A Preliminary Analysis of the June 2003 New York State Regents Examination in Physics

Joseph L. Zawicki (SUNY Buffalo State College); Michael Jabot (SUNY Fredonia State College); Kathleen Falconer (SUNY Buffalo State College); Dan MacIsaac (SUNY Buffalo State College); Dave Henry (SUNY Buffalo State College); Rita Fischer (Elba Central School)

Abstract

We describe the analysis of 1000 NYS Regents Examinations in Physics from the June 17th, 2003 offering in terms of Rasch item analysis, reading level, conceptual level (modified Bloom taxonomy), and format. We include comments from the OPHUN-L statewide physics educator's listserv regarding latency (amount of time necessary to complete the exam) and number of students achieving passing and mastery scores for the same exam. Our analysis generally confirms teacher's contentions that offerings of the NYS Regents Examinations in Physics have been increasing in terms of reading, conceptual and format difficulty since June 2000, and supports teacher claims of increased latency.

Introduction

Comments posted to statewide physics educators' listserv after the June 17th administration of the New York State Regents Examination in Physics indicated a generally depressed passing rate and high levels of both teacher and student frustration (SUNY Oneonta, 2003). The actual exam and the scoring key are available on-line (NYSED, 2003a). Comments suggested that both the number of students achieving passing and mastery rates on the exam were extraordinarily low, and that students were taking longer to complete the test than they had in the past (SUNY Oneonta, 2003). Similar concerns were raised about the June 2002 Administration (Sullivan, 2002; Lorenthen, 2002). A study conducted on the administration of the June 2002 examination indicated that the student response to individual questions fell within what might be considered a generally acceptable range that appeared to parallel student performance on prior, syllabus-based exams (Zawicki & Jabot, 2002). A complete comparison between the 2001 and 2002 exams is still pending. Syllabus-based exams were based on the New York State Regents Physics Syllabus that was in place between 1987 and 2001; the core-based exams developed from the core curriculum guide that is used to develop local programs. The scores on core-based exams are established via a standard setting process. The previous study concluded the major factor affecting the passing rate on the examination was the adoption of a fairly rigorous scaled scored system.

Paper Collection

In order to identify significant issues related to the current administration of the examination, a call for student papers (answer sheets) was placed through both the Science Teachers Association of New York State (STANYS) and the New York State Section of the American Association of Physics Teachers (NYSS-AAPT). As well, a call was made on the aforementioned OPHUN-L listserv.

A set of preliminary data was compiled and presented to the New York State Science Consortium for use during the Fourth Science Education Summit. This article will present a summary of that data.

The response to the call for papers was overwhelming. At the time of the analysis papers had been collected from most, but not all regions of New York State, as shown in Table 1.

Table 1. Student papers initially submitted, organized by STANYS section.

STANYS Section	*Number of Papers*
NYC (& Manhattan)	0
Catskill-Leatherstocking	5
Central-Western	74
Eastern	74
Mohawk Valley	80
Nassau	324
North Central	17
Northeastern	24
Northwestern	114
Southeastern	126
Southern	71
Southwestern	271
Suffolk	18
Westchester	21
Western	473
Total	***1692***

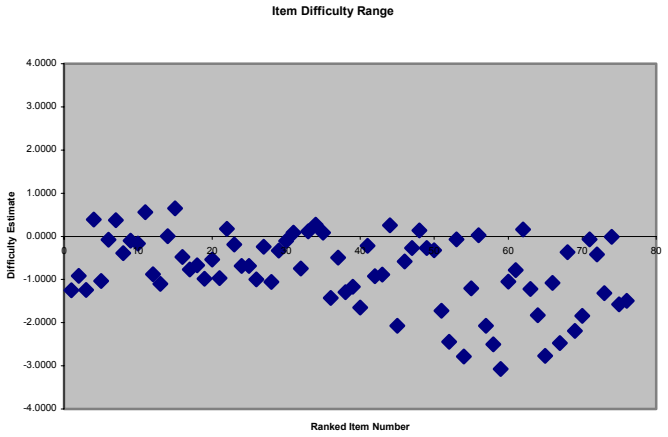
While over 2000 student papers were eventually collected, for this analysis we were able to use just under 1000 papers to analyze the multiple choice sections (Parts A and B-1); slightly under 500 papers were used to analyze the constructed response sections (Parts B-2 and C).

