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ABSTRACT

This study uses iterative solution techniques to determine empirically optimal standards for student to faculty ratios by discipline and student level for a group of 11 public, research universities. all of whom were members of the Association of American Universities. One set of benchmark standards was based on four-variable solutions within disciplines where the four levels were lower division, upper division, master's and professional, and doctoral. A second set of benchmark standards was based on six-variable solutions that separately identified individual instruction and dissertation hours. These benchmarks were derived through a statistical process that found the set of standards that best described the relationship between student credit hours and instructional full-time equivalency personnel (IFTE) within discipline for the 11 institutions. Benchmark instructional personnel costs were computed by linking predicted IFTE and the known distribution of IFTE among these institutions with benchmark salary information. Both of the benchmarks were more accurate than state formula funding standards and both models were reasonably accurate. Possible applications of the benchmarks in considerations regarding hiring and resource allocation are noted. Two tables which present the data are appended. (SW)

Comparable Standards for Credit Hour Production

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Jean Endo
Editor
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Abstract

Whether forced by financial pressures or flagging public support, calls for responsible use of resources require measurement of performance compared with empirical, pedagogical, comparative, or at least parochial standards. Except for parochial standards, higher education has few quantifiable benchmark measures against which to demonstrate efficient use of human resources for instructional purposes. This study uses iterative solution techniques to empirically determine optimal standards for instructional production by discipline and student level for a group of 11 public AAU institutions. The standards, and the technique used, are offered for discussion. This study also reports the distribution by discipline of tenure-track faculty, teaching assistants, and other faculty at these 11 institutions. The instructional standards are applied to sample campus data to demonstrate their use in creating *instructional efficiency indexes* for planning and evaluation. A method of extending the analysis to standards for instructional personnel costs is also presented.

Description of the Issue

How can it be that higher education has no widely accepted, publicly reported standards relating instructional personnel resources to instructional production? More important, how can we possibly demonstrate responsible use of resources without performance standards for instruction, our central purpose? The absence of performance standards is especially troublesome because being over or understaffed are bad situations calling for very different solutions. An understaffed institution can show improvement by producing fewer *student-credit-hours* (SCH) with the same *instructional full-time equivalent personnel* (IFTE) or by producing the same SCH with more IFTE. An understaffed institution cannot show improvement by producing more SCH with the same or fewer IFTE. The situation is reversed for the overstaffed institution. But to correct either situation, or to objectively defend current production, standards are needed that accurately relate instructional input to output. It would be better if student learning were an output variable associated with faculty input and the relationship between production loads and learning was understood. Unfortunately, that question remains beyond the scope of this paper. This paper assumes that the level of student learning is of an appropriate and acceptable level within these institutions. Instead, this paper will determine normative, benchmarks for SCH production per IFTE. The paper will further assume that the distribution of tenure-track faculty, teaching assistants, and other faculty at these insitutions reflects good practice.

A review of the available literature finds at least four possible sources of instructional production standards. The first comes from a body of research on the relationship between class size and learning (Smith & Glass, 1980) that shows increasingly larger gains associated with smaller classes (about 15 or fewer) and progressively smaller losses associated with increasing class size (Smith & Glass, 1980; Figure 4, p. 444). Unfortunately, there is no way to translate the curvilinear relationship into a practical standard without an established acceptable level of learning. In addition, the research has not been extensive enough to support disciplinary and student level differences at the college level. The second source comes from review of formula-funding standards of the type used by many state governments to determine the instructional component of state appropriations for general operating resources (Ahumada, 1990) but applies to any allocation system of relative weighting standards by student level (Dijkman, 1985; Skoro and Hryvniak, 1980; Smith, 1992). These standards are typically uniform across institutional types and were usually found through descriptive studies done at the time the funding ratios were established. Generally, these standards have changed little even though higher education has greatly increased in size and complexity. In defense of their use as performance standards, funding ratio standards do most often recognize disciplinary and student level differences and serve as a comparative standard, or at least served as comparative standards at some time in history. Unfortunately, if put to the test, the funding ratio standards are inaccurate descriptions of production for modern public research universities. Chatman (1993) reported that the mean error by discipline between predicted need for IFTE and actual IFTE using funding ratios was nearly 25%. A third possible source of instructional production standards is recent institutional history. Because it is by definition parochial, recent institutional history yields only a descriptive standard that can reflect change over time but fails to show direction for improvement. Parochial standards might show more SCH being produced per IFTE, but they fail to show whether that is better or worse. The fourth source relies on regular collection and exchange of information among similar institutions to support mathematical optimization solution techniques and yields a comparative standard. Optimization techniques, used this way, support statements of departmental performance relative to the collective performance of similar departments. The best fitting solutions are arguably a normative standard or benchmarks.

