Development of Nationally Normed Engineering Graphics Concepts and Skills Tests

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Abstract

At the 2001 ASEE Annual Conference a paper was presented proposing a nationally normed test for engineering graphics. This test would be used to provide diagnostics to determine what students know when they enter college and could be used at the beginning and end of an introductory graphics course or set of courses to determine what has been learned. Such a test would allow faculty to determine the effectiveness of pedagogical changes. At the 2001 ASEE Annual Conference in Albuquerque and the subsequent Engineering Design Graphics MidYear meeting in Berkeley, two discussions were held. The results of these discussions indicated that there should be two tests. The first would be a multiple-choice test like the one developed by Sorby that could be available on the Web. The second would be one that would assess knowledge and skill in engineering graphics using taxonomy appropriate for Engineering Graphics. During the time between now and the Annual meeting two tests will be constructed and shared with the members of the EDG Division. Discussion at the 2002 ASEE meeting will be focused on getting the two tests into production for evaluation at different schools.

Introduction

In a paper presented at the 2001 ASEE meeting in Albuquerque we proposed that the Engineering Graphics discipline needed to a nationally normed test to determine skill and knowledge before and after taking graphics courses[1]. The Division currently has a test for visualization called the Purdue Spatial Visualization Test: Rotation[2]. This new test would a test similar to the multiple choice test developed by Sorby[3] but would contain problems that required students to demonstrate skill and not just knowledge. The presentation and discussion at the 2001 Annual Conference and subsequent discussion indicated that there should be two tests. The first would be a multiple-choice test to be used as a placement test and pre- and post-test for educational research and development. The second test would provide an analysis of skills and knowledge at a higher level. As this set of tests is being discussed and developed, Clark and Scales have proposed that the field of Engineering Graphics needs its own taxonomy[4]. Bloom's Taxonomy[5] is well known for determining levels of knowledge but it does not fit the Engineering Graphics field very well. During the discussion at these two meetings there was general agreement about the list of topics that needed to be covered as proposed by Crittenden[6], Barr[7], and Meyers[8] and the work done by Clark and Scales[4].

Developments

Following the discussion in Albuquerque, it was obvious that two different types of tests were needed. One should be a diagnostic test like the one developed by Sorby and one should measure skill and knowledge level. At both the 2001 ASEE Annual Conference and again at the EDGD MidYear Meeting, there was general agreement on the topics that needed to be covered by these tests. Table 1 listing the graphics topics from our paper at Albuquerque is given below.

TABLE 1: TOPICS FOR TESTING COMPETENCE

CRITTENDEN	BARR	MEYERS	INDUSTRY	*KNOWLEDGE*	*APPLICATION*
Descriptive Geometry	2.25/5	5/13	NR		
Developments	NR	NR	NR		
Dimensioning	3.63	12/13	3.1/5	X	X
Drafting Skills	1.81	4/13	NR		
Geometric Construction	2.25*	NR	NR		
Geometry	2.25*	5/13	NR		
Graphing	2.63	6/13	NR	X	X
Intersections	2.25*	6/13*	NR		
Kinematics	NR	NR	NR		
Lettering	1.75	NR	NR		
Mathematics	2.7-2.8	5/13	2.5		
O. P. Theory	3.69	12/13	NR	X	X
Reading Drawings	NR	10/13	3.9	X	
Scales	NR	NR	NR	X	
Sectional Views	3.50	12/13	3.1	X	X
Sketching	4.38	13/13	3.4		X
Software Use	4.4*	13/13	3.1		X
Solid Modeling	4.4	13/13	3.1		X
Threads & Fasteners	3.00	5/13	NR	X	
Tolerances	3.00	6/13	2.7	X	X
Visualization	5.00	12/13	3.6		X

NR - Not Rated in this study * Not rated by this nomenclature - rating for similar topic supplied

At the MidYear Meeting, it became apparent that to measure skill and knowledge levels really requires taxonomy suitable for Engineering Graphics. Clark and Scales are in the process of doing this task.

Both Sorby's test and a draft test were circulated during the session at the MidYear Meeting so that the discussion participants had test to study and consider. One interesting development was the discovery that Tom Krueger from University of Texas at Austin had developed a test similar to the Sorby test and had used item analysis to validate the test. There are 100 items on that test. Assuming that Sorby's test could be combined with Krueger's test there would 150 questions of which 50 could be selected by a Web based program for national testing. Follow-up with Sorby and Krueger will be part of the development activities during the next six months.

During the discussion, the following comments were made: Please note that these comments paraphrased from notes taken at the two meetings.

Aaron Clark – we cannot have a discipline without a Taxonomy
Sheryl Sorby – through item analysis her test has been validated. Pre- and post-test scores at Michigan Tech and RPI seem to be consistent.
Jon Duff – we do need a test that can provide a graphics diagnostic for a person. We need to know how a person thinks about geometry
Larry Goss – the dimensioning problem on the draft skills test is overkill
Ron Barr – we should not be focused on manual drawings but should be looking at how well students can visualize and create 3D models.
Doug Baxter – if graphics is integrated across the curriculum when should you give a pre- and post-test and a knowledge/skills test?

Development Work

Assuming that the Krueger test is available and that we can combine it with the Sorby test to create a bank of test questions, we will explore creation of a Web site that could randomly pick 45 – 50 questions to be used as a pre- and post-test. The questions would be put into electronic form and would be checked against the current ANSI standards.

Additional work will be done on questions for the skills/knowledge test. These will developed so that there are sets of multiple choice or true-false (with a list of reasons) questions to go with drawings that contain both correct and incorrect features. For each problem that is put into a multiple choice or true-false format, there will be problem that could be drawn / modeled on CADD or paper.

As drafts are prepared they will be circulated to EDGD Division volunteers who agree to take the test and develop an answer key. These tests and answer keys will be collected and the summary of the collection of answers will be presented at the 2002 ASEE Annual Conference.

Conclusions

There seems to be a consensus of those EDGD members that reliable tests are needed for measuring gains in knowledge and skills. One would be used for pre- and post-tests for introductory graphics courses so that education research and development can be done against a national norm. This has proved valuable to Physics and other disciplines. The second one would measure skills and knowledge at the end of a period of instruction and could potentially provide a diagnostic for professionals on strengths and weaknesses. There is concern that we need to devise a strategy that allows such tests to grow and change as advances in technology change that ways that people work.

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