because traditional norm-referenced tests are specifically constructed to estimate each individual's ability level and to permit comparative statements (e.g., ranking) across individuals. As a result we have seen the development of a new kind of testing, criterion-referenced testing. Criterion-referenced tests are specifically designed to meet the measurement needs of the new instructional models.

The movement toward criterion-referenced testing in the schools represents an important development advocated by many educators. Such a movement seems particularly relevant in vocational education programs. However, many problems relating to matters such as test construction, interpretation of test scores, and the development of reporting systems have yet to be resolved.

The purpose of this brief section of the report is to introduce the nature of criterion-referenced testing, to make some distinctions between norm-referenced and criterion-referenced tests and measurements, and to describe one use of criterion-referenced testing in an individually prescribed instruction program. Extensions to vocational education are clear. However, it should be noted that some of the discussion in this section pertains specifically to paper and pencil tests whereas all our woodworking materials are performance tasks.

Criterion-Referenced Tests: Definition and Some Related Problems

The term "criterion-referenced test" was introduced by Glaser (1963) to make the distinction between tests designed to compare individuals and tests designed to measure individual achievement relative to some specified domain of tasks. Of the various definitions proposed for criterion-referenced tests (e.g., Kriewall, 1969; Ivens, 1970) we prefer the definition proposed by Glaser and Nitko (1971). That is,

> A criterion-referenced test is one that is deliberately constructed to yield measurements that are directly interpretable in terms of specified performance standards.

According to Glaser and Nitko (1971):

> Performance standards are generally specified by defining a class or domain of tasks that should be performed by the individual. Measurements are taken on representative samples of tasks drawn from this domain, and such measurements are referenced directly to this domain for each individual measured.

Defining well-specified content domains, developing procedures for generating appropriate samples of test items, and setting performance standards represent significant problems for measurement specialists, but they will not be discussed further in this report, although it should be noted that partial answers to problems one and two have been addressed earlier in the report.

Unfortunately, because of their newness and some unique problems to be described later, there is a shortage of information on criterion-referenced tests. However, it is still disappointing to note that seldom do even the most recent educational measurement textbooks include more than one or two pages on the topic. According to Cronbach (1970) "The testing movement has given too much attention to comparative interpretations (to individual differences) and too little to absolute, criterion-referenced measurement." The need for such information is easily seen when one considers the fact that more and more schools each year are adopting instructional models that require criterion-referenced testing.

A Comparison of Norm Referenced and Criterion-Referenced Testing

Norm-referenced tests. Almost all of the available aptitude and achievement tests can be classified as norm-referenced because they are designed to measure individual differences. The meaning which can be attached to any particular score depends upon a comparison of that score to other scores achieved by students taking the test. A standard procedure is to report the percentage of scores that fall below particular scores in different groups of examinees (i.e., percentile norms tables), thus making it possible to interpret an individual's score relative to the scores of students in several different groups, if desired.

A norm-referenced test is constructed specifically to maximize the variability of test scores, since such a test is more likely to produce fewer errors in ordering the individuals on the measured ability. Since norm-referenced tests are often used for selection purposes, it follows that minimizing the number of errors in ranking individuals is extremely important.

It is a well-known fact that norm-referenced tests are constructed using test construction procedures where items are usually selected to produce tests with desired statistical properties rather than to be representative of some content domain (Gronlund, 1971). It is partly because of this fact that the test scores cannot be interpreted relative to some content domain. Both easy and difficult test items do not usually appear in norm-referenced tests because they contribute very little to test score variance. Also, items which do not measure the same ability as the majority of other items in the test are usually removed. Empirical evidence to support these conclusions is provided by Cox (1965). His work revealed that the selection of items from a total item pool by the usual item selection procedures (i.e., utilizing item difficulty indices--proportions of individuals passing items, and item discrimination indices--measures of the relationship between item success and performance on some criterion test usually the total test score) resulted in tests which contained proportions of items measuring instructional objectives different from those in the total item pool.

Criterion-referenced tests. The emphasis on mastery learning in the new instructional models has led to an interest by measurement specialists in criterion-referenced testing. Criterion-referenced tests can be used to serve two purposes. First, they can be used to provide very specific information on the performance levels of individuals on the instructional objectives. This information can be used, for example, to determine whether an individual has "mastered" particular objectives (Block, 1971). To aid in making individual mastery decisions on particular objectives is one of the major reasons for developing the objective and test item bank in woodworking.

Second, criterion-referenced tests can be used to evaluate the effectiveness of instruction. Norm-referenced tests given at the end of a course are usually inappropriate for making evaluative decisions on the effectiveness of instruction because they are not designed to cover the instructional objectives. However, criterion-referenced tests are quite useful to the curriculum evaluator because of the specificity of the test results to the instructional objectives.

Typically, the items on a criterion-referenced test can be thought of as a sample from some well-defined content domain. Knowing a student's test score does not allow us to accurately say which items were answered correctly, but we can make a pretty good estimate of the proportion of items in the domain that he could answer (Popham & Husek, 1969).

What are the appropriate procedures for constructing criterion-referenced tests using items presented in multiple-choice format? It should be clear that since a score on a criterion-referenced test is compared to some performance standard rather than to the performance of other individuals, for the test to be a good measuring instrument it will be necessary to change the item selection and test construction procedures.

Since comparisons among individuals are of little or no interest when using a criterion-referenced test, it follows that a test constructor is not usually concerned with developing a test to maximize the variance of test scores. Therefore, a test developer should not use traditional item selection procedures described earlier to choose items because they were specifically designed to produce a test with maximum test score variance. For example, criterion-referenced tests are often used either before students are taught specific instructional objectives or immediately after students have been taught specific instructional objectives. In the former situation, most students will answer few or none of the test items and in the latter situation, they will answer most or all of the items. It is clear then that in both situations very little variation in total test scores within the group of students will result. Consequently, the usual indices for assessing the discriminating power of an item will be very close to zero, which is considered an indication of a poor test item in constructing a norm-referenced test. Thus, there is the distinct possibility that if traditional item selection procedures developed for use with norm-referenced tests are applied to the problem of constructing criterion-referenced tests many good items will be unwisely discarded.

It would seem that what is needed now is a test theory developed specifically for criterion-referenced tests. Some progress has been made in this direction by Cronbach and Gleser (1965), Kriewall (1969), Glaser and Nitko (1971), and Hambleton and Novick (1972).

Criterion-referenced testing is somewhat different when applied to the woodworking area since our items consist of performance tasks rather than multiple-choice items. Hence some of the issues described above are not relevant to our materials.

A summary. Although a test cannot be classified as either a norm-referenced or criterion-referenced test by simply looking at it, the two kinds of tests are designed for quite different reasons, and constructed using different procedures. The norm-referenced test is constructed using traditional item selection procedures for the purpose of making comparisons among individuals. In contrast, a criterion-referenced test is designed to facilitate decision-making relating to individual performance and effectiveness of instruction. Procedures for constructing the tests are only now being developed.

Distinction Between Testing Instruments and Measurement

The differences between norm-referenced and criterion-referenced tests can be further clarified by properly distinguishing between testing instruments and measurement. Certainly criterion-referenced measurement is substantially different from norm-referenced measurement. In the latter, one is primarily interested in using the measurements for making comparative decisions among individuals, whereas in the former the measurements are used to evaluate student performance relative to specific performance levels.

The major distinction between norm-referenced and criterion-referenced measurement is in terms of the kind of information available. With the availability of a theory for making norm-referenced measurements we have procedures for constructing optimum measuring instruments, i.e., norm-referenced tests. Then the pertinent question seems to be whether or not the instructional models which require different kinds of measurement require new kinds of tests or the usual tests with alternate procedures for interpreting test scores. We subscribe to the belief that new tests are needed, constructed in ways which are substantially different from the traditional approaches to test construction. We dintinguish a criterion-referenced test from a norm-referenced test on the basis of the procedures used to construct them.

It should be noted that a norm-referenced test can be used for criterion-referenced measurement, albeit with some difficulty, since the sampling of items is such that in many cases objectives will not be covered on the test, or will be covered with only a few items. Also, a criterion-referenced test constructed by procedures especially designed to make criterion-referenced measurements can be used to make norm-referenced measurements. However, a norm-referenced test is constructed specifically to maximize the variability of test scores (whereas a criterion-referenced test is not) since such a test is most likely to produce the fewest errors in ordering the individuals on the measured ability. Clearly a norm-referenced test can be used to make criterion-referenced measurement, and a criterion-referenced test can be used for norm-referenced measurement, but both usages will be less than optimal.

Thus it would seem misleading to talk about tests as either norm-referenced or criterion-referenced since measurements obtained from either testing instrument can be explained with a norm-referenced interpretation, criterion-referenced interpretation, or both. But it is clear that a test constructed for making one kind of measurement is not likely to be optimum for the other.

Decision-Theoretic Approach to Criterion-Referenced Measurement

Our own conceptual framework for criterion-referenced measurement goes this way. Like Cronbach and Gleser (1965), we see testing as a decision-theoretic process; that is, tests are given for the purpose of aiding in making decisions. This is certainly true in vocational education, where we want to assess mastery or non-mastery of students on specific instructional objectives. One of the main differences between norm-referenced and criterion-referenced tests is in terms of the kinds of decisions they are specifically designed to make. Norm-referenced tests are particularly useful in situations where one is interested in "fixed-quota" selection (i.e., only a certain number of individuals will be selected regardless of their qualifications), or ranking individuals on some ability tests. Decisions relating to mastery of instructional materials are best done with criterion-referenced tests. With a criterion-referenced test we have what Cronbach and Gleser (1965) would call a "quota-free" selection problem. That is, there is no quota on the number of individuals who can exceed the <u>cut-off</u> score on a criterion-referenced test. A cut-off score is set for a criterion-referenced test to separate examinees into two mutually exclusive groups. One group is made up of examinees with high enough test scores ($\geq$ the cut-off score) to assume they have mastered the material to a desired level of proficiency. The second group is made up of examinees who did not achieve the minimum proficiency standard. Establishing cut-off scores is primarily a value judgment.

The educational goal is to have everyone achieve the standards. This is attempted by individualizing instruction to the point of providing alternate instructional modes (Cronbach, 1967), individual pacing and sequencing, and providing various remedial programs.

The primary measurement problem in the new objective-based curricula programs such as the ones being proposed in vocational education is one of determining if $\hat{P}_i$, an estimate of P_i, is greater than P_o. Here P_i is the "true" score for an individual i in some particular content domain. It represents the proportion of items in some content domain that he could answer successfully. Since we cannot administer all items in the domain, we sample some small number to obtain an estimate of P_i, represented as $\hat{P}_i$. The value of P_o is the somewhat arbitrary cutting score used to divide individuals into the two mastery categories described above.