Both Allan M. Bloom (1983) and Chatman (1993) used iterative mathematical solutions to determine a set of common optimal standards by student level and discipline that minimized error between predicted and actual IFTE for the participating institutions. An iterative technique was required because the number of SCH generated by each campus, and the IFTE used to generate that SCH, describe a system of equations within each discipline. The iterative, optimization technique derives a common set of SCH standards by level that collectively best fits the system of equations. Using this approach, either the solutions of Bloom or Chatman show that the accuracy of formula ratios can be easily bettered.

Repeating an earlier observation, it is remarkable that there is no widely accepted and commonly held set of standards regarding the relationship of IFTE used to SCH produced. It is more remarkable that no set of normative standards exists given that there is widespread agreement on the principal factors of the relationship: student or course level, instructional type, disciplinary area, and faculty IFTE. To illustrate, with over 3,000 institutions offering lower division course work in English, semester after semester, year after year, there is no widely accepted set of standards regarding the relationship of personnel resources (IFTE) to production (SCH) in English or any other field.

Perhaps there are some very good reasons why that is the case. Maybe institutional characteristics and missions preclude the formation of normative standards. Possibly, public and independent institutions and selective and open institutions teach very differently, reflecting different student bodies, missions, and institutional philosophies. Conceivably, there is too much heterogeneity for a universal student-to-faculty ratio in lower division English courses. But then, if course size is first a reflection of instructional delivery strategy, it is difficult to imagine that there is more between institution variance in delivery within student level and discipline than there is within institution variance by level and discipline. If there should be considerable consistency in instructional method by level and discipline within similar institutions, then there should be a solution able to best describe the relationship between IFTE used and SCH produced.

Methodology

The most obvious method to find normative student to faculty ratios within discipline and level would be to simply collect that information from a set of similar institutions, report descriptive measures, and examine the degree of dispersion. However, such a collection does not readily exist and its creation would require considerable effort by many institutions. A second method would be to rely on existing data exchange information and determine the set of SCH standards by level that yield least error within common disciplines for a set of similar institutions. This second, unobtrusive, method is the method employed in this paper and its goal is similar to that of Bloom's (1983) "Differential Instructional Productivity Indices" and Chatman's (1993) "Empirically Determined Student Level Weighting Factors by

Academic Discipline."

Specifically, there are data sharing consortiums that regularly exchange information about credit hour production output by student level and discipline. Credit hour production by student level and discipline is exactly the output information needed for a descriptive study. Unfortunately, on the input side of the equation, exchanges may only share total IFTE by discipline, not IFTE distributed by student level of SCH output. The absence of IFTE by student level information prevents straightforward descriptive analysis. What is required instead is an iterative mathematical solution or a statistical approach.

