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Assessment of Computerized Placement Test for College Mathematics at Baltimore City Community College

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Abstract

Today's college ACCUPLACER System's Computerized Placement Test (CPT) plays a major role for determining whether post-secondary students are ready for placement into Arithmetic, Elementary Algebra, Intermediate Algebra, or College Mathematics courses. It is widely used in most college systems in the U.S. This paper discusses some of the issues to be addressed about the assessment and evaluation of CPT such as analyzing the reliability of the test scores and evaluating the validity of CPT. The results of this study suggest that the reliability (or correlation) between Arithmetic and Elementary Algebra test scores is less than Elementary Algebra and College Mathematics test scores.

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Introduction

The ACCUPLACER System, which has been on the market since 1986 with growing users, is designed to provide placement and advising information for students entering college. It includes a Computerized Placement Test (CPT) which is a self-paced, un-timed test given on a personal computer. This testing is an adaptive assessment test customized for each student. Subsequent test questions are based upon responses to previous questions. The first question in a particular test is of average difficulty, and is chosen randomly from several "starter" questions of the same level of difficulty. This provides a more accurate method of measuring an individual student's skill levels than a general test. It also means that no two tests taken are precisely the same. The students will be able to know their result after testing session. Students' scores will determine which courses they are eligible to take (College Board, 1997).

The advantages of the CPT are the following: (a) it is the only computer adaptive placement test delivered over the Internet to give students course placement in any location; (b) it tests students with fewer questions in less time and with immediate results; (c) it is un-timed giving more flexibility in the computer lab; (d) provides access for the colleges to customize their needs such as faculty preferences and setting cutoff scores (Sireci, Patelis, Rizavi, Dillingham, & Rodriguez, 2000).

The purpose of this paper is two-fold: (1) to determine the reliability and correlation of Arithmetic with Elementary Algebra test scores and Elementary Algebra with College Mathematics test scores, and (2) to determine which mathematics exams scores are more reliable and correlated to better test students' ability. The Cronbach's Alpha and inter-item correlation have been calculated for Arithmetic with Elementary Algebra test scores and Elementary Algebra with College Mathematics test scores. Also, a comparison between the two cases has been made. Finally, the validity of the CPT has been reviewed and the necessary recommendations are suggested.

Related Literature

There are a number of factors that affects the reliability of any test score either associated with the examinees or the testing condition itself. Some of these are test length, test content, item difficulty, item discrimination, group heterogeneity, student test-wiseness, time limit, and security precautions. Commercial standardized tests like one used in the ACCUPLACER System are expected to have reliability around 0.9 (Frisbie, 1988).

In the college, placing students in the appropriate level such as developmental mathematics is a difficult task particularly when it comes to cutoff scores. Most colleges face challenges to come up with the better cut-off scores so that the Accuplacer becomes the best predictor of student's skill for the subject area he/she is testing. However, the College Board does not provide specific cut-off score for the CPT given the diversity of the students and courses across different colleges (Patelis, 1999).

According to BCCC (2005) Office of Institutional Research, reports for 2002 and 2003 show that more than 50% of the students who attempted the CPT and were placed in Mat–80 and Mat–81 did not pass their assigned classes. The report did not indicate any particular reason why this happened.

Since Fall 1998, BCCC mathematics department has been using the cut-off scores for the CPT presented in Table 1 (J. Finucci, personal communication, April 2, 1998). The cut-off scores were developed based on the mathematics proficiency statement from the College Board, comparison of cut-off scores of other community colleges and the expected proportion of students to pass the course (Leshan & Icore, 1995).

Table 1

Cut-off Scores for the CPT at BCCC

Mathematics Placement			
Raw Score			Required Courses
Arithmetic	Elementary Algebra	College Math	
0 – 35	< 32		Mat–80 ISP
> 35	< 32		Mat–80
Any score	32 – 42		Mat–80
	43 – 62		Mat–81/BA103
	> 62	< 45	Mat–82
		45 – 63	Mat–107/ Mat–128/Mat–111/Mat–125
		> 63	See Dept. Chair

According to the CPT validity study for BCCC by the College Board, the correlation coefficient between Arithmetic CPT scores and the grade from the Mat–81 course is relatively strong (0.34) as compared to the correlation between other CPT scores and corresponding course grade (Patelis, 1999). From this one may infer that the ACCUPLACER score does not reflect the placement of the student in the properly course level.

Method

The CPT is a series of Mathematics and English computerizes exams, which assesses students' skills in five different areas: (1) Reading Comprehension, (2) Sentence Skills, (3) Arithmetic, (4) Elementary Algebra, and (5) College Mathematics (College Board, 1997). In order to assess the reliability of the test scores of the CPT Mathematic exams at BCCC, data were collected from August 2004 to April 2006 and results are described in detail. Statistical analysis using Cronbach's Alpha and inter-item correlation was performed.

Arithmetic exam includes 17 questions from three areas: (1) operation with whole numbers and fractions, (2) operations with decimals and percents, (3) applications and problem solving. Elementary Algebra exam has 12 questions from three areas: (1) operation with integers and rational numbers, (2) operations with algebraic expressions, (3) equations solving, inequalities, and word problems. College Mathematics exam has five areas with 20 questions: (1) algebraic operation, (2) solutions of equations and inequalities, (3) coordinate geometry, (4) applications and other algebra topics, (5) functions and trigonometry.

Students begin exams with one section and, depending on his/her performance, may advance to other sections. At BCCC, students are allowed to use calculators (Leshan & Icore, 1995). The report of the CPT is given in two scales: percentile score and total right score. Then, based on the cut-off scores of the college and the score of the student, placement decisions are made. The scale ranges from 0 to 120, with a mean of 48.29, and standard deviation of 26.21 (Sireci et al., 2000).

According to Sireci et al. (2000), Elementary Algebra score has estimated reliability of 0.93. Based on results from research done on BCCC, the CPT score yields with reliability around 0.90 and correlations around 0.88 (Leshan & Icore, 1995).

Since the CPT is computer adaptive test and students are tested on randomly chosen questions from the bank containing about 120 questions in each course areas, assessing item reliability is difficult. In this study, the reliability was assessed by pairing of Arithmetic with Elementary Algebra scores and Elementary Algebra with College Mathematics scores for the same student taking the CPT at same date.

Data

CPT scores of Arithmetic, Elementary Algebra and College Mathematics exams of about 4071 students who have been retested for the second time within 24 hours were collected from a poll of all CPT scores of 10990 BCCC students who have taken the test from August 2004 until April 2006. The data were obtained from BCCC (2005, 2006) Office of Institutional Research. Then data were sorted

for Arithmetic (ARTH) with Elementary Algebra (EA) scores and Elementary Algebra (EA) with College Mathematics (CM) scores bases. 3082 sample data were obtained for EA and ARTH scores, 986 for EA and CM scores. Reliability and correlation values including scatter diagrams were obtained for ARTH with EA and EA with CM using Cronbach's Alpha and inter-item correlations. Example of the data listed is given in Table 2. More sample data are included in the Appendix.

Table 2

Example of the Data Listed

ST.ID	subject1	score1	subject2	score2
1	EA	23	ARTH	26
2	EA	29	ARTH	39
3	EA	33	ARTH	37

Analysis

The data were analyzed using the SPSS (2003) software tool. For Elementary Algebra and Arithmetic scores (N = 3082) the results are presented in Table 3, Table 4, and Figure 1.

Table 3

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.331	.528	2

Table 4

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Variance	N of Items
Item Means	30.517	26.089	34.944	8.855	39.202	2
Item Variances	126.754	21.142	232.365	211.223	22307.630	2
Inter-Item Correlations	.359	.359	.359			2

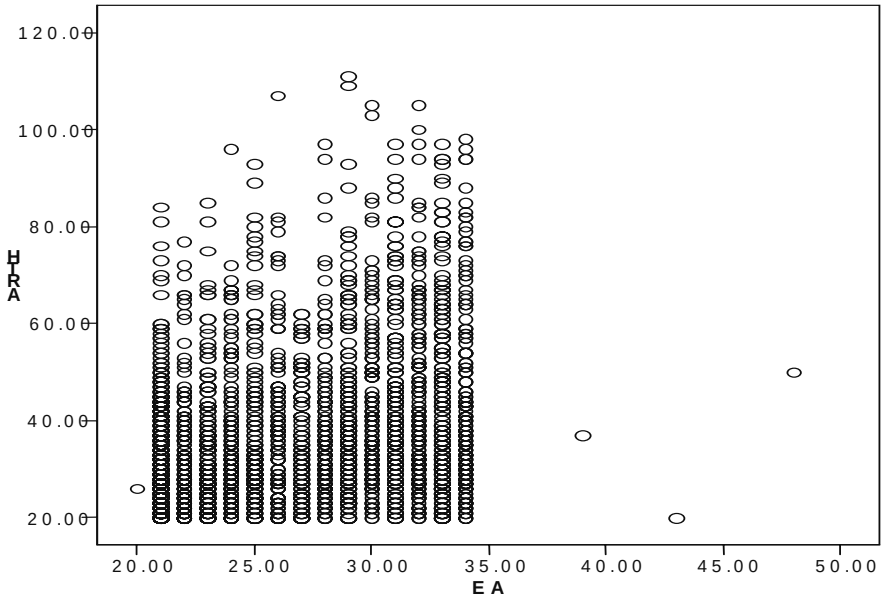

Figure 1. Scatter Diagram for Elementary Algebra and Arithmetic Scores

For Elementary Algebra and College Mathematics score (N = 986) the results are presented in Table 5, Table 6, and Figure 2.

Table 5

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.812	2

Table 6. Summary Item Statistics

	Mean	Minimum	Maximum	Range	Variance	N of Items
Item Means	59.785	34.178	85.392	51.214	1311.437	2
Item Variances	340.173	309.144	371.203	62.058	1925.620	2
Inter-Item Correlations	.683	.683	.683			2

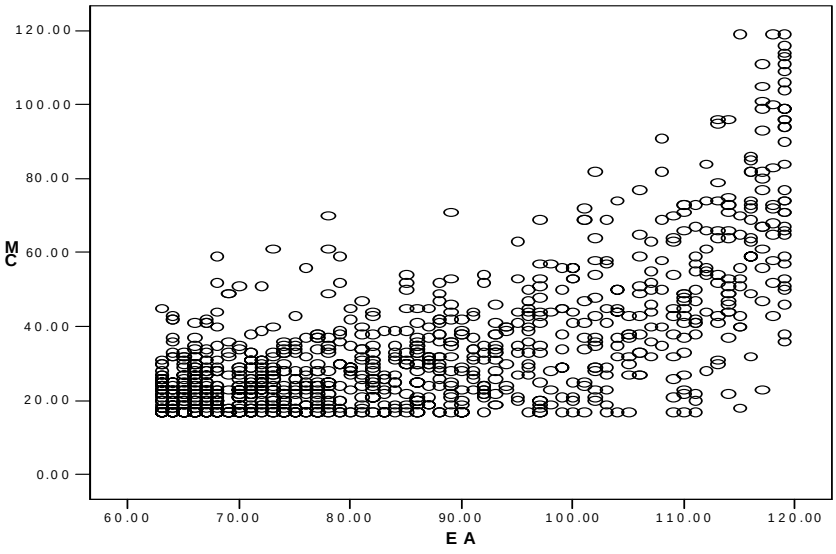

Figure 2. Scatter Diagram for Elementary Algebra and College Mathematics Scores

Discussion

The two Cronbach's Alpha coefficients (see Table 2 & Table 4) that are returned by SPSS (2003) are raw Cronbach's Alpha and standardized Cronbach's Alpha. Raw Cronbach's Alpha is based upon item correlation. The stronger the items are inter-related, the more likely the test to be a consistent predictor. Standardized Cronbach's Alpha is based upon item covariance**.** It is based on a linear transformation. Standardized Cronbach's Alpha is not superior to its raw counterpart, but it is used when there are relatively heterogeneous variances, which is the case in Table 2 and Table 4.