Basically then, the tester's problem is to locate each examinee in the correct mastery category. There are two kinds of errors that occur in this classification problem: false positive errors, and false negative errors. A false positive error occurs when the tester estimates an examinee's ability to be above the cutting score when in fact it is not. A false negative error occurs when the reverse is true. The seriousness of making a false positive error depends to some extent on the structure of the instructional objectives. It would seem that this kind of error has the most serious effect on program efficiency when the instructional objectives are highly related. On the other hand, the seriousness of making a false negative error would seem to depend on the length of time a student would be assigned to a remedial program because of his low test performance. It should be noted that many students who are misclassified are, of course, close to the cutting score; hence the remedial work is not completely inappropriate for them.

In practical applications of criterion-referenced testing it would seem that in order to evaluate the test it would be necessary to know something about the consistency of decision-making across alternate forms of the criterion-referenced test (i.e., test reliability). Another consideration is the validity of decision-making with these tests. The problem of reliability and validity estimation for criterion-referenced tests has not to date been satisfactorily solved; however, there are several papers that deal with the topic, including Bormuth (1970), Hambleton and Gorth (1971), Hambleton and Novick (1972), and Popham and Husek (1969).

Criterion-Referenced Testing: An Application

In the final part of this section we will consider the application of criterion-referenced tests to the area of individual assessment in an individually prescribed instruction program.

A new instructional model, typical of many being implemented in schools around the country, is the one being used in the Jamesville-DeWitt (JD) High School in DeWitt, New York (O'Reilly & Hambleton, 1971; Hambleton, Gorth & O'Reilly, 1972).

This ninth grade individualized instruction program in science is organized into <u>instructional modules</u> which consist of instructional activities designed to teach a single major concept which has been expressed in terms of behavioral objectives. The instructional activities which make up a module are subdivided into smaller submodules called learning activity packages (LAPs). As each student proceeds through an instructional module there are four types of decisions which must be made about him. To provide information for decision-making the following criterion-referenced tests are administered: a module pretest, a module posttest, and several LAP pretests and posttests.

Briefly let us consider each decision separately. As a student begins to work on a module, a module pretest is administered. On the basis of his test performance, a prescription indicating the particular LAPs that a student needs instruction on in the module is prepared by the teacher. Such a procedure will ensure that students will be working only on learning experiences directed toward goals which have not been mastered previously. The module posttest which is either the same test or an alternate form of the module pretest can be used for prescribing remedial work for a student, for grading, and for evaluating the effectiveness of the instruction in the LAPs.

Analogous to the module pretests, the LAP pretests are used to prescribe a set of objectives within the LAP that the student must demonstrate competency in before moving on to the next LAP in his prescription. LAP posttests are used to determine the extent to which students have satisfactorily completed the objectives of the LAP.

Decisions relating to the diagnosis of learning difficulties can also be made from the criterion-referenced tests if the incorrect responses to the items have been carefully constructed, i.e., incorrect choices are included in an item because they are indicative of particular learning difficulties. Apparently this systematic construction of incorrect choices to multiple-choice items for the purpose of diagnosing learning difficulty has not been carefully explored but offers much potential. In addition to being an excellent way of extracting more information from a criterion-referenced test, it offers a systematic way of constructing choices to multiple-choice items.

One problem that remains to be solved for programs similar in format to the JD model is the development of guidelines for establishing cut-off points (i.e., how many items must an individual pass on a criterion-referenced test to demonstrate mastery).

<u>Summary</u>

In this section we have attempted to highlight some of the special characteristics of criterion-referenced tests and compare them with norm-referenced tests. Also, the application of criterion-referenced testing to the problem of individual assessment in an individually prescribed instruction program was briefly discussed. Some pertinent comments were included that made specific reference to performance testing in woodworking.

It should be clear from this section that there are still many problems that remain to be resolved in developing an operational criterion-referenced measurement model for assessing student mastery in the schools. It is encouraging to note that at this time there is probably more research being conducted in this area than any other in educational measurement. Thus it should not be long before practical solutions are found to the problems.

7. OBJECTIVE AND TEST ITEM BANK

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/01	1.	Sharpen a plane iron, given a ground plane iron, oilstone, and oil.	Plane iron to razor edge.	Cutting edge is razor sharp.	Put film of oil on oilstone. Hone cutting edge to remove wire edge, until sharp.
01/01	2.	Sharpen a chisel, given a ground chisel, oilstone, and oil.	Chisel to razor edge.	Cutting edge is razor sharp. Bevel is flat and not rounded.	Put film of oil on oilstone. Hone cutting edge to remove wire edge, until sharp.
01/01	3.	Sharpen a knife, given a ground knife, oilstone, and oil.	Knife to razor edge.	Cutting edge is razor sharp. Bevel is flat and not rounded.	Put film of oil on oilstone. Hone cutting edge to remove wire edge, until sharp.
01/[illegible]	4.	Sharpen a scraper, given a ground hand scraper, oilstone, oil, file, and a burnisher.	Scraper with sharp hooked edge.	Scraper cutting edge has uniform hooked edge and is sharp. No marks left after trial scrape.	File edge of scraper until sharp. Roll sharp edge with burnisher to form hooked edge.
01/01	5.	Joint a blade, given a circular saw blade, circular saw, machine, and oilstone.	Circular blade is true round.	Circular saw teeth have flat tips.	Place blade on saw arbor in reverse. Project blade slightly above table, pushing oilstone over revolving blade.
01/02	6.	Lay out table top for gluing, given pieces of stock for the table top, tools, and stock list.	Proper grain direction.	All joints have same grain pattern and grain direction. Identification marks.	Lay out pieces of stock for the table top for grain direction, grain pattern, and glue joint.
01/02	7.	Lay out legs and rails for mortise and tenon joint, given pieces of stock for legs and rails, tools, and a stocklist.	Mortise and tenon joint marked out for a snug fit.	Size, depth, and location of mortise and tenon.	Lay out tenon on both [illegible] of rail. Lay out [illegible] on legs to receive [illegible]