Bloom (1983) recognized that it was possible to unobtrusively determine a normative standard for credit hour production from the information available through a regional exchange. Specifically, he asserted that there may exist a set of SCH standards by level within discipline that best fits a collection of institutions and this set of SCH benchmarks can be found using optimal solution techniques. The method Bloom used in his three-dimensional solution assumed that there was one best relationship between instructional effort and output by level within discipline. His method further assumed that error about this true relationship would be distributed normally within a set of 20 *Southern University Group Teaching Load Data Exchange* institutions. Bloom noted (1983, pp. 189-190) that the model showed promise and was particularly interested in the model's degree of stability across time and institutional type. Bloom's model included discipline (two-digit CIP level), course level (lower, upper, and graduate), and IFTE. Chatman (1993) employed a similar iterative technique but extended course level distinctions to four ɔls: lower, upper, masters and first professional, and doctoral. Chatman also used data from an arguably more homogeneous data exchange of 20 public AAU institutions and the solution technique employed by Chatman required no parametric assumptions. Chatman reported marked improvement in accuracy over state formula ratios and Bloom's solutions for public AAU institutions.

This study extends the work of Chatman (1993) in three important ways. First, the group of 20 institutions was reduced to 11 by including those public AAU institutions with complete and consistent records for the fall semesters of 1990, 1991, and 1992. This reduction was imposed because subsequent analysis of the 1993 data suggested inconsistencies and anomalies in reporting by some institutions. In addition, a three-year period provides a more stable representation of activity. The 11 institutions were the Universities of Colorado (Boulder), Florida, Kansas, Missouri (Columbia), Nebraska, North Carolina (Chapel Hill), Texas (Austin), Virginia; Iowa State University, Purdue University, and SUNY Buffalo. The second extension of the 1993 study was the addition of eight disciplinary areas: agriculture, architecture, area and ethnic studies, home economics, leisure sciences, medical technology, public administration, and vocational/technical areas. The resulting 26 disciplinary areas provide a more comprehensive representation of campus academic programs. The third extension of the 1993 study is that two instructional types, individualized instruction and dissertations hours, were treated as additional variables. Treating individualized instruction and dissertation hours as additional variables expanded the four-variable model to a six-variable model. In addition, this study avoids Chatman's (1993) dubious use of restricted solutions based on the error of the model's fit to the data. Instead, the restriction to institutions with complete and consistent records for three years should have a similar effect without imposing arbitrary standards.

The method of solution used to find best fit was the technique available using *Microsoft Excel's Solver* program. *Solver* dynamically exchanged data with *Excel*, passing values back and forth in an iterative manner, until a locally optimal solution was found or until the solution could not be improved upon. The solution technique options used in this study were: tangent option using linear extrapolation from a tangent vector with forward differencing derivatives for estimates of partial derivatives and a quasi-Newton method search (Tangent, Forward, Newton options). The other available option selections were tested and found to have little effect on the optimal solution.

Solver attempted to minimize mean absolute difference between actual and predicted IFTE need where the fit by institution was equally weighted. Briefly, various student to faculty ratios by level of student were tried by *Solver* and the error between the resulting IFTE required by the ratios and the actual IFTE was assessed and compared against prior solutions until ratios were found that minimized mean error. The solution was constrained in two ways. First, the SCH expectation for higher student levels could meet but not exceed that of lower levels. Second, all SCH expectations had to be greater than zero. These constraints were asserted as required of any solution that was to be considered generally reasonable.

It should be understood that this technique did not produce a single best solution, a problem inherent to the solution technique and common to Bloom (1983) and Chatman (1993). To some unknown extent, the terminal solution was influenced by the initially seeded values. One method to examine the robustness of the terminal solution would have been to offer a series of initial values and repeat the solution. Another method to control variance due to seeded values, the one used here, began with a uniform set of SCH ratios found by a regression fit to all observations (the inverses of normalized beta weights). The common seeded values were used to find an initial solution (see Universal Model in Table 1). *Solver* was reactivated until change produced improvement in mean error of less than 1%. To evaluate whether it was important to distinguish individual instruction and dissertation hours from other SCHs, iterative solutions were also found for four-variable models (lower, upper, masters and professional, and doctoral) using state funding formula ratios. The use of state funding formula ratios in a four-variable model was a replication of the method reported by Chatman (1993).