As shown in Table 2 to Table 4, the analysis results reported are the following: (a) the correlation between Arithmetic and Elementary Algebra scores ($r = 0.359$) is weaker than the correlation between Elementary Algebra and College Mathematics scores ($r = 0.683$); (b) the reliability between Elementary Algebra and College Mathematics scores (standardized Cronbach's Alpha = 0.812) is much higher than the reliability of Arithmetic and Elementary Algebra scores (standardized Cronbach's Alpha = 0.528).

The higher the Alpha the more reliable the test will be. There isn't a generally agreed cut-off. Usually, Alpha = 0.7 and above is acceptable. It is a common misconception that if the Alpha is low, it must be a bad test. Actually, a test may measure several attributes/dimensions rather than one, and, thus, the Cronbach's Alpha is deflated. For example, it is expected that the scores of GRE-Verbal, GRE-Quantitative, and GRE-Analytical may not be highly correlated because they evaluate different types of knowledge (Nunnally, 1994).

Therefore, analysis results of this study may imply that Elementary Algebra and College Mathematics tests assess student's skill more consistently than Elementary Algebra and Arithmetic tests. In other words, Elementary Algebra test works more consistently with College Mathematics test than with Arithmetic.

Conclusion and Future Research

The study shows that the scores of the CPT administrated at BCCC for mathematics courses have less consistency. Some of the reasons that may contribute to lower consistency and need further investigations are the following:

1. BCCC offers general mathematics reviews. It does not have any preparatory class for the CPT. This might contributed to lower reliability value as it has been seen above. Creating a preparatory class for the CPT taking students, informing them to take the class first before they take the test and making the students to be familiar with the test help to minimize the random error that affect the reliability result.
2. Setting cut-off scores based on the expected proportion of students to pass the test will have a negative impact on the validity of the test. More research needs to be done in order to get more accurate cutoff scores.
3. The number of questions given per each section in the CPT is too small to properly cover broad content area of each course. On average, the CPT tests a student a total of 17 questions from Arithmetic, Elementary Algebra, and College Mathematics. This does have a negative impact towards the validity and the reliability of the test.

The CPT is used only to predict academic readiness for a course. It cannot guarantee success in the course because other factors such as study skills, regular attendance, and interest towards learning can contribute greatly to success. Therefore, colleges are expected to have a policy for placement that includes these factors to be able to get a high success rate.

The CPT is the single sole test used by BCCC to place students. Instead of placing student by the cut-off scale of the CPT results alone, it would be a good idea to use students' academic background along with the CPT scores to place student in appropriate course level. This also requires further study.

Appendix
Data Listed

ST.ID	subject1	score1	subject2	score2
1	EA	93	CM	26
2	EA	116	CM	59
3	EA	105	CM	32
4	EA	86	CM	20
5	EA	87	CM	30
6	EA	86	CM	45
7	EA	89	CM	32
8	EA	71	CM	17
9	EA	102	CM	20
10	EA	92	CM	23
11	EA	85	CM	22
12	EA	89	CM	17
13	EA	66	CM	29
14	EA	63	CM	24
15	EA	102	CM	29
16	EA	88	CM	47
17	EA	116	CM	59
18	EA	70	CM	35
19	EA	107	CM	32
20	EA	68	CM	40
21	EA	67	CM	27
22	EA	77	CM	21
23	EA	92	CM	54
24	EA	102	CM	58
25	EA	99	CM	56
26	EA	64	CM	19
27	EA	67	CM	21
28	EA	111	CM	17
29	EA	64	CM	33
30	EA	88	CM	17
31	EA	74	CM	35
32	EA	97	CM	48
33	EA	102	CM	48
34	EA	63	CM	18
35	EA	82	CM	44
36	EA	112	CM	66
37	EA	110	CM	23
38	EA	63	CM	17
39	EA	91	CM	43
40	EA	71	CM	17

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