The statewide passing rate on the June 2002 New York State Regents Physics Examination was approximately 63%; previous passing rates hovered between 80-85%, on average (NYSED, 2003b). Data reported to the statewide physics listserv suggest a passing rate of approximately 60% on the 2003 exam (Johnson, 2003). Together with the preliminary data analysis, these data support the conclusion that the passing rate is either close to or somewhat below the passing rate observed in 2002, which is itself 20% below typical passing rates in 2001, previous to the adoption of the new core curriculum in physics (NYSED, 2001)

Rasch Item Analysis

A Rasch Analysis was performed following Bond and Fox (2001). The analysis indicated difficulty estimates for questions on the multiple choice sections of the exam (Parts A and B-1) fell between –2.17 (relatively easy) to 0.67 (somewhat difficult). The difficulty estimates on the constructed response sections of the exam (Parts B-2 and C) fell between –3.35 (easy) to 0.25 (modestly difficult). The results are shown in Figure 1. Q ranking of questions, based upon item difficulties, appears in Appendices A and B.

Figure 1. Item Difficulty Estimates, NYS Regents Physics Examination, June 2003



According to this preliminary analysis, question #45 appeared to be among the easiest question on these sections of the exam, with 89.8 percent of the students in the sample population responding correctly. Question #15, which required students to distinguish between inertia and momentum, was the most difficult item, with only 33.8 percent of the students in the sample responding correctly.

The analysis of the constructed response items suggested that Question #59 was among the easiest, with 96.6 percent of the students responding correctly. This question asked students to draw a line of best fit for a series of points that they plotted on a graph. Question #62 was among the most difficult, with only 43.8 percent of the students answering correctly. This question asked students to explain how they could determine if a pair of iron bars were magnetic. Incorrect student responses frequently referred to the "charge" on the magnets, a common misconception (Arons, 1997).

In general, it appeared that the "easier" questions were typically single step questions that required the straightforward application of formulas or concepts. The more difficult questions addressed common misconceptions or required a greater physics understanding. An further analysis of question types is in preparation.

A comparison of the average difficulties of each exam section has not been completed at this time; the general range of item difficulties reflects a reasonable range for a test of this sort.

Reading Level

The reading level of selected NY Regents Examinations in Physics since 2000 were assessed using the McLaughlin-SMOG instrument (1969). The instrument was selected based upon a projected 92-100% comprehension. The data indicated that the reading level of the June exam was substantially higher than recent syllabus-based exams. The data are shown in Table 2.

Table 2. Exam reading levels using the McLaughlin-SMOG instrument.

Exam Administration	Grade equivalent
June 2000	8^{th}
June 2001	10^{th} (Low)
June 2002	10^{th} (High)
June 2003	11^{th}

Conceptual Level

The conceptual level of the questions on a series of exams was also analyzed using a modification of Bloom's Taxonomy (Bloom & Krathwohl, 1956). The categories of knowing, using (1), using (2), and integrating were used for this analysis. A team of five experienced physics instructors including 4 college physics faculty was enlisted to analyze recent exams. The data suggest that core-based exams are asking questions that are slightly "higher" conceptually. The data are shown in Table 3.

Table 3. Average conceptual level for recent NYS Regents Physics Examinations.

Exam Administration	Average Conceptual Level
June 2000	1.61
June 2001	1.59
June 2002	1.89
June 2003	1.74

Test Format

Examinations were also analyzed with respect to format – the number and types of questions that students were expected to answer. Syllabus-based administrations of physics examinations (administered until January 2001) required students to answer approximately 75 multiple-choice questions and to provide written answers to about 12 questions; the written responses were based upon 3 problems. Core-based exams (Post January 2001) required students to answer nearly 45 multiple-choice questions and to provide written responses to around 24 questions; the written responses were based on about 12 problems. The data is presented in Table 4. In general, there is marked trend towards more written response questions.