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/02	8.	Lay out pieces of stock for a crosslap joint, given pieces of stock for a brace, tools, and a stocklist.	Brace is laid out for a proper fit.	Joint is of same thickness as the piece of stock. Joint marked for proper angle and stock width.	Mark brace piece of stock for crosslap joint.
01/02	9.	Make a rod layout of a project, given a sketch and measurements for the project, straight edge, rule dividers, and a combination square.	Layout rod of a project.	Marks are marked on rod in relation to sketch. Identification of joints.	Transfer measurements from sketch to layout rod, full size.
01/02	10.	Make a rod layout of a project, given a sketch and measurements for the project, straight edge, rule dividers, and a try square.	Layout rod of a project.	Marks are marked on rod in relation to sketch. Identification of joints.	Transfer measurements from sketch to layout rod, full size.
01/02	11.	Make a rod layout of a project, given a sketch and measurements for the project, straight edge, rule dividers, and a steel square.	Layout rod of a project.	Marks are marked on rod in relation to sketch. Identification of joints.	Transfer measurements from sketch to layout rod, full size.
01/02	12.	Make a transfer of a project, given a sketch and a layout board for the project, straight edge, rule dividers, and a combination square.	Transfer marks to rod of a project.	Lines on a piece of stock properly marked from transfer board.	Transfer measurements from a layout board to a piece of stock.
01/02	13.	Make a transfer of a project, given a sketch and a layout board for the project, straight edge, rule dividers, and a try square.	Transfer marks to rod of a project.	Lines on a piece of stock properly marked from transfer board.	Transfer measurements from a layout board to a piece of stock.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/02	14.	Make a transfer of a project, given a sketch and a layout board for the project, straight edge, rule dividers, and a steel square.	Transfer marks to rod of a project.	Lines on a piece of stock properly marked from transfer board.	Transfer measurements from a layout board to a piece of stock.
01/02	15.	Make a full-size layout of a project, given a sketch of the project, a straight edge, rule dividers, a steel square, and a strip template.	Transfer marks to full-size layout board.	Lines accurately marked to full size showing location of joints and type of construction.	Transfer lines from strip template to layout board.
01/03	16.	Sand a piece of stock, given a piece of stock for the project, sand paper, and a block.	A piece of stock with a smooth surface.	Sanding with the grain. No sandpaper marks. Thickness of the piece of stock uniform.	Sand a piece of stock with block and sandpaper.
01/03	17.	Sand a piece of stock, given a piece of stock for the project, sand-paper, and a vibrator sander.	A piece of stock with a smooth surface.	Sanding with the grain. No sandpaper marks. Thickness of the piece of stock uniform.	Sand a piece of stock with a vibrator sander.
01/03	18.	Sand a piece of stock, given a piece of stock for the project, sand-paper belts, and a belt sander.	A piece of stock with a smooth surface.	Sanding with the grain. No sandpaper marks. Thickness of the piece of stock uniform.	Sand a piece of stock with a belt sander.
01/03	19.	Scrape a piece of stock, given a piece of stock for the project, and a hand scraper.	A piece of stock with all nicks and scratches removed.	All nicks and scratches removed. Scraping with the grain. Thickness of the piece of stock to be uniform.	Scrape a piece of stock with a hand scraper.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/04	20.	Apply glue and clamps, given pieces of stock for a breadboard, tools, powdered glue, and clamps.	Glued up breadboard.	Glue consistency, application of glue, placement of clamps, uniform pressure of clamps, direction of grain.	Mix glue, apply glue to a piece of stock, clamp up breadboard, remove excess glue.
01/04	21.	Apply glue and clamps, given pieces of stock for a salad bowl, tools for gigs, powdered glue, and clamps.	Glued up salad bowl.	Glue consistency, application of glue, placement of clamps, uniform pressure of clamps in direction of grain.	Mix glue, apply glue to a piece of stock, clamp up salad bowl with gigs, remove excess glue.
01/04	22.	Apply glue and clamps, given pieces of stock for a table top, powdered glue, and clamps.	Glued up table top.	Glue consistency, application of glue, placement of clamps, uniform pressure of clamps, board surface is flat.	Mix glue, apply glue to a piece of stock, clamp up table top, remove excess glue.
01/04	23.	Apply glue and clamps, given pieces of stock for a bookcase, material, tools, white glue, and clamps.	Glued up bookcase.	Application of glue, placement of clamps and blocks, clamp pressure, squaring up bookcase.	Apply glue to stock, clamp up bookcase with blocks in proper location, remove excess glue.
01/04	24.	Apply glue and clamps, given pieces of stock for a bookcase, material, tools, powdered glue, and clamps.	Glued up bookcase.	Application of glue, placement of clamps and blocks, clamp pressure, glue consistency, squaring up bookcase.	Mix glue, apply glue to stock, clamp up bookcase with blocks in proper location, remove excess glue.
01/04	25.	Apply glue and clamps, given pieces of stock for an arch header, tools, blocks, powdered glue, and clamps.	Glued up arch header.	Application of glue, placement of clamps and blocks, blocks to have equal pressure, glue consistency.	Mix glue, apply glue to pieces of stock, clamp up arch header, remove excess glue.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/04	26.	Apply glue and clamps, given pieces of stock for an arch header, tools, blocks, white glue, and clamps.	Glued up arch header.	Application of glue, placement of clamps and blocks, blocks to have equal pressure.	Apply glue to pieces of stock, clamp up arch header, remove excess glue.
01/04	27.	Apply glue and clamps, given pieces of stock for an arch header, tools, blocks, hot glue, and clamps.	Glued up arch header.	Application of glue, placement of clamps and blocks, blocks to have equal pressure, glue consistency.	Heat glue, apply glue to pieces of stock, clamp up arch header, remove excess glue.
01/04	28.	Apply glue and clamps, given pieces of stock for frames, tools, blocks, white glue, and clamps.	Glued up frame.	Application of glue, placement of clamps and blocks, blocks to be of equal pressure. Frame to be square.	Apply glue to joint parts, clamp up frame with blocking, squaring up frame.
01/04	29.	Apply glue and clamps, given pieces of stock for frames, tools, blocks, hot glue, and clamps.	Glued up frame.	Application of glue, placement of clamps and blocks, blocks to be of equal pressure. Frame to be square. Consistency of glue.	Heat glue, apply glue to joint parts, clamp up frame with blocking, squaring up frame.
01/04	30.	Apply glue and clamps, given pieces of stock for frames, tools, blocks, powdered glue, and clamps.	Glued up frame.	Application of glue, placement of clamps and blocks, blocks to be of equal pressure. Frame to be square. Consistency of glue.	Mix glue, apply glue to joint parts, clamp up frame with blocking, squaring up frame.
01/05	31.	Assemble and square a bookcase. Cut and install shelf standards, given hacksaw, shelf standards, fasteners, hammer, bookcase parts with grooves.	Assembled bookcase with standards installed.	Bookcase squared up. Standard numbers match and standard holes line up. Method used to assemble bookcase.	Assemble bookcase, cut standards to length, install standards, square up bookcase.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/05	32.	Assemble and square a bookcase. Cut and install shelf standards, given hacksaw, shelf standards, nails, hammer, bookcase parts with grooves.	Assembled bookcase with standards installed.	Bookcase squared up. Standard numbers match and standard holes line up. Placement of nails to assemble bookcase.	Assemble bookcase, cut standards to length, install standards, square up bookcase.
01/05	33.	Assemble and square a bookcase. Cut and install shelf standards, given hacksaw, shelf standards, screws, tools, bookcase parts with grooves.	Assembled bookcase with standards installed.	Bookcase squared up. Standard numbers match, standard holes line up. Placement of screws to assemble bookcase.	Assemble bookcase, cut standards to length, install standards, square up bookcase.
01/05	34.	Assemble and square up a cabinet and cut and install shelf standards, given a hacksaw, shelf standards, fasteners, hammer, and cabinet parts with grooves.	Assembled cabinet with standards installed.	Cabinet assembled and squared. Standard numbers match, standard holes line up. Method used to assemble cabinet.	Assemble cabinet, cut standards to length, install standards, square up cabinet.
01/05	35.	Assemble and square up a cabinet and cut and install shelf standards, given a hacksaw, shelf standards, nails, hammer, and cabinet parts with grooves.	Assembled cabinet with standards installed.	Cabinet assembled and squared. Standard numbers match, standard holes line up. Placement of nails to assemble cabinet.	Assemble cabinet, cut standards to length, install standards, square up cabinet.
01/05	36.	Assemble and square up a cabinet and cut and install shelf standards, given a hacksaw, shelf standards, screws, tools, bookcase parts with grooves.	Assembled cabinet with standards installed.	Cabinet assembled and squared. Standard numbers match, standard holes line up. Placement of screws to assemble cabinet.	Assemble cabinet, cut standards to length, install standards, square up cabinet.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/05	37.	Assemble and square a chest, given fasteners, a hammer, chest parts, and tools.	Assembled chest.	Chest assembled and squared. Tight joints, placement of fasteners.	Assemble chest parts with fasteners, square up chest.
01/05	38.	Assemble and square a chest, given nails, hammer, chest parts, and tools.	Assembled chest.	Chest assembled and squared. Tight joints, placement of fasteners, standard holes line up.	Assemble chest parts with nails, square up chest.
01/05	39.	Assemble and square a chest, given screws, tools, and chest parts.	Assembled chest.	Chest assembled and squared. Tight joints, placement of fasteners, standard holes line up.	Assemble chest parts with screws, square up chest.
01/07	40.	Remove saw marks on concave cuts, given milled boards with concave cuts, a file, and sandpaper.	Milled board with smooth concave cuts.	All saw marks removed. No sandpaper marks. Uniform concave cuts.	Milled boards with smooth concave cuts.
01/07	41.	Set nails, given nailed milled boards, and tools.	Milled boards with nail set below surface.	Size nailset used. Depth of set nail, consistence with thickness of a piece of stock.	Set nails below surface of wood.
01/07	42.	Remove bandsaw marks, given bandsawed boards with concave cuts, a file, and sandpaper.	Bandsawed boards with smooth concave cuts.	All bandsaw marks removed. No sandpaper marks. Uniform concave cuts, within design limits.	File out bandsaw marks. Sand concave cuts smooth.
01/09	43.	Position two pieces of wood together, given a miter vise, two pieces of wood, and glue.	Two pieces of wood fastened in miter vise.	How wood was placed in vise. Surface should be flush. Joint to be tight.	Fasten wood in miter vise.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
01/09	44.	Apply hinges to a drop leaf table, given hinges, screws, tools, combination square, and a drawing for hinge location.	Installed hinges on a drop leaf table.	Size of cutout for hinge. Hinge set in flush with surface. Correct hinge location and direction.	Mark out hinge location. Chisel out hinge pocket. Install hinge to table and leaf.
01/09	45.	Apply hinges to a drop leaf table, given hinges, screws, tools, try square, and a drawing for hinge location.	Installed hinges on a drop leaf table.	Size of cutout for hinge. Hinge set in flush with surface. Correct hinge location and direction.	Mark out hinge location. Chisel out hinge pocket. Install hinge to table and leaf.
01/09	46.	Apply hinges to a drop leaf table, given hinges, screws, tools, steel square, and a drawing for hinge location.	Installed hinges on a drop leaf table.	Size of cutout for hinge. Hinge set in flush with surface. Correct hinge location and direction.	Mark out hinge location. Chisel out hinge pocket. Install hinge to table and leaf.
01/09	47.	Apply hinges to a door, given butt hinges, door screws, tools, combination square, and a drawing for hinge location.	Installed hinges on a door.	How hinge location is marked. Size of cutout for hinge. Set-in of hinge into door to be uniform.	Mark out hinge location. Chisel out hinge pocket. Install hinge to door.
01/09	48.	Apply hinges to a door, given butt hinges, door screws, tools, try square, and a drawing for hinge location.	Installed hinges on a door.	How hinge location is marked. Size of cutout for hinge. Set-in of hinge into door to be uniform.	Mark out hinge location. Chisel out hinge pocket. Install hinge to door.
01/09	49.	Apply hinges to a door, given butt hinges, door screws, tools, steel square, and a drawing for hinge location.	Installed hinges on a door.	How hinge location is marked. Size of cutout for hinge. Set-in of hinge into door to be uniform.	Mark out hinge location. Chisel out hinge pocket. Install hinge to door.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/01	50.	Measure and mark a piece of stock, given a bench rule, sharp pencil, combination square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a combination square.
02/01	51.	Measure and mark a piece of stock, given a bench rule, sharp pencil, try square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a try square.
02/01	52.	Measure and mark a piece of stock, given a bench rule, sharp pencil, steel square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a steel square.
02/01	53.	Measure and mark a piece of stock, given a steel tape, sharp pencil, combination square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a combination square.
02/01	54.	Measure and mark a piece of stock, given a steel tape, sharp pencil, try square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a try square.
02/01	55.	Measure and mark a piece of stock, given a steel tape, sharp pencil, steel square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a steel square.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/01	56.	Measure and mark a piece of stock, given a zig-zag rule, sharp pencil, combination square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a combination square.
02/01	57.	Measure and mark a piece of stock, given a zig-zag rule, sharp pencil, try square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a try square.
02/01	58.	Measure and mark a piece of stock, given a zig-zag rule, sharp pencil, steel square, a piece of stock, and specifications.	Marked piece of stock as per specifications.	Accurate measured lines marked on a piece of stock.	Measure a piece of stock. Mark the piece of stock with a steel square.
02/02	59.	Mark one end of a board square, given a try square, a board with a straight edge, and a pencil.	Board with one end marked square.	Accuracy of square line.	Mark a piece of stock with a try square.
02/02	60.	Mark both ends of a board square to a given length, given a try square, a board with a straight edge, and a pencil.	Board layed out to length, both ends marked square.	Accuracy of square line. Accuracy of length.	Mark a piece of stock with a try square.
02/02	61.	Mark one end of a board square, given a combination square, a board with a straight edge, and a pencil.	Board with one end marked square.	Accuracy of square line.	Mark a piece of stock with a combination square.
02/02	62.	Mark both ends of a board square to a given length, given a combination square, a board with a straight edge, and a pencil.	Board layed out to length, both ends marked square.	Accuracy of square line. Accuracy of length.	Mark a piece of stock with a combination square.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/02	63.	Mark one end of a board square, given a steel square, a board with a straight edge, and a pencil.	Board with one end marked square.	Accuracy of square line.	Mark a piece of stock with a steel square.
02/02	64.	Mark both ends of a board square to a given length, given a steel square, a board with a straight edge, and a pencil.	Board layed out to length, both ends marked square.	Accuracy of square line. Accuracy of length.	Mark a piece of stock with a steel square.
02/03	65.	Determine if an edge is square, using a try square, given part of a job and a try square.	A piece of stock with an edge square to face.	Student correctly determines that material is square.	Place square on a piece of stock to check edge squareness with face.
02/03	66.	Determine if a surface is plumb, using a spirit level, given a surface and a level.	A surface that is plumb.	Student correctly determines that material is plumb.	Place level on a piece of stock. Check the piece of stock for plumb.
02/03	67.	Determine if a surface is flat, using a spirit level, given a surface and a level.	A surface that is flat.	Student correctly determines that material is flat.	Place level on a piece of stock. Check surface if flat.
02/03	68.	Determine if an edge is square, using a try square, given parts of a job and a try square.	A piece of stock with an edge square to face.	Student correctly determines that the surface is square with the edge.	Place square on a piece of stock to check edge squareness with face.
02/03	69.	Determine if a surface is flat, using a try square, given parts of a job and a try square.	A piece of stock with a flat surface.	Student correctly determines that the surface is flat.	Place square on a piece of stock. Check if surface is flat.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/03	70.	Determine if an edge is square, using a steel square, given parts of a job and a steel square.	A piece of stock with a square to edge face.	Student correctly determines that the surface is square with edge.	Place square on a piece of stock to check edge squareness with face.
02/03	71.	Determine if a surface is flat, using a steel square, given parts of a job and a steel square.	A piece of stock with a flat surface.	Student correctly determines that the surface is flat.	Place square on a piece of stock. Check if surface is flat.
02/04	72.	Check the squareness of the joints and adjust to make square, given a blueprint, project, and hand tools.	A project that is square inside and outside.	Student correctly determines that the material is square.	Place square on project to check squareness.
02/04	73.	Check the squareness of the joints, given a blueprint, frame, and a steel square.	Determination of whether the frame is square.	Student correctly determines that the material is square.	Place steel square on frame to check squareness.
02/04	74.	Check the squareness of the joints, given a blueprint, chest, and a steel square.	Determination of whether the chest is square.	Student correctly determines that the material is square.	Place steel square on chest to check squareness.
02/04	75.	Check the squareness of the joints, given a blueprint, bookcase, and a steel square.	Determination of whether the bookcase is square	Student correctly determines that the material is square.	Place steel square on bookcase to check squareness.
02/04	76.	Check the squareness of the joints, given a blueprint, table, and a steel square.	Determination of whether the table is square.	Student correctly determines that the material is square.	Place steel square on table to check squareness.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/04	77.	Check the squareness of the joints, given a blueprint, a frame, and a try square.	Determination of whether the frame is square.	Student correctly determines that the material is square.	Place try square on frame to check squareness.
02/04	78.	Check the squareness of the joints, given a blueprint, chest, and a try square.	Determination of whether the chest is square.	Student correct determines that the material is square.	Place try square on chest to check squareness.
02/04	79.	Check the squareness of the joints, given a blueprint, table, and try square.	Determination of whether the table is square.	Student correctly determines that the material is square.	Place try square on table joints to check squareness.
02/04	80.	Check the squareness of the joints, given a blueprint, frame, and combination square.	Determination of whether the frame is square.	Student correctly determines that the material is square.	Place combination square in corner of frame to check squareness.
