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Findings from the

2003 SPIN-UP/TYC
Background Survey of Two-Year College Physics Programs

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INTRODUCTION

The SPIN-UP/TYC Project, standing for Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges, was funded in 2002 by the Advanced Technological Education Program of the National Science Foundation, and conducted by the American Association of Physics Teachers (AAPT) to help identify best practices in physics instruction at the two-year college level. The study was linked to a parallel AAPT SPIN-UP project focusing on four-year colleges and universities. A central part of the project was the use of a carefully-designed screening survey to establish objective criteria for selecting exemplary two-year college sites to be visited.

In order to situate the campuses that responded to this survey in the universe of all two-year schools, the Statistical Research Center (SRC) at the American Institute of Physics (AIP) was contracted to conduct a background survey that included a representative sample of all two-year college physics programs nationwide. In addition to the sample, the background survey also gathered information on every program that had responded to the in-depth site-selection survey.

This report will focus on the characteristics of all responding schools that comprised the representative sample, and their similarities and differences with the schools that responded to the site selection survey, and to the handful that were chosen for site visits. The purpose is both to draw an accurate picture of the current situation of the average two-year college physics program, and to identify the ways in which the 70 departments providing information on the site selection survey and the 10 sites that were chosen for visits were similar to two-year college physics programs in general, and the ways in which they were exceptional.

The large background survey consisted of a systematic sample of one in four campuses across the nation offering physics, as identified in the AIP Two-Year College Academic Workforce Study, which had been completed in 2001. Out of the 263 sample cases, we heard from 178, or 67%. Included in this number were a handful of the 70 schools which had responded to the more detailed site selection survey, conducted separately in a mailing to the roughly 1,000 presidents of schools that hold membership in the American Association of Community Colleges, and an overlapping mailing to the roughly 700 members of AAPT. In order to ensure sufficient numbers to make accurate comparisons between these two groups, we surveyed the rest of these 70 schools as well, hearing from 65, or 93%. Among the respondents were 9 of the 10 campuses that were ultimately visited by the SPIN-UP/TYC Team.

BACKGROUND DATA

Tables 1, 2, and 3 provides a comparison of background data from these three groups involved in the study:

1. the representative sample of all two-year college campuses that offered physics, hereafter referred to as the sample;

2. the subset of all two-year college physics programs that responded to the separate site selection survey and thus constituted the pool from which the visited schools were selected, which we will call the (site selection) pool; and

3. the subset of group 2 schools that were visited by the SPIN-UP/TYC teams, which we call the visited sites.

As these tables show, there was broad similarity in structural characteristics between the pool and the visited sites, although the small number of cases in the latter group makes comparison somewhat less reliable. Still, the only major exceptions were that the visited sites were on average slightly larger in terms of number of physics faculty, but had fewer women among their ranks. There was also slightly different minority enrollment in the two groups. Otherwise, we find broad structural similarities between these two groups. This is important, because it suggests that differences in physics departments' programs and practices were not simply a product of differing environments and background conditions, such as school or program size, faculty characteristics, and the like. Rather, those program differences, which qualified the ten schools for site visits, were likely the result of clear and probably conscious policies and curriculum initiatives.

On the other hand, **Tables 1-3** also show greater differences on these same background variables between the pool and the sample schools. This is not so surprising, given the way in which pool schools were self-selected, but it does mean that careful thought needs to be given in devising ways to generalize the findings about what works best, since some of the differing background factors may facilitate reform, while others may present barriers to instituting new approaches. Among the larger differences are:

1. Campus type – while most departments were at autonomous, standalone two-year schools, a significant minority was part of a larger community college system. In such cases, "pool schools" were more likely to be the main campus of the system, while sample schools were more likely to be subcampuses. This has implications for issues of resources and control.

2. School size – parallel to the preceding finding, pool schools were on average about 25% larger in terms of overall student enrollments than the nationwide average.

Table 1. Campus Background Data

		Sample Schools	Site Selection Survey Respondents ("Pool" Schools)	Visited Campuses
Total Number of Campuses in Study		263	70	10
Number Responding to AIP Survey		178	65	9
Response Rate (%)		67%	93%	90%
Number of Students Enrolled at Campus:	Mean	3,983	5,017	4,748
	Median	2,729	3,853	4,067
Racial Composition				
African-American		10%	11%	8%
Hispanic		9	8	12
Asian-American		4	6	6
Native American		1	1	1
White (Inferred)		76	74	73
Type of Campus				
Stand-Alone		63%	68%	89%
Main Campus of a System		11	21	11
Sub-Campus in a System		15	6	0
Other		11	5	0

NCES IPEDS 2001-02 Data, AIP 1996 Physics in the Two-Year Colleges

3. Physics program size – concomitantly, physics programs at pool schools tend to be somewhat larger, with more physics faculty and more sections of physics offered, than sample schools.

4. Among the faculty, there tended to be somewhat more women at pool schools, and slightly more people who had earned a PhD.

5. The use of part-time faculty was a bit higher at pool schools.

However, there were also a few important ways in which we found no differences between physics programs at sample schools and pool schools. There was broad similarity in the regional distribution of campuses around the country in the two groups. And while schools from urban areas were over-represented in the pool and schools from small towns were under-represented, there was no significant difference in the proportion of minority enrollment at the two groups of schools. Finally, faculty turnover seemed broadly similar,

Table 2. Physics Program Faculty Characteristics

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Number of full-time physics faculty (mean)	1.7	1.9	2.4
Of which, % tenure-track	18%	17%	*
Number of part-time physics faculty (mean)	.9	1.4	1.5
% of part-timers among faculty	26%	33%	34%
% of women among faculty	15%	21%	13%
% of faculty with a PhD	33%	38%	*
Number of years teaching at this school			
Full-Time (mean)	11	11	*
Part-Time (mean)	2	2	*

*Low number and missing data put responses below acceptable reliability level

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measured by the average number of years that both full- and part-timers had been teaching at their current campus. However, there was a hint that the pool schools might currently be experiencing a faster growth trajectory than is typical in the sample—in the latter, the number of positions being recruited for this year and next was only half the number of faculty reported to have left in the previous two years, while among the pool programs, the recruitment number was almost twice the number of recent departures.

PROGRAM DATA

The first question on the survey asked department chairs to rank in importance the primary goals of their physics program. As **Table 4** shows, transfer students are the primary focus of all three groups of departments. However, among the few departments that see their main focus elsewhere, more of the sample than the pool sites saw their priority as preparing students for entry into the industrial workforce.

While goals were fairly consistent across all three groups, efforts to introduce significant curricular and other program changes showed much wider variation. While all of the visited schools and three-fourths of the pool sites reported some type of reform initiative in the past five years, the proportion for sample

Table 3. Physics Course Information

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Number of physics sections offered, Fall 2001			
Mean	5.4	6.4	6.6
Median	4	5	5
Distribution of courses (as % of all sections offered)			
Calculus-Based	30%	35%	28%
Algebra/Trigonometry-Based	37	33	36
Conceptual	13	12	18
Applied/Technical	7	8	4
Physics/Physical Science for Education Majors	5	6	6
Other Physical Science	5	6	8
Other	3	1	0

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schools was just under half. And, as **Table 5** shows, the same holds for the *number* and *variety* of reforms undertaken. Visited schools report the most, and sample schools the least, types of changes and kinds of courses involved. And overall, sample schools signaled an average of 2.3 changes of the types listed to their various physics courses over the past five years, compared to 5.2 such changes for the pool and 9.3 for the visited sites.

This is exactly what would be expected given the survey design – many of the pool schools were probably more motivated to respond to the site selection survey precisely because they were more involved in reform efforts than the average sample school, and had more to report. And the visited sites were selected from the pool specifically because of the intensity and breadth of their reforms.

Table 5 reveals that the greatest differences between the three categories of schools were in areas like changes in the pedagogical approach used in conceptual physics courses, which were found in roughly two-thirds of the visited schools, one third of the pool schools, and less than a fifth of the sample schools. Such contrasts were found at the other end of the course spectrum as well, for instance in revisions to the lab curriculum of the calculus-based introductory course, undertaken by two-thirds of the visited sites, over one-half of the pool schools, but less than a third of the same schools.

In addition to detailed descriptions of the changes undertaken by each of the three

Table 4. Physics Program Priorities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Adjusted % citing this goal as *most important*			
Preparing students for transfer	72%	79%	100%
Preparing students for work	13	6	0
Preparing student to be K-12 teachers	4	1	0
Preparing students as future citizens	7	8	0
Other	4	6	0
% citing as second most important			
Preparing students for transfer	12%	12%	0%
Preparing students for work	45	37	11
Preparing student to be K-12 teachers	20	28	67
Preparing students as future citizens	19	18	22
Other	4	5	0

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types of schools, the survey provides broader contrasts about which courses are most often targeted for reform and which kinds of reform efforts are most commonly undertaken. Not surprisingly, **Table 6** shows that the most widely-taught courses, calculus-based and algebra/trig-based introductory physics, are most likely to be the subject of reform efforts. However, it is worth noting that the largest contrast is in the proportion of site select schools which had added and/or revised the content of courses aimed specifically at introducing physics to future K-12 teachers. This is clearly related to the high percentage of these schools which cited this as their second most popular goal.

Table 7 also shows that laboratories are most often the focus of reform efforts, specifically involving major revisions in lab curriculum and/or upgrades in equipment. Almost as common were changes in the pedagogical approach used in various courses. Interestingly, departments across the country seemed to be as ready to add entire new courses as they were to change the content of existing courses. And finally, few departments felt it necessary to remove courses to offset the new ones they added, pointing to generally growing size and breadth in the physics curriculum.

Such reform efforts cost money, and one key determinant of whether and to what extent they can be launched is where funding for implementation can be found.

Table 5. Curricular Changes Over the Past Five Years

	Sample Schools		"Pool" Schools		Visited Campuses	
Responding schools	178		65		9	
% making at least one change	47%		75%		100%	
Type of Course	**Of schools that made changes, % that:**		**Of schools that made changes, % that:**		**Of schools that made changes, % that:**	
	Added Course	**Removed Course**	**Added Course**	**Removed Course**	**Added Course**	**Removed Course**
Conceptual	16%	6%	8%	2%	0%	0%
Alg/Trig-based	6	4	6	2	0	0
Calculus-based	10	5	8	0	22	0
Technical	6	6	14	6	11	0
For K-12 teachers	8	1	14	0	56	0
Other	12	1	4	0	0	0
	Changed Existing Course:		**Changed Existing Course:**		**Changed Existing Course:**	
	Content	**Pedagogy**	**Content**	**Pedagogy**	**Content**	**Pedagogy**
Conceptual	12	18	14	35	22	67
Alg/Trig-based	18	35	27	49	22	44
Calculus-based	16	27	29	37	33	33
Technical	8	15	14	16	11	33
For K-12 teachers	6	8	12	22	22	56
Other	2	1	4	4	11	11
	Upgraded Lab:		**Upgraded Lab:**		**Upgraded Lab:**	
	Equip-ment	**Curric-ulum**	**Equip-ment**	**Curric-ulum**	**Equip-ment**	**Curric-ulum**
Conceptual	18	18	31	20	44	33
Alg/Trig-based	51	45	71	51	89	67
Calculus-based	46	31	65	55	67	67
Technical	12	15	16	16	22	22
For K-12 teachers	8	10	12	14	11	33
Other	2	1	8	4	11	11

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Table 6. Type of Course Most Frequently Impacted in Curricular Changes

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% of schools indicating a change in at least one course	47%	75%	100%
Of schools that made a change, type of course changed:			
Conceptual	48%	59%	78%
Algebra/Trigonometry-based	75	92	89
Calculus-based	69	86	100
Technical	31	43	44
For K-12 teachers	19	37	89
Other	15	10	11

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Table 7. Most Frequently Indicated Aspect of Change to Curriculum

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% of schools indicating at least one curricular change	47%	75%	100%
Of schools that made a change, % that:			
Added course	45%	39%	56%
Removed course	18	10	0
Changed course content	33	55	56
Changed course pedagogy	51	74	100
Upgraded lab equipment	60	76	89
Revised lab equipment	55	71	78

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As **Table 8** illustrates, by far the most important source of funding was tapping general college resources for purchasing equipment and supplies, and that here the visited schools were far more successful than either of the other two categories. Reallocation of funds already assigned to the physics program was the second most used source, and here the pool and visited schools actually came in below the average indicated by the sample schools. However, the smaller results that emerged in the latter sites suggest the limited nature of this particular resource. This conclusion is also reinforced by the fact that many departments, of all types,

Table 8. Major Sources of Funding for Curricular Changes

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Internal reallocation of departmental resources	34%	28%	22%
College funds from outside the physics program for equipment and supplies	49	50	89
College funds from outside the physics program for personnel, personnel time, etc.	7	13	22
Funding from outside the college	16	22	22
Other types of support	1	2	0

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described internal reallocation as a minor source of funds.

Other sources of funding, including general college funds to offset lost time or to add faculty or staff and extramural funding were much less commonly available. Here again, visited schools were most often successful, followed by pool schools and lastly sample schools. Somewhat surprisingly, that contrast was greatest with college funding to pay for faculty salaries. What all these results suggest is that the most active departments are those who are especially adept at "prospecting" for funds within their larger institutions, likely building influence and alliances with those controlling the spigot, rather than going outside to foundations, industry, and so forth.

NON-CURRICULAR INITIATIVES

Best practices include far more than changes in the classroom and laboratory. Our survey asked about four different kinds of activity that could serve to invigorate two-year college physics programs: recruitment and retention, supplying career information to students, tracking student outcomes, and other programmatic efforts.

Regarding the first of these, we found that almost two-thirds of departments claimed to be making at least some effort to increase recruitment and improve the retention of students. Among the pool schools and visited sites, this rose to 89% and 100%, respectively. However, larger differences emerge when we look at how many of these specific measures departments had adopted. While sample schools checked on average 1.2 different

Table 9. Recruitment and Retention Activities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding Schools	178	65	9
% taking any measure	66%	89%	100%
Average number of different measures implemented	1.2	2.1	3.3
Open house	9%	14%	22%
Summer workshop for K-12 students	8	15	44
Student or faculty visits to local schools	23	34	44
Targeted recruitment of STEM students	24	42	56
Targeted recruitment of underrepresented students	11	31	44
Workshops for local K-12 teachers	10	29	56
Special intro sections for potential physics majors	4	0	0
Host prospective physics students and families	5	5	11

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recruitment or retention activities, the number almost doubles to 2.1 among pool schools and almost triples to 3.3 among the visited sites.

However, no single activity was adopted by a large fraction of the schools. As **Table 9** illustrates, the most commonly employed practices were targeted recruitment of likely Science, Technology, Engineering and Mathematics (STEM) majors , used by 24% of the departments overall, and visits by faculty and students to local high schools, used by 23%. The latter is a form of local outreach that has been recently touted in meetings and workshops on building and sustaining a strong two-year college science program. No other recruitment/retention strategy was implemented by more than 11% of the sample departments surveyed. On the other hand, pool and visited schools were much more active, with between a third and a half offering workshops for both k-12 students and teachers and engaging in targeted recruitment of underrepresented students.

A better job seemed to be done when it came to providing career information to their students. Almost three-fourths of the departments reported that at least one of the five dissemination methods listed on the survey was used, and a sixth of the schools offered an additional channel they had developed to deliver such information. The average number of such methods employed by departments in each of the three categories was much more even – 1.4, 2.0, and 2.8 at sample, pool and visited schools, respectively –

Table 10. Channels Used to Provide Career Information to Students

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% using any channels	77%	92%	100%
Average number of different channels used	1.4	2.0	2.8
Alumni visits to physics program	10%	22%	22%
Field trips to local industries	19	28	44
Career services offices	48	60	78
Visits from industry representatives	13	26	33
Materials from professional societies	35	45	67
Other	18	22	33

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than was the case for curricular changes or recruitment and retention. However, this may be in part because some of the avenues required little active effort on the part of the physics program itself. As is evident in **Table 10**, the most common approach, taken by about half the programs, was to rely on the school's career services office. In second place, just over a third distributed career materials from the professional societies. Still, 19% arranged trips to local industries and 13% had industry representatives visit the campus. And in every case, pool and visited sites tended to be more active in feeding this information to students than was the case for the typical two-year college campus.

We also asked about a potpourri of other efforts that departments might make to enrich their physics program and enhance the experience for their students. **Table 11** shows the sixteen different items we listed on the questionnaire, along with an option for the department to list other activities that they engage in. Once again, about three-quarters of the departments mentioned at least one thing that they did, and once again, virtually all of the pool and visited sites did so. As with recruitment and retention measures, the number of initiatives employed by campuses in the each of the three categories varied considerably, from 2.0 at sample schools to 4.2 at pool schools and 7.1 at the visited sites.

From **Table 11** we can see the most commonly-cited initiatives, with two of the most popular being curricular: a third of the departments offered courses geared to STEM majors distinct from transfer-oriented courses, and a fifth offered courses aimed specifically at future k-12 schoolteachers. Surprisingly,

Table 11. Other Program Enhancement Activities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% citing any of these activities	75%	94%	100%
Average number of different types of activities cited	2.0	4.2	7.1
Regular student advising for STEM students	24%	55%	78%
Faculty or peer mentor	19	23	22
Required meetings with advisor	10	15	11
Student study room or lounge	15	28	11
Physics or STEM club	10	28	78
Industrial internships	5	15	44
Summer research program	9	32	56
School year research program	9	17	22
School year co-op program	8	23	57
Outside advisors on advisory committee	2	5	11
Students on advisory committee	1	2	0
Alternative physics courses for different majors	14	15	44
Targeted courses for technology students	34	39	33
Courses for education majors	20	39	78
Track outcomes of physics majors	9	34	56
Track outcomes of STEM majors	8	34	67
Other	6	14	44

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only a quarter of schools mentioned offering advising to STEM students as regular part of their program, and only a fifth assigned a faculty or peer mentor as a matter of course. However, the programs deemed outstanding and selected for site visits were far more likely to have worked on fostering a nurturing atmosphere by, for example, developing clubs for physics or STEM majors, and they also are more likely to offer industry internships, co-op education opportunities, or summer work placements.

Finally, we asked about departmental efforts to track student outcomes. Only 36% of the sample schools, compared to 60% of the pool and 78% of the visited sites, engaged in any form of such tracking. **As Table 12** illustrates, the most common type of tracking effort reported was periodic surveys of past students,