Table 4. Regents Physics Exam Formats

Exam Administration	Multiple Choice Items	Written Responses	Problems (for written responses)
June 2000	75	11	3
January 2001	75	10	3
June 2001	75	11	4
January 2002	75	11	3
June 2002	45	24	12
August 2002	47	21	8
January 2003	50	27	10
June 2003	47	29	16

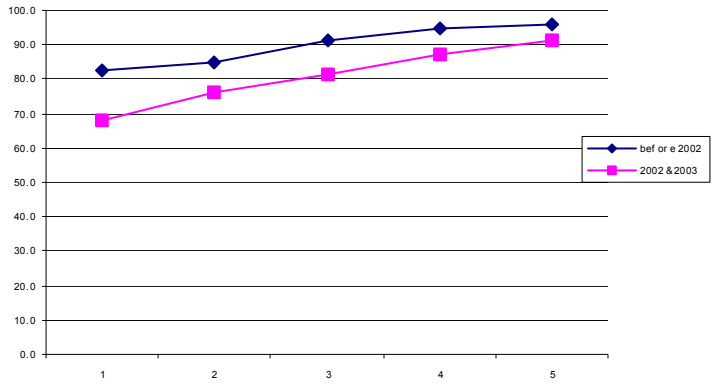
Latency

Comments on the statewide listserv indicated that students were taking longer to complete the exam than they had in past years. The data on reading level, conceptual level and test format all support anecdotal comments from the listserv that students are taking longer to complete the exam.

Overall Exam Difficulty

The authors were able to obtain data from teachers that had students completing both AP-B and Regents physics examinations. The data are shown in Figure 2. We analyzed student Regents Examination scores based upon AP-B scores. For students scoring a "5" on the AP-B Physics exam, scores on core-based exams were approximately 5 points lower than those on the syllabus-based exams. For students scoring a "1" on the AP-B Physics exam, scores on core-based exams were approximately 14 points lower than those on syllabus-based exams. The data support the conclusion that the recent core-based exams were scored more harshly than recent syllabus-based exams.

Figure 2. Student scores on Physics AP-B and NYS Regents Physics Examinations



Discussion

SED raised the issue has that physics is an "advanced" science, targeting only "elite" students, in response to concerns raised after the administration of the 2002 examination (NYSED, 2002). If this is the case, then surely it was an advanced science prior to the adoption of the New York State Core Curriculum in Physics. The reading level, the conceptual level of the individual items, and the overall difficulty of the exam have increased significantly. Prior to the implementation of the core, the syllabus was designed to address physics as a senior level elective. While it may be extremely appropriate to increase the rigor of the current statewide assessments, it is difficult to appreciate that such a dramatic shift was required over such a brief time period. In fact, the core writing team was charged with producing a document amenable to teaching physics at any high school grade level. Traditionally, Regents examinations have provided ample time for students to complete each assessment. A time constraint turns

the test into power test, where time is a significant factor. Given this charge, the readability of the exam, as well as its overall length, need to be carefully reconsidered.

Recommendations

Several suggestions should be considered at this point in time. The student ability levels established at the last round of standard setting should be revisited. There is clearly a disconnect with the field. Whether or not the current student ability level is appropriate, the evidence suggests that such changes are occurring too rapidly for the field to adapt. Additional resources, such as contact with content specialists within the department or with specialists from outside organizations, such as the STANYS SAR network or the Oneonta Physics Mentor network, need to be either maintained or established. Any changes, such as those in reading level, conceptual level, focus, or overall exam difficulty should be effectively communicated with the field.

The expectations for proficiency and distinction are not clearly defined in the NYS Core Curriculum for Physics; other states have included such expectations (Arizona Department of Education, 1997). New York State should consider developing and publishing such expectations prior to the publication of the end of course assessments.

The length of time required for students to complete the exam needs to be carefully evaluated. During future administrations, teachers should collect data about the length of time that students use to complete the exam. Item analysis, through BOCES or similar organizations, should be routinely completed; this data would serve to resolve testing issues as well as to foster appropriate program review.

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Appendix A Regents Physics Exam, June 2003, Rasch Analysis, Multiple choice items

Item	*Key*	*R1*	*R2*	*R3*	*R4*	*RC (%)*	*Papers (n)*	*Difficulty Estimate*
Q45	3	57	26	860	15	89.8	958	-2.17
Q40	3	40	3	807	106	84.2	956	-1.69
Q36	2	122	777	38	21	81.1	958	-1.46
Q38	3	12	54	759	131	79.2	956	-1.35
Q3	2	129	749	38	42	78.2	958	-1.28
Q1	4	25	136	47	750	78.3	958	-1.28
Q39	3	38	145	739	33	77.1	955	-1.23
Q13	4	17	61	153	723	75.5	954	-1.14
Q28	1	708	176	35	34	73.9	953	-1.06
Q26	3	55	102	706	94	73.7	957	-1.03
Q5	1	703	114	118	22	73.4	957	-1.02
Q19	2	53	701	149	53	73.2	956	-1.01
Q21	3	62	159	695	39	72.5	955	-0.98
Q42	4	28	211	26	690	72.0	955	-0.96
Q2	2	11	689	17	240	71.9	957	-0.94
Q12	3	66	172	682	37	71.2	957	-0.91
Q43	4	50	167	60	678	70.8	955	-0.90
Q17	1	653	49	197	57	68.2	956	-0.77
Q32	1	646	190	39	80	67.4	955	-0.74
Q24	3	220	88	643	7	67.1	958	-0.71
Q25	4	71	150	93	641	66.9	955	-0.71
Q18	3	55	266	637	1	66.5	959	-0.68
Q46	2	108	617	48	185	64.4	958	-0.59
Q20	3	23	298	607	27	63.4	955	-0.56
Q37	2	258	597	49	52	62.3	956	-0.51
Q16	4	33	302	26	594	62.0	955	-0.50
Q8	4	178	68	135	571	59.6	952	-0.40
Q29	4	90	147	152	566	59.1	955	-0.38
Q47	4	135	73	200	545	56.9	953	-0.29
Q27	2	308	536	40	71	55.9	955	-0.25
Q41	3	201	153	535	66	55.8	955	-0.24
Q23	3	312	77	528	39	55.1	956	-0.21
Q10	1	517	318	60	59	54.0	954	-0.17
Q30	2	304	509	139	3	53.1	955	-0.13
Q6	3	202	242	504	9	52.6	957	-0.11
Q9	2	201	503	159	89	52.5	952	-0.11
Q14	2	424	479	17	35	50.0	955	-0.01
Q35	2	146	463	256	91	48.3	956	0.06
Q31	2	100	460	210	186	48.0	956	0.08
Q33	2	184	449	93	229	46.9	955	0.12
Q22	2	121	441	395	1	46.0	958	0.16
Q44	4	188	54	292	422	44.1	956	0.24
Q34	4	122	371	46	418	43.6	957	0.25
Q7	2	95	394	320	148	41.1	957	0.36
Q4	4	313	20	237	387	40.4	957	0.39
Q11	3	69	76	352	458	36.7	955	0.54
Q15	1	324	13	42	576	33.8	955	0.67

Appendix B Regents Physics Exam, June 2003, Rasch Analysis, Constructed items

Item	*Key*	*R0*	*R1*	*R2*	*RC (%)*	*Papers (n)*	*Difficulty Estimate*
Q59	1	16	458	0	96.6	474	-3.35
Q54	2	27	51	398	89.0	476	-2.84
Q65	1	27	447	0	94.3	474	-2.81
Q58	1	34	440	0	92.8	474	-2.56
Q69	2	23	60	391	91.0	474	-2.32
Q67	1	45	430	0	90.5	475	-2.26
Q52	1	46	430	0	90.3	476	-2.24
Q57	1	52	422	0	89.0	474	-2.09
Q70	2	37	50	387	86.9	474	-1.89
Q64	2	36	56	381	86.5	473	-1.85
Q51	1	66	410	0	86.1	476	-1.83
Q75	2	19	118	337	83.5	474	-1.62
Q76	1	87	387	0	81.6	474	-1.49
Q73	2	37	127	310	78.8	474	-1.31
Q63	1	106	367	0	77.6	473	-1.24
Q55	2	61	92	322	77.5	475	-1.24
Q66	2	50	131	293	75.6	474	-1.13
Q60	1	125	350	0	73.7	475	-1.03
Q61	1	150	324	0	68.4	474	-0.77
Q72	2	132	106	236	61.0	474	-0.45
Q50	1	201	273	0	57.6	474	-0.31
Q68	1	206	269	0	56.6	475	-0.27
Q49	1	210	266	0	55.9	476	-0.24
Q71	1	238	237	0	49.9	475	0.00
Q56	1	242	233	0	49.1	475	0.04
Q74	1	243	231	0	48.7	474	0.05
Q53	1	246	230	0	48.3	476	0.07
Q48	1	253	223	0	46.8	476	0.13
Q62	1	266	207	0	43.8	473	0.25