02/04	81.	Check the squareness of the joints, given a blueprint, a chest, and combination square.	Determination of whether the chest is square.	Student correctly determines that the material is square.	Place combination square at chest joints to check squareness.
02/04	82.	Check the squareness of the joints, given a blueprint, bookcase, and combination square.	Determination of whether the bookcase is square.	Student correctly determines that the material is square.	Place combination square at bookcase joints to check squareness.
02/04	83.	Check the squareness of the joints, given a blueprint, table, and combination square.	Determination of whether the table is square.	Student correctly determines that the material is square.	Place combination square at table joints to check squareness.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/05	84.	Crosscut one end and remove checks, given a piece of stock, a crosscut handsaw, and a square.	A piece of stock with one end cut square.	All checks cut off square. Least amount of stock removed.	Saw off end square.
02/05	85.	Crosscut two ends and remove checks, given a piece of stock, a crosscut saw, a square, and dimensions.	A piece of stock with both ends cut square.	All checks cut off square. Length of board ± 1/16 inch.	Saw off ends square and to length.
02/05	86.	Rip edge of a piece of stock, given a piece of stock, a marking gauge, ripsaw, and dimensions.	A piece of stock with edge ripped to size.	Edge of a piece of stock ripped parallel.	Ripsaw edge of a piece of stock to dimension.
02/05	87.	Miter one end, given a piece of stock, miter box, and dimensions.	A piece of stock with one end miter cut.	Miter to be accurate and neat. Use of miter box.	Miter cut one end of a piece of stock using miter box.
02/05	88.	Miter two ends on a piece of stock, given a piece of stock, miter box, and dimensions.	A piece of stock with two ends miter cut.	Miter to be accurate and to the correct length. Use of miter box.	Miter cut both ends of a piece of stock using miter box.
02/07	89.	Joint edge with the grain, given a piece of stock, a square, and a hand plane.	Stock with one end jointed square and straight.	Edge to be straight and square.	Joint edge of board with hand plane.
02/07	90.	Chamfer edge to specifications, given a piece of stock, specifications, bevel square, and a hand plane.	A piece of stock with one edge chamfered.	Chamfer to be straight to size. Bevel of cut. Smoothness of cu .	Chamfer edge of board with a hand plane.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/07	9..	Chamfer on the end to specifications, given a piece of stock, specifications, bevel square, and a hand plane.	A piece of stock with one end chamfered.	Chamfer to be straight to size. Bevel of cut. Smoothness of cut.	Chamfer one end of board with a hand plane.
02/07	92.	Miter one end to specifications, given a piece of stock, specifications, combination square, and a hand plane.	A piece of stock with one end mitered.	Miter planed exact.	Miter one end of board with a hand plane.
02/07	93.	Bevel across the grain to specifications, given a piece of stock, specifications, bevel square, combination square, and a hand plane.	A piece of stock with one end beveled.	Correct bevel and square.	Bevel one end with hand plane.
02/07	94.	Bevel on the edge to specifications, given a piece of stock, specifications, bevel square, and a hand plane.	A piece of stock with one edge beveled.	Correct bevel and straight.	Bevel one edge with hand plane.
02/07	95.	Square off one end to specifications, given a piece of stock, specifications, try square, and a hand plane.	A piece of stock with one end square.	End to be square and smooth and to size.	Square one end with hand plane.
02/08	96.	Select correct size drill, and drill hole to specification, given a hand drill, drills, lumber, and specification.	Hole drilled in a piece of wood.	Size of hole, location of hole and correct angle. Clean surface.	Using hand drill, drill a hole in a piece of stock.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/08	97.	Select correct size bit, and bore hole to specification, given a bit brace, bits, lumber, and specification.	Hole bored in a piece of wood.	Size of hole, location of hole and correct angle. Clean surface.	Using a bit brace and bit, bore a hole in a piece of wood.
03/03	98.	Select correct size drill, and drill a hole to specification, given an electric drill, drills, lumber, and specification.	Hole drilled in a piece of wood.	Size of hole, location of hole and correct angle. Clean surface.	Using electric drill and drill, drill a hole in a piece of wood.
04/14	99.	Select correct size countersink and countersink a hole to specification, given an electric drill, countersink, lumber, and specification.	A countersunk hole in a piece of wood.	Depth and size of countersunk hole.	Using electric drill and countersink, countersink a hole in a piece of wood.
04/14	100.	Select correct size drill, and drill holes to specification, given a drill press, drills, lumber, and specification.	Holes drilled in a piece of wood.	Use of drill press, setup, correct size holes. Location of holes and correct angle.	Using a drill press and drills, drill holes in a piece of wood.
04/14	101.	Select correct size countersink and countersink a hole to specification, given a drill press, countersink, lumber, and specification.	A countersunk hole in a piece of wood.	Use of drill press, setup, depth and size of countersunk hole.	Using a drill press and countersink, countersink a hole in a piece of wood.
04/19	102.	Select correct size drill, and counterbore holes to specification, given a boring machine, counterbore, lumber, and specification.	A counterbored hole in a piece of wood.	Setup of boring machine. Size of counterbored hole.	Using a boring machine, counterbore a hole in a piece of wood.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/09	103	Install top and corner blocks on table frame, given a table frame, top, screws, tools, corner blocks, glue, and handscrews.	Table frame with top attached.	Placement of blocks. Table top tight to frame. Equal overhang.	Screw blocks to frame. Install table top with screws through blocks.
	104.	Plane the scratches and machine marks on the surface of a piece of wood, given parts of a job, and hand plane.	A smooth piece of wood with no scratches or marks on surface.	No plane blade marks. Smoothness of surface. Surface is flat and within size limits.	Plane the surface of a piece of stock.
	105.	Scrape the scratches and machine marks on the surface of a piece of wood, given parts of a job, and hand scraper.	A smooth piece of wood with no scratches or marks on surface	No scraper blade marks. Smoothness of surface. Surface is flat and within size limits.	Scrape the surface at an angle toward you.
	106.	Scrape the scratches and machine marks on the surface of a piece of wood, given parts of a job, and cabinet scraper.	A smooth piece of wood with no scratches or marks on surface.	No scraper blade marks. Smoothness of surface. Surface is flat and within size limits.	Scrape the surface at an angle toward you.
	107.	Plane a piece of stock to a specified thickness, given a piece of stock, a smooth plane, vise, and specifications.	A planed piece of stock.	Piece of stock planed flat and straight to correct thickness.	Plane a piece of stock with a smooth plane.
	108.	Joint a piece of stock to specifications, given a piece of stock, a smooth plane, vise, and specifications.	A piece of stock with a jointed edge.	Piece of stock planed straight and square to correct width.	Plane the edge of a piece of stock with a smooth plane.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/10	109.	Taper a piece of stock to specifications, given a piece of stock, smooth plane, vise, and specifications.	A tapered piece of stock.	Correct taper planed straight and square to edge.	Plane a piece of stock to taper specifications with a smooth plane.
02/12	110.	Plane a piece of stock to specified thickness, given a piece of stock, jack plane, vise, and specifications.	A planed piece of stock.	A piece of stock planed straight and flat to correct thickness.	Plane a piece of stock with a jack plane.
02/12	111.	Joint a piece of stock to specifications, given a piece of stock, jack plane, square, vise, and specifications.	A piece of stock with a jointed edge.	A piece of stock planed straight and square to correct width.	Plane the edge of a piece of stock with a jack plane.
02/12	112.	Taper a piece of stock to specifications, given a piece of stock, jack plane, vise, and specifications.	A tapered piece of stock.	Correct taper planed.	Plane a piece of stock to taper specifications with a jack plane.
02/12	113.	Plane a piece of stock to specified thickness, given a piece of stock, jointer plane, vise, and specifications.	A planed piece of stock.	Stock planed flat and smooth to correct thickness.	Plane a piece of stock with a jointer plane.
02/12	114.	Joint a piece of stock to specifications, given a piece of stock, jointer plane, square, vise, and specifications.	A piece of stock with a jointed edge.	Piece of stock planed straight and square to correct width.	Plane the edge of a piece of stock with a jointer plane.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
02/12	115.	Taper a piece of stock to specifications, given a piece of stock, jointer plane, vise, and specifications.	A tapered piece of stock.	Correct taper planed.	Plane a piece of stock to taper specifications with a jointer plane.
02/12	116.	Plane a piece of stock to a specified thickness, given a piece of stock, fore plane, square, vise, and specifications.	A planed piece of stock.	A piece of stock planed flat and straight to correct thickness.	Plane a piece of stock with a fore plane.
02/12	117.	Joint a piece of stock to specifications, given a piece of stock, fore plane, square, vise, and specifications.	A piece of stock with a jointed edge.	A piece of stock planed straight and square to correct width.	Plane the edge of a piece of stock with a fore plane.
02/12	118.	Taper a piece of stock to specifications, given a piece of stock, fore plane, vise, and specifications.	A tapered piece of stock.	Correct taper planed.	Plane a piece of stock to taper specifications with a fore plane.
03/05	119.	Mold material for the project to specified shape, given a portable router, jig, a piece of stock, cutters, fence, and wrenches.	A molded edge on a piece of stock.	Router setup to specifications, smoothness of molded edge with no burns.	Using router and cutter, shape the edge of a piece of stock.
03/05	120.	Trim plastic laminate on top, given a portable router, jig, a piece of stock, laminate trimmer, fence, and wrenches.	A top with laminate trimmed.	Trimmed edge straight. Laminate flush with edge.	Trim excess laminate flush with edge.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
03/05	121.	Trim plastic laminate on back splash, given a portable router, jig, stock, laminate trimmer, fence, and wrenches.	A back splash with laminate trimmed.	Trimmed edge straight. Laminate flush with edge.	Trim excess laminate flush with edge.
03/05	122.	Rabbet wood for frame, given a portable router, jig, a piece of stock, straight cutter, fence, and wrenches.	A frame with a rabbetted edge.	Size of cut. Smoothness of cut.	Cut rabbet on edge of frame.
03/05	123.	Groove a piece of stock to specifications, given a portable router, jig, a piece of stock, router cutter, fence, and wrenches.	A piece of wood with a completed groove cut in surface.	Size of cut. Smoothness of cut. Location of cut.	Cut groove in wood.
03/05	124.	Cut wood to cove shape, given a portable router, jig, a piece of stock, cove cutter, fence, and wrenches.	A molding with cove cut.	Size and smoothness of cut.	Cut cove molding on edge of wood.
04/01	125.	Taper the sides of a piece of stock, given a jointer, a piece of stock, C-clamps, stop and push stick, and specifications.	A piece of stock with tapered sides.	Jointer setup. Taper correct to specifications.	Clamp stops to fence. Set up for depth of cut. Use push to taper sides.
04/01	126.	Face best side of a piece of stock, given a jointer, a piece of stock, and a push stick.	A piece of stock with one face straight and flat.	Depth of cut. Surface straight and flat.	Adjust jointer cut. Face best side of stock.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/01	127.	Joint the best edge of a piece of stock, given a jointer and a piece of stock.	A piece of stock with one edge straight.	Depth of cut. Edge of the piece of stock straight and square to face.	Adjust jointer cut. Joint edge of stock.
04/01	128.	Joint edges for gluing of a piece of stock, given jointer and a piece of stock.	Pieces of stock with edges milled for gluing.	Depth of cut. Edges of the piece of stock to form spring joint. Edges to be straight and square.	Adjust jointer cut. Joint edges of stock.
04/01	129.	Joint ends of a piece of stock, given a jointer and a piece of stock.	A piece of stock with ends jointed.	Depth of cut. End to be square. Edges not to be split out.	Adjust jointer cut. Joint edge only 2 inches. Reverse stock and joint end.
04/01	130.	Joint veneer, given a jointer, a piece of stock, and hand screw clamps.	Piece of veneer with straight edges.	Veneer with straight edges. No splitting or chipping of veneer.	Clamp veneer with hand screw clamps. Adjust cut. Joint edges of veneer.
04/01	131.	Bevel edges of a piece of stock, given a jointer and a piece of stock.	A piece of stock with a beveled edge.	Setup of jointer. Correct bevel on the piece of stock.	Adjust angle of fence. Joint bevel.
04/01	132.	Rabbet edge of a piece of stock, given a jointer and a piece of stock.	A piece of stock with a rabbet on edge.	Setup of jointer. Size of rabbet.	Remove jointer guard. Adjust fence and depth of cut. Mill rabbet.
04/01	133.	Square a piece of stock, given jointer and a piece of stock.	A piece of stock that is square.	Squareness of the piece of stock.	Joint ends. Joint edges square with ends.
04/02	134.	Set up a circular saw with a dado head, to dado grooves, given a piece of stock for a bookcase, a circular saw, and a dado head.	Sides of bookcase with dado groove for shelves.	Setup of dado head. Dado groove size. Groove square with edge and location.	Set up circular saw. Mill stock.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/02	135.	Set up a circular saw with a dado head to groove, given a piece of stock for a cabinet, a circular saw, and a dado head.	Cabinet stock with rabbet grooves.	Setup of dado head. Rabbet groove size and location.	Set up circular saw. Mill stock.
04/04	136.	Set up a radial arm saw with a dado head to groove, given a piece of stock for a chest, a radial arm saw, and a dado head.	Chest stock with grooves for bottom.	Setup of radial arm saw. Size, depth and location of grooves.	Set up radial arm saw with dado head. Mill groove in stock.
04/16	137.	Set up a router with a cutter to dado, given a piece of stock for a hutch, an overhead router, and a straight cutter.	Hutch stock sides with dado grooves for shelves.	Setup of router. Size of dado groove. Groove square with edge.	Set up router. Route dado grooves in side stock.
04/03	138.	Adjust and clean rolls, given a thickness planer, tools, straight edge, cleaning fluid, and rags.	Thickness planer with clean and adjusted rolls.	Clean and smooth rolls. Adjustment of rolls. Stock should pass through planer with no trouble or marks.	Scrape pitch from roll Using fluid, clean rolls. Adjust rolls using straight edge.
04/03	139.	Plane a piece of stock to thickness, given a thickness-planer, stock list, and a piece of stock.	A piece of stock planed to thickness,	Size of finished stock. Operational procedure.	Adjust thickness planer. Plane stock to thickness.
04/03	140.	Plane a piece of stock to width, given a thickness planer, a stock list, a piece of stock, and a hand screw clamp.	A piece of stock planed to width.	Clamping of stock. Size of finished stock.	Adjust thickness planer. Clamp stock together. Plane stock to width.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/06	141.	Lay out and cut scallops, given a bandsaw, a piece of stock, pattern, and drawing.	Stock with scallop cutouts.	Pattern lines showing. Smooth bandsaw cuts.	Lay out pattern on stock. Cut out scallops.
04/06	142.	Lay out and cut circles, given a bandsaw, a piece of stock, a pattern, and a drawing.	Round piece of stock.	Pattern lines showing. Smooth bandsaw cuts.	Lay out circle. Cut out circle.
04/06	143.	Lay out and cut arcs, given a bandsaw, a piece of stock, a pattern, and a drawing.	Stock with arcs cut out.	Pattern lines showing. Smooth bandsaw cuts.	Lay out arc. Cut out arc.
04/06	144.	Lay out and cut cabriole legs, given a bandsaw, a piece of stock, a pattern, and a drawing.	Bandsawed cabriole legs.	Pattern lines showing. Smooth bandsaw cuts.	Lay out cabriole legs. Bandsaw cuts.
04/06	145.	Lay out and cut a flat miter, given a bandsaw, a piece of stock a pattern, and a drawing.	Stock with miter cuts.	Pattern lines showing. Smooth bandsaw cuts.	Lay out miter cuts. Bandsaw miter cuts.
04/06	146.	Lay out and cut diagonals for turning, given a bandsaw, a piece of stock, a pattern, and a drawing.	Stock with ends cut diagonally.	Depth of cuts. Accuracy of cuts.	Bandsaw ends of stock corner to corner.
04/06	147.	Set up and resaw a piece of stock, given a bandsaw, a piece of stock, jigs, and a drawing.	Resawed pieces of stock.	Jig set up. Size of stock after resawed.	Set up jig for resawing.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/06	148.	Replace bandsaw blade and make adjustments, given a bandsaw and a blade of desired size.	Replaced bandsaw blade ready for cutting.	Guides adjusted properly. Blade tension.	Place blade on wheels. Adjust guide wheel and block jaws, adjust tension.
04/06	149.	Remove bandsaw marks from a board with convexed cuts.	A board with smooth scalloped cuts.	Smoothness of curves. Cuts to size or to line.	Sand curves against rotation of sander.
04/06	150.	Remove bandsaw marks from a board with scalloped cuts.	A board with smooth scalloped cuts.	Smoothness of curves. Cuts to size or to line.	Sand curves against rotation of sander.
04/06	151.	Remove bandsaw marks from a board with arc cuts.	A board with smooth arc cuts.	Smoothness of curves. Cuts.	Sand curves against rotation of sander.
04/08	152.	Set up machine and cut a stub mortise, given a mortising machine, a piece of stock, tools, C-clamps, stop, and jigs.	A piece of stock with a stub mortise.	Location of mortise. Size of mortise. Depth.	Set up mortiser. Cut stub mortise.
04/11	153.	Set up machine and cut an angle mortise, given a mortising machine, a piece of stock, tools, C-clamps, a stop, and jigs.	A piece of stock with an angle mortise.	Location of mortise. Size of mortise. Depth and angle accuracy.	Set up mortiser. Cut angle mortise.
04/11	154.	Set up machine and cut a haunched mortise, given a mortising machine, a piece of stock, tools, C-clamps, stop, and jigs.	A piece of stock with a haunched mortise.	Location of mortise. Size of mortise. Depth of each.	Set up mortiser. Cut haunched mortise.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/11	155.	Set up machine and cut a through mortise, given a mortising machine, a piece of stock, tools, C-clamps, stop, and jigs.	A piece of stock with a through mortise.	Location of mortise. Size of mortise. Condition of both sides.	Set up mortiser. Cut a through mortise.
04/12	156.	Set up a tenoner for offset shoulder and cope sash rails, given a tenoner, coping heads, a piece of stock, try square, wrench, stops, and jigs.	A sash rail with coped and tenon ends.	Accuracy of cut and cope. Check style for fit.	Set up tenoner. Cut cope and tenon.
04/12	157.	Set up a tenoner for angle shoulder and cope rails, given a tenoner, coping heads, stock, bevel square, wrench, stops, and jigs.	A door rail with angle shoulder and cope cuts.	Accuracy of cut and cope, and angle cut. Check style for fit.	Set up tenoner. Cut cope and tenon.
04/12	158.	Set up a tenoner for square shoulder for frame mullions, given a tenoner, coping heads, a piece of stock, try square, wrench, stops, and jigs.	A frame mullion with square shoulder tenon.	Size of tenon cut. Size of finished tenon. Check in mortise.	Set up tenoner. Cut square shoulder tenon.
04/12	159.	Set up a tenoner for square shoulder and cope sash muntins, given a tenoner, coping heads, a piece of stock, try square, wrench, stops, and jigs.	A sash muntin with coped and tenon ends.	Accuracy of cut and cope. Check for fit.	Set up tenoner. Cut cope and tenon.

CODE (Block/Unit)	OBJECTIVE NO	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION
04/13	160.	Dress a grinding wheel and grind a blade, given a dull plane iron blade attachment, stone dresser, and a grinding wheel.	A ground plane blade.	Grinding wheel dressed flat and square to sides.	Dress grinding wheel. Grind plane blade.
04/13	161.	Dress a grinding wheel and grind a chisel, given a dull chisel blade attachment, stone dresser, and a grinding wheel.	A ground chisel.	Grinding wheel dressed flat and square to sides.	Dress grinding wheel. Grind chisel blade.
04/14	162.	Set up and drill holes in a piece of stock as per dimensions, given a drill press, bit, a piece of stock, and a gig for drilling a series of holes.	A piece of stock with a series of drilled holes.	Hole location. Size of holes. Depth of holes. Quality of holes.	Set up gig on drill press. Drill series of holes.
04/14	163.	Set up and drill holes in a piece of stock as per dimensions, given a drill press, bit, a piece of stock, and a setup for drilling a series of holes.	A piece of stock with a series of drilled holes.	Hole location. Size of holes. Depth of holes. Quality of holes.	Set up gig on drill press. Drill series of holes.
04/15	164.	Rough turn a piece of stock to diameter, and turn balusters as per sample, given a piece of stock, wood lathe, lathe tools, and a sample turning.	A turned baluster.	Size and shape of baluster matched with sample.	Set up lathe. Rough turn baluster. Cut out baluster.
04/15	165.	Rough turn a piece of stock to diameter, and turn balusters as per sample, given a piece of stock, wood lathe, lathe tools, and a drawing.	A turned baluster.	Size and shape of baluster matched with drawing.	Set up lathe. Roug turn baluster. Cut out baluster.

CODE (Block/Unit)	OBJECTIVE NO.	OBJECTIVE	FINAL PRODUCT	EVALUATION	OPERATION	
04/15	166.	Rough turn a piece of stock to diameter, and turn balusters as per pattern, given a piece of stock, wood lathe, lathe tools, and a pattern.	A turned baluster.	Size and shape of baluster matched with pattern.	Set up lathe. turn baluster. out baluster.	Rough Cut
04/15	167.	Rough turn a piece of stock to diameter, and turn spindles as per sample, given a piece of stock, wood lathe, lathe tools, and a sample turning.	A turned spindle.	Size and shape of spindle matched with sample.	Set up lathe. turn spindle. out spindle.	Rough Cut
04/15	168.	Rough turn a piece of stock to diameter, and turn spindles as per drawing, given a piece of stock, wood lathe, lathe tools, and a drawing.	A turned spindle.	Size and shape of spindle matched with drawing.	Set up lathe. turn spindle. out spindle.	Rough Cut
04/15	169.	Rough turn a piece of stock to diameter, and turn spindles as per pattern, given a piece of stock, a wood lathe, lathe tools, and a pattern.	A turned spindle.	Size and shape of spindle matched with pattern.	Set up lathe. turn spindle. out spindle.	Rough Cut

8. MATERIALS NEEDED TO TEST EACH OBJECTIVE

Objective Number	Materials Needed
1.	Ground plane iron, oilstone and oil.
2.	Ground chisel, oilstone and oil.
3.	Ground knife, oilstone and oil.
4.	Ground hand scraper, oilstone, oil, file and burnisher.
5.	Circular saw blade, circular saw machine and oilstone.
6.	3 pieces of 1" x 6" x 2', jointer, thickness planer.
7.	1 piece of 1 x 4 x 2', 2 pieces of 2 x 2 x 30". Try-square, zig zag rule, pencil, specs.
8.	2 pieces of 1" x 3" x 2', folding rule, combination square, pencil, specs.
9.	1 piece of 1" x 2" x 3', sketch of project, folding rule, combination square, pencil, straight edge.
10.	1 piece of 1" x 2 x 3', sketch of project, folding rule, Try square, pencil, straight edge.
11.	1 piece of 1" x 2" x 3', sketch of project, folding rule, steel square, pencil, straight edge.
12.	1 piece of 1" x 10" x 3', sketch of project, straight edge, folding rule, layout board, combination square, pencil.
13.	1 piece of 1" x 10" x 3', sketch of project, layout board, straight edge, try square, folding rule, pencil.
14.	1 piece of 1 x 10" x 3', sketch of project, layout board, straight edge, steel square, folding rule and pencil.
15.	1 piece of 1" x 10" x 3', sketch of project, strip template, straight edge, folding rule, steel square and pencil.
16.	1 piece of 1" x 6" x 12", 1/4 sheet of #0 sandpaper, 1/4 sheet of #2/0 sandpaper, sanding block.
17.	1 piece of 1" x 6" x 2', vibrator sander, sandpaper to fit vibrator sander #2/0.
18.	1 piece of 1" x 6" x 2', belt sander abrasive belt for sander #1/0.
19.	1 piece of 1" x 6" x 2', hand scraper.
20.	4 pieces of 1" x 4" x 12" hardwood, powdered glue, container to mix glue, glue brush, bar clamps.
21.	4 pieces of 2" x 12" x 12" hardwood, powdered glue, container to mix glue, glue brush, handscrew clamps.

Objective Number	Materials Needed
22.	3 pieces of 1" x 6" x 18", powdered glue, container to mix glue, glue brush, bar clamps.
23.	Stock for bookcase, white glue, clamping blocks, bar clamps, steelsquare, glue brush.
24.	Stock for bookcase, powdered glue, container to mix glue, clamping blocks, bar clamps, glue brush, steel square.
25.	Stock for arch leader, powdered glue, container to mix glue, glue brush, clamp blocks, pipe clamps.
26.	Stock for arch leader, glue brush, clamp blocks, white glue, pipe clamps.
27.	Stock for arch leader, hot glue in glue pot, glue brush, clamp blocks, pipe clamps.
28.	Stock for drawer case frame, white glue, glue brush, clamp blocks, bar clamps, steel square, folding rule.
29.	Stock for drawer case frame, hot glue in glue pot, glue brush, clamp blocks, bar clamps, steel square, folding rule.
30.	Stock for drawer case frame, powdered glue, glue brush, clamp blocks, bar clamps, steel square, folding rule.
31.	Stock for complete book case with grooves, shelf standards, shelf standard screw nails, fasteners, hammer, steel square, folding rule, hack saw, nail set.
32.	Stock for complete book case with grooves, shelf standards, shelf standard screw nails, finish nails, hammer, steel square, folding rule, hack saw, nail set.
33.	Stock for complete book case with grooves, shelf standards, shelf standard screw nails, flat head wood screws, screw driver, hand drill and drill bet hammer, steel square, folding rule, hack saw, nail set.
34.	Stock for complete cabinet case with grooves, shelf standards, screw nails, fasteners, hammer, steel square, folding rule, hack saw, nail set.
35.	Stock for complete cabinet case with grooves, shelf standards, screw nails, finish nails, hammer, steel square, folding rule, hack saw, nail set.
36.	Stock for complete cabinet case with grooves, shelf standards, screw nails, flat head wood screws, screw driver, hand drill and twist drill hammer, steel square, folding rule, hack saw, nail set.

Objective Number	Materials Needed
37.	Stock for complete chest, fasteners, hammer, steel square, folding rule, nail set.
38.	Stock for complete chest, finish nails, hammer, steel square, folding rule, nail set.
39.	Stock for complete chest, flat head wood screws, hand drill and twist drill, screw driver, hammer, steel square, folding rule.
40.	1 piece of 1 x 6 x 2' with concave cuts, wood file, sandpaper.
41.	2 pieces 1" x 4" x 2' nailed together with finish nails to form L hammer, nail set.
42.	1 piece of 1" x 6" x 2' with concave cuts, wood file and sandpaper.
43.	2 pieces 1" x 2" x 1' with one end mitered to 45° white glue, miter vise.
44.	Drop leaf table top with 2 drop leafs, drop leaf hinges, combination square, folding rule, chisel, pencil, screw driver, specs, and hammer.
45.	Drop leaf table top with 2 drop leafs, drop leaf hinges, try square, folding rule, chisel, specs, pencil, screw driver, and hammer.
46.	Drop leaf table top with 2 drop leafs, drop leaf hinges, steel square, folding rule, chisel, specs, pencil, screw driver and hammer.
47.	1 door, butt hinges, hinge screws, combination square, drawing for hinge location, chisel, butt gauge, screw driver and hammer.
48.	1 door, butt hinges, hinge screws, try square, drawing for hinge location, chisel, screw driver, butt gauge and hammer.
49.	1 door, butt hinges, hinge screws, steel square, drawing for hinge location, chisel, screwdriver, butt gauge, and hammer.
50.	Specs for a project, 1 piece of 1 x 6 x 2', folding rule, combination square, and pencil.
51.	Specs for a project, 1 piece of 1" x 6" x 2' folding rule, try square and pencil.
52.	Specs for a project, 1 piece of 1" x 6" x 2' folding rule, steel square, and pencil.

Objective Number	Materials Needed
53.	Specs for a project, 1 piece of 1" x 6" x 2' steel tape, combination square, and pencil.
54.	Specs for a project, 1 piece of 1" x 6" x 2' steel tape, try square, and pencil.
55.	Specs for a project, 1 piece of 1" x 6" x 2' steel tape, steel square, and pencil.
56.	Specs for a project, 1 piece of 1" x 6" x 2', zig-zag rule, combination square and pencil.
57.	Specs for a project, 1 piece of 1" x 6" x 2' zig-zag rule, try square and pencil.
58.	Specs for a project, 1 piece of 1" x 6" x 2' zig-zag rule, steel square and pencil.
59.	1 piece of 1" x 6" x 2' with one edge straight and square, try square and pencil.
60.	1 piece of 1" x 6" x 2' with one edge straight and square, try square, pencil and specs.
61.	1 piece of 1" x 6" x 2' with one edge straight and square, combination square, and pencil.
62.	1 piece of 1" x 6" x 2' with one edge straight and square, combination square, pencil and specs.
63.	1 piece of 1" x 6" x 2' with one edge straight and square, steel square and pencil.
64.	1 piece of 1" x 6" x 2' with one edge straight and square, steel square, pencil and specs.
65.	1 piece of 1" x 4" x 1', and try square.
66.	Any vertical surface and level.
67.	Any flat surface and level.
68.	1 milled piece of 1" x 4" x 1' and try square.
69.	1 milled piece of 1" x 8" x 1' and try square.
70.	1 milled piece of 1" x 4" x 1" and steel square.
71.	1 milled piece of 1" x 12" x 2' and steel square.
72.	Any project that is assembled, blueprint, steel square, and folding rule.

Objective Number	Materials Needed
73.	1 drawer case frame, blueprint, rule and steel square.
74.	1 assembled chest, blueprint, rule and steel square.
75.	1 assembled book case, blueprint, folding rule, and steel square.
76.	1 completed table, blueprint, folding rule and steel square.
77.	1 assembled drawer ease frame, blueprint, folding rule, and try square.
78.	1 assembled chest, blueprint, folding rule and try square.
79.	1 assembled table, blueprint, folding rule, and try square.
80.	1 assembled frame, blueprint, folding rule and combination square.
81.	1 assembled chest, blueprint, folding rule and combination square.
82.	1 assembled bookcase, blueprint, folding rule and combination square.
83.	1 assembled table, blueprint, folding rule and combination square.
84.	1 piece of 1" x 6" x 2', crosscut saw, square and pencil.
85.	1 piece of 1" x 6" x 2', specs, crosscut saw, square and pencil.
86.	1 piece of 1" x 6" x 2', specs, marking gauge, and ripsaw.
87.	1 piece of 1" x 2" x 12", specs, and miter box.
88.	1 piece of 1" x 2" x 2', specs, and miter box.
89.	1 piece of 1" x 6" x 1', try square and hand plane.
90.	1 piece of 1" x 4" x 1', specs, hand plane and level square.
91.	1 piece of 1" x 6" x 1', specs, hand plane and level square.
92.	1 piece of 1" x 3" x 1', specs, combination square, pencil and hand plane.
93.	1 piece of 1" x 6" x 1', specs, combination square, level square, pencil and hand plane.
94.	1 piece of 1" x 4" x 1', specs, hand plane and level square.

Number	Materials Needed
95.	1 piece of 1" x 6" x 1', specs, try square, pencil and hand plane.
96.	1 piece of 1" x 4" x 1', specs, folding rule, pencil, hand drill, and twist drill.
97.	1 piece of 1" x 4" x 6", specs, folding rule, pencil, bit brace and auger bit.
98.	1 piece of 1" x 4" x 1', specs, folding rule, pencil, hand electric drill and twist drill.
99.	1 piece of 1" x 4" x 1', specs, hand electric drill and counter sink.
100.	1 piece of 1" x 4" x 1', specs, folding rule, pencil, drill press and twist drill.
101.	1 piece of 1" x 4" x 1', specs, drill press and countersink.
102.	1 piece of 1" x 4" x 1', specs, folding rule, pencil, boring machine and counterbore.
103.	1 assembled table frame and table top, corner blocks, hand drill, twist drills, glue, handscrew clamps, screws, screw driver and folding rule.
104.	1 piece of 1" x 6" x 12", folding rule and hand plane.
105.	1 piece of 1" x 6" x 12", folding rule and hand scraper.
106.	1 piece of 1" x 6" x 12", folding rule and cabinet scraper.
107.	1 piece of 1" x 6" x 12", specs, folding rule, wise and smooth plane.
108.	1 piece of 1" x 4" x 12", specs, vise and smooth plane.
109.	1 piece of 1" x 4" x 2', specs, folding rule, vise and jack plane.
110.	1 piece of 1" x 6" x 18", specs, folding rule, vise and jack plane.
111.	1 piece of 1" x 6" x 18", specs, folding rule, pencil, vise, try square and jack plane.
112.	1 piece of 1" x 4" x 2', specs, folding rule, pencil, vise, and jack plane.
113.	1 piece of 1" x 6" x 18", specs, folding rule, vise and jointer plane.

Objective Number	Materials Needed
114.	1 piece of 1" x 4" x 2', specs, folding rule, try square, vise and jointer plane.
115.	1 piece of 1" x 4" x 18", specs, folding rule, pencil, vise and jointer plane.
116.	1 piece of 1" x 6" x 2', specs, try square, folding rule, vise and fore plane.
117.	1 piece of 1" x 4" x 3', specs, folding rule, try square, vise and fore plane.
118.	1 piece of 1" x 4" x 3', specs, folding rule, vise and fore plane.
119.	1 piece of 1" x 2" x 2', drawing of molding, portable router, router molding cutters, wrenches and jig.
120.	1 plastic laminated top, portable router, laminate trimmer cutter, and wrenches.
121.	1 plastic laminated backsplash, portable router, laminate trimmer cutter, and wrenches.
122.	1 completed frame, portable router, straight cutter, wrenches, router gig with fence and folding rule.
123.	1 piece of 1" x 6" x 2', portable router, router cutter, wrenches, folding rule and router jig with fence.
124.	1 piece of 1" x 4" x 2', portable router, cove cutter, wrenches, and jig with fence.
125.	1 piece of 1" x 4" x 2', specs, jointer machine, C-clamps, stop blocks, puch stick and folding rule.
126.	1 piece of 1" x 6" x 2', jointer machine, and push stick.
127.	1 piece of 1" x 6" x 2' and jointer.
128.	2 pieces of 1" x 6" x 2' and jointer.
129.	1 piece of 1" x 8" x 1' and jointer.
130.	4 pieces of veneer stock, jointer and hand screw clamps.
131.	1 piece of 1" x 4" x 2' and a jointer.
132.	1 piece of 1" x 4" x 2' and a jointer.
133.	1 piece of 1" x 6" x 1' and a jointer.
134.	2 sides of a bookcase, folding rule, circular saw, and dado head.

Objective Number	Materials Needed
135.	2 pieces of stock for a cabinet, folding rule, circular saw and dado head.
136.	Stock for a chest, radial arm saw, dado head, and folding rule.
137.	Stock for sides of a hutch, overhead router, straight cutter and folding rule.
138.	Thickness planer, straight edge, cleaning fluid, rags and wrenches.
139.	2 pieces of 1' x 6' x 2', stock list, thickness planner and folding rule.
140.	4 pieces of 1/2" x 3" x 3', stock list, thickness, hand screw clamps and folding rule.
141.	1 piece of 1" x 6" x 3', pattern template, pencil, bandsaw, and drawing of scallop.
142.	2 pieces of 3/4 x 10" x 12", compass and drawing of project.
143.	2 pieces of 3/4" x 8" x 4', pattern and drawing of project, bandsaw and pencil.
144.	4 pieces of 2" x 3" x 30", pattern and drawing of project, bandsaw and pencil.
145.	2 pieces of 1" x 2" x 2', drawing, bandsaw, and pencil.
146.	2 pieces of 2" x 2" x 2', drawing of project, and bandsaw.
147.	2 pieces of 1" x 3" x 2', wood fence, C-clamps, drawing of project and bandsaw.
148.	Band saw and band saw blade.
149.	A board with convexed cuts and a spindle sander.
150.	A board with scalloped cuts and a spindle sander.
151.	A board with arc cuts and a spindle sander.
152.	1 piece of 2" x 2" x 2', mortising machine, C-clamps, stop blocks, wrenches and folding rule.
153.	1 piece of 2" x 2" x 2', mortising machine, C-clamps, stop blocks, wrenches and folding rule.
154.	1 piece of 2" x 2" x 2', mortising machine, C-clamps, stop blocks, wrenches and folding rules.

Objective Number	Materials Needed
155.	1 piece of 2" x 2" x 2', mortising machine, C-clamps, stop blocks, wrenches and folding rule.
156.	1 piece of 1" x 2" x 2', tennoner and coper, coping heads, wrenches, stop blocks, try square, and folding rule.
157.	1 piece of 1" x 2" x 2', tennoner and coper, coping heads, wrenches, stop blocks, level square and folding rule.
158.	4 pieces of 1" x 2" x 2', tennoner and coper, coping head, wrenches, stop blocks, try square and folding rule.
159.	4 pieces of 1" x 1" x 12", tennonver and coper, coping head, wrenches, stop blocks, try square and folding rule.
160.	Grinding machine, stone dresser, grinding attachment and plane iron blade.
161.	Grinding machine, stone dresser, grinding attachment and chisel.
162.	1 piece of 1" x 4" x 12", drill press, machine bit, try square, folding rule, pencil, and gig for drilling holes.
163.	1 piece of 1" x 4" x 2', drill press, machine bit, try square, folding rule, pencil and set up for drilling a series of holes.
164.	1 piece of 2" x 2" x 2', wood lathe, lathe cutting tools, sample turning, folding rule, pencil and outside calipers.
165.	1 piece of 2" x 2" x 3', wood lathe, lathe cutting tools, baluster drawing, folding rule, pencil and outside calipers.
166.	1 piece of 2" x 2" x 3' wood lathe, lathe cutting tools, pattern of baluster, folding rule, pencil, and outside calipers.
167.	4 pieces of 1 1/4" x 1 1/4" x 30", wood lathe, lathe cutting tools, sample turning, folding rule, pencil, and outside calipers.
168.	1 piece of 2" x 2" x 2', wood lathe, lathe cutting tools, drawing of spindle folding rule, pencil and outside calipers.
169.	1 piece of 2" x 2" x 2', wood lathe lathe cutting tools, pattern of spindle, folding rule, pencil, and outside calipers.

9. REFERENCES

Atkinson, R. C. Computer-based instruction in initial reading. In Proceedings of the 1967 Invitational Conference on Testing Problems. Princeton, N.J.: Educational Testing Service, 1968.

Block, J. H. Criterion-referenced measurements: Potential. School Review, 1971, 69, 289-298.

Bloom, B. S. Learning for mastery. Evaluation Comment, 1968, 1(2).

Bormuth, J. R. On the theory of achievement test items. Chicago: University of Chicago Press, 1970.

Boyd, J. L. Jr., & Shimberg, B. Handbook of performance testing: A practical guide for test makers. Princeton, N.J.: Educational Testing Service, 1971.

Carroll, J. E. A model of school learning. Teachers College Record, 1963, 64, 723-733.

Cox, R. C. Item selection techniques and evaluation of instructional objectives. Journal of Educational Measurement, 1965, 2, 181-185.

Cronbach, L. J. How can instruction be adapted to individual differences? In R. M. Gagné (Ed.), Learning and individual differences. Columbus, Ohio: Merrill Books, 1967.

Cronbach, L. J. Validation of educational measures. In Proceedings of the 1969 Invitational Conference on Testing Problems. Princeton, N.J.: Educational Testing Service, 1970.

Cronbach, L. J., & Gleser, G. C. Psychological tests and personnel decisions. (2nd ed.) Urbana, Ill.: University of Illinois Press, 1968.

Flanagan, J. C. Functional education for the seventies. Phi Delta Kappan, 1967, 49, 27-32.

Glaser, R. Instructional technology and the measurement of learning outcomes. American Psychologist, 1963, 18, 519-521.

Glaser, R. Adapting the elementary school curriculum to individual performance. In Proceedings of the 1967 Invitational Conference on Testing Problems. Princeton, N.J.: Educational Testing Service, 1968.

Glaser, R., & Nitko, A. J. Measurement in learning and instruction. In R. L. Thorndike (Ed.), Educational measurement. Washington, D.C.: American Council on Education, 1971.

Gronlund, N. E. Measurement and evaluation in teaching. (2nd ed.) New York: The MacMillan Co., 1971.

Hambleton, R. K., & Gorth, W. P. Criterion-referenced testing: Issues and applications. Center for Educational Research Technical Report #13, School of Education, University of Massachusetts, Amherst, 1971.

Hambleton, R. K., Gorth, W. P., & O'Reilly, R. P. A formative evaluation model for classroom instruction. Center for Educational Research Technical Report #16, School of Education, University of Massachusetts, Amherst, 1972.

Hambleton, R. K., & Novick, M. R. Toward an integration of theory and method for criterion-referenced tests. American College Testing Technical Report, Iowa City, 1972, in press.

Ivens, S. H. An investigation of item analysis, reliability and validity in relation to criterion-referenced tests. Unpublished doctoral dissertation, Florida State University, 1970.

Kriewall, T. E. Applications of information theory and acceptance sampling principles to the management of mathematics instruction. Unpublished doctoral dissertation, University of Wisconsin, 1969.

Lord, F. M. Estimating norms by item-sampling. Educational and Psychological Measurement, 1962, 22, 259-267.

Lord, F. M. Some test theory for tailored testing. In W. Holtzman (Ed.), Computer-assisted instruction, testing, and guidance. New York: Harper and Row, 1970.

Lord, F. M., & Novick, M. R. Statistical theories of mental test scores. Reading, Mass.: Addison-Wesley, 1968.

O'Reilly, R. B., & Hambleton, R. K. A CMI model for an individualized learning program in ninth grade science. Center for Educational Research Technical Report #14, School of Education, University of Massachusetts, Amherst, 1971.

Popham, W. J., & Husek, T. R. Implications of criterion-referenced measurement. Journal of Educational Measurement, 1969, 6, 1-9.

APPENDIX A

PRETEST MATERIALS

Two Sample Tests and Evaluation Sheets
Constructed from the Objective and Test Item Bank

Name: ____________________

WOODWORKING PERFORMANCE TEST
I

Evaluation

1. Sharpen a plane iron with a ground plane, iron, oilstone and oil. ○
2. Sharpen a chisel with a ground chisel, oilstone and oil. ○
3. Sand a piece of stock with stock for the project, sandpaper and a block. ○
4. Remove the saw marks on concave cuts with milled boards with concave cuts, a file and sandpaper. ○
5. Measure and mark a piece of stock with a bench rule, pencil, try square, stock and specifications. ○
6. Measure and mark a piece of stock with a zig-zag rule, pencil, try square, stock and specifications. ○
7. Square one end of a board to remove bad end with a try square. ○
8. Cross cut two ends and remove checks with stock, cross cut saw, square, and dimensions. ○
9. Chamfer on the end to specifications with stock, specifications, combination square and hand plane. ○
10. Square off one end to specifications given stock specifications, try square, and hand plane. ○
11. Select correct size bit and bore holes to specifications given hand drill, drills, lumber and specifications. ○
12. Select correct size drill and drill a hole to specifications given an electric drill, drills, lumber and specifications. ○
13. Select correct size countersink and countersink a hole to specifications given a drill press, countersink, lumber and specifications. ○
14. Plane a piece of stock to specified thickness with a piece of stock, smooth plane, vise and specifications. ○
15. Joint a piece of stock to specifications given stock, jack plane, square, vise, and specifications. ○

16. Joint edge for gluing of stock given jointer and a piece of stock

17. Bevel edge of stock given jointer and a piece of stock.

18. Rabbet edge of stock given jointer and stock.

19. Plane stock to width, given thickness planer, stock list, stock and hand screw clamp.

20. Lay out and cut diagonals for turning given bandsaw, stock pattern and drawing.

21. Replace bandsaw blade and make adjustments given bandsaw and blade of desired size.

22. Remove bandsaw marks from a board with convexed cuts.

23. Remove bandsaw marks from a board with scalloped cuts.

24. Dress grinding wheel and grind blade given a dull plane iron blade attachment, stone dresser and grinding wheel.

25. Dress grinding wheel and grind chisel given a dull chisel blade attachment, stone dresser and grinding wheel.

26. Determine if a surface is flat, using a spirit level given a surface and level.

27. Determine if a surface is flat, using a steel square, given parts of a job and steel square.

BEST COPY AVAILABLE

WOODWORKING PERFORMANCE TEST

I.
Evaluation

1. Cutting edge is razor sharp and bevel is flat (not rounded).
2. Cutting edge is razor sharp and bevel is flat (not rounded).
3. Sanding is with the grain. No sandpaper marks should be seen and the thickness should be uniform.
4. All saw and sandpaper marks should be removed, leaving a uniform concave cut.
5. The measured lines on the stock should be accurate.
6. The measured lines on the stock should be accurate.
7. The squared line should be accurate.
8. All checks should have been cut off square and the length of the board should be accurate to within $\pm$ 1/16".
9. The miter should be planed exactly.
10. End should be square, smooth and to size.
11. The holes should be the correct size, in the correct location and with the correct angle to a clean surface.
12. The holes should be the correct size, in the correct location and with the correct angle to a clean surface.
13. Drill press should have been set up correctly with a correct depth and size countersunk hole resulting.
14. The stock should be planed flat and straight to the [illegible]
15. The stock should be planed straight and square to [illegible]
16. The [illegible] should be accurate and the edges [illegible] form a spring joint straight and square.
17. The [illegible] have been set up correctly to [illegible] bevel [illegible] the stock.
18. The [illegible] have been set up correctly to [illegible] size rabbet.

19. The stock should be clamped correctly and the size of the finished stock should be accurate.

20. Cuts should be accurate and of the correct depth.

21. The guides should be adjusted properly with the correct tension.

22. The cuts and curves should be smooth and to size or to line.

23. The cuts and curves should be smooth and to size or to line.

24. Grinding wheel should be dressed flat and square to sides of wheel with the ground plane iron having the correct angle.

25. Grinding wheel should be dressed flat and square to sides of wheel and the ground chisel blade should have the correct angle.

26. Student should correctly determine if material is flat or not.

27. Student should correctly determine if surface is square with edge or not.

Name: ____________________

WOODWORKING PERFORMANCE TEST
II

Evaluation

1. Sharpen a scraper with a ground hand scraper, oilstone, oil file, and burnisher. ○
2. Sand a piece of stock with stock for the project, sandpaper and a vibrator sander. ○
3. Sand a piece of stock with stock for the project, sandpaper belts and a belt sander. ○
4. Set nails given nailed milled boards and tools. ○
5. Measure and mark a piece of stock with a bench rule. ○
6. Square both ends of a board to cut to length with a try square, board with straight edge and a pencil. ○
7. Square both ends of a board to cut to length with a combination square. ○
8. Rip edge of a piece of stock given stock, marking gage, hand ripsaw, and dimensions. ○
9. Chamfer to specifications given stock, specifications, level square and hand plane. ○
10. Select correct size drill and drill holes to specification given hand drill, drills, lumber and specifications. ○
11. Select correct size bit and bore holes to specification with a bit brace, bits, lumber and specifications. ○
12. Select correct size drill and drill holes to specification with a drill press, drills, lumber and specifications. ○
13. Select correct size drill and counterbore holes to specification with a boring machine, counter bore, lumber and specifications. ○
14. Joint a piece of stock to specifications given stock, smooth plane, square, vice and specifications. ○
15. Taper a piece of stock to specifications given stock, hand plane, vice and specifications. ○

16. Taper sides of stock to specifications given jointer, stock, C-clamps, stop and push stick and specifications.

17. Joint best edge of a piece of stock give jointer and a piece of stock.

18. Joint the ends of stock given jointer and a piece of stock.

19. Plane stock to thickness with thickness planer, stock list and stock.

20. Lay out and cut scallops given a bandsaw, stocks, pattern and drawing.

21. Set up and resaw stock given bandsaw, stock, jigs and drawing.

22. Remove bandsaw marks from a board with arc cuts.

23. Set up and drill holes in stock as per dimensions given drill press, bit, stock and gig for drilling series of holes.

24. Rough turn stock to diameter and turn balusters as per sample given stock, wood lathe, lathe tools and sample turning.

25. Dress grinding wheel and grind chisel given a dull chisel blade attachment, stone dresser and grinding wheel.

26. Determine if an edge is square using a try square given part of a job and try square.

27. Determine if an edge is square using a steel square given part of a job and a steel square.

WOODWORKING PERFORMANCE TEST

II.
Evaluation Sheet

1. The scraper cutting edge should have a uniform hooked edge and be sharp. Trial scrape should leave no marks.

2. Sanding should be done with the grain with no sandpaper marks showing. Also the thickness of the stock should be uniform.

3. Sanding should be done with the grain with no sandpaper marks showing. Also the thickness of the stock should be uniform.

4. Student should use correct nailset and the depth of the set nail should be consistent with the thickness of the stock.

5. The measured lines should be accurate.

6. The squared line should be accurate and the length should be accurate.

7. The squared line should be accurate and the length should be accurate.

8. The edge of the stock should be ripped parallel and the width of the board should be within ± 1/16".

9. The chamfer should be straight, to size with an accurate bevel. Also cut should be smooth.

10. The holes should be of the correct size, location, and angle to a <u>clean</u> surface.

11. The holes should be of the correct size, location, and angle to a <u>clean</u> surface.

12. The holes should be of the correct size, location, and angle to a <u>clean</u> surface.

13. The boring machines should be set up correctly, with the correct size of counterbored hole.

14. The stock should be planed straight and square to the correct width.

15. The taper should be correct.

16. Jointer should be correctly set up and the taper should be to specifications.

17. The cut should be of the correct depth with the edge of the stock straight and square to face.

18. The cut should [illegible] square. The [illegible] should not be split out.

19. The procedure of the operation should be correct, ending up [illegible] the correct size stock.

20. Pattern lines showing with smooth bandsaw cuts.

21. Jig setup should be correct. Size of stock should be correct.

22. The curves and cuts should be smooth.

23. The size, location, and depth of hole ~~should be accurate~~. [illegible] cuts should be clean.

24. The size and shape of baluster should be matched with sample.

25. The grinding wheel should be dressed flat and square to side of sheel and the angle of the ground plane iron should be correct.

26. The squared line should be accurate.

27. The squared line should be accurate.

APPENDIX B

BLOCK AND UNIT BREAKDOWN

EVALUATION SERVICE CENTER FOR OCCUPATIONAL EDUCATION

Block and Unit Break

Cabinetmaking and Millwork

Code	Block	Code	Unit
01	Bench Work		
		01	Maintenance
		02	Layout
		03	Sanding
		04	Glueing
		05	Assembling
		06	Forming
		07	Finishing
		08	Cutting
		09	Fitting
		10	Lamination
02	Hand Tools		
		01	Measuring Tools
		02	Layout Tools
		03	Testing Tools
		04	Rafter & Framing Square
		05	Sawing Tools
		06	Clamps
		07	Edge Cutting Tools
		08	Boring Tools
		09	Fastening Tools
		10	Smoothing Tools
		11	Lathe Tools
		12	Planes
03	Power Hand Tools		
		01	Circular Saw
		02	Reciprocating Saw
		03	Drill
		04	Plane
		05	Router
		06	Floor Sanders
		07	Belt Sanders
		08	Nailing Machines
		09	Disc Sanders
		10	Finishing Sanders
04	Machinery		
		01	Jointer
		02	Circular Saw
		03	Thickness Planer
		04	Radial Arm Saw
		05	Scroll Saw
		06	Band Saw
		07	Belt Sanders
		08	Spindle Sander
		09	Disc Sander
		10	Shaper

EVALUATION SERVICE CENTER FOR OCCUPATIONAL EDUCATION

Block and Unit Breakdown

Cabinetmaking and Millwork (cont'd) [illegible]

Code	Block	Code	Unit
04	Machinery (con't)		
		11	Mortiser
		12	Coper-Tenoner
		13	Grinder
		14	Drill Press
		15	Lathe
		16	Router
		17	Drum Sanders
		18	Multi-operations
		19	Boring Machines
05	Related Science		
		01	Safety
		02	Hand Tools
		03	Power Tools (Hand)
		04	Machinery
		05	Materials
		06	Fasteners
		07	Hardware
		08	Woods
		09	Orientation
		10	Construction Procedures
06	Related Mathematics		
		01	Square Measure
		02	Board Measure
		03	Cubic Measure
		04	Plane Geometry
		05	Percentage
		06	Costs
07	Related Drawing		
		01	Orthographic Projection
		02	Pictorial Drawing
		03	House Plans
		04	Blue Print Reading
08	Projects		
		01	Door
		02	Cabinet
		03	Table
		04	Mantel
		05	Mill Stock
		06	Plastic Laminate
		07	Template
		08	Cleanup & Safety
		09	Stocklist