Although the initial, seeded, solutions for the six-variable models came from a comprehensive regression model, regression was not suitable for many disciplinary solutions. The reason regression did not work well in series of equations like these was because the solution parameters and relationships between parameters could not be restricted to ranges that most would accept as valid. When solutions were tried at the disciplinary level, regression tended to maximize fit at the expense of reasonableness. One the other hand, the relative values of the parameters of the iterative method could be restricted in a way that increased face validity. The parameters were restricted so that SCH production expectations per IFTE were equal or decreased as student level increased.

One final note about the solution methodology employed concerns the definitions of SCH and IFTE. Instructional full-time equivalent faculty was found by combining all appointments supported by departmental accounts for instruction. That faculty FTE supported by restricted funds, whatever the source, was excluded, but the FTE of graduate assistants supported by instructional accounts was included. In addition, the appointment of faculty or other teaching personnel providing instruction in other departments was distributed across the departments in proportion to course assignments. The data exchange includes information about IFTE by tenure-track faculty, teaching assistants, and others faculty, but that distinction was not made in this phase of the analysis for two reasons. First, because the credentials of the person providing instruction, while important, was irrelevant to the solution. Credentials were irrelevant because the unit of analysis, SCH produced, logically could not be function of rank -- A full-professor teaching a class of 30 does not produce more SCH than a part-time adjunct instructor teaching a class of 30. The second reason was based on the assumption that the relative distribution of IFTE was similar for this homogeneous collection of institutions.

In the last section of this paper, the benchmark standards are applied to actual SCH production at an institution not included in the research data base of 11. The relationship between the resulting IFTE need and actual IFTE by discipline is expressed as an *instructional efficiency index* (IEI). The IEI was introduced by Chatman (1993) and has been changed to a simple index in this paper. The 1993 index reached a maximum of 100 and fell below 100 as the absolute value of the difference between IFTE need and IFTE actual increased. In this paper, the ratio becomes a more straightforward measure, exceeding 100 when actual IFTE exceeds IFTE need (overstaffed) and falling below 100 when actual IFTE falls below need (understaffed). Expressing the IEI in this manner identifies direction for improvement.

Results

Table 1 displays the state formula, four-variable, and six-variable optimal solution ratios and their mean accuracy for the set of 11 AAU public institutions. The mean state formula ratios were collected by for a Colorado Commission on Higher Education study and were shared by Erica Gosman while with the University of Colorado System. The optimal solutions were substantially better than the formula funded ratio for most disciplines. On average, the mean error of state formula ratios was 23%, being highest in law (63%) and lowest in the physical sciences (5%). The six-variable optimal solutions averaged 13%

error and the range of error for the six-variable optimal solutions was somewhat better, from a high in multi/interdisciplinary studies (34%) to a low in the visual and performing arts (5%). Four-variable solutions were similarly better than formula funded ratios, 13% mean error, and were better than six-variable solutions in seven disciplines. The most notably disciplinary advantage for a four-variable solution was architecture where the four-variable solution exhibited 6% less error. The most notable disciplinary advantage for a six-variable solution was public administration where error was 9% less. The most likely explanation for these differences is that the seeded solutions lead to local optimal solutions that were not absolutely best. For the remaining 24 of 26 disciplinary areas, the difference in mean accuracy between the four- and six-variable solutions was 3% or less. As a matter of practice or convenience, four-variable models are probably adequate but six-variable models are slightly more accurate. The six-variable models were more accurate in 14 cases.

Insert Table 1 About Here

Clearly, it is unlikely that state formula ratios are the norm in practice among public AAU institutions, at least in most disciplines. On average, it is much more likely that the optimal solutions represent a normative standard. In six areas the optimal solutions provide a very good fit: agriculture at 7%, engineering at 6%, letters at 8%, mathematics at 9%, physical sciences at 6%, and visual arts at 5%. In four areas, the data were not fit well by the optimal solution: area and ethnic studies at 32%, health sciences at 21%, leisure sciences at 30%, and multi/interdisciplinary sciences at 34%. It may be the case that the curriculum of these four disciplines is too diverse to be fit well by uniform solutions. The remaining 16 disciplinary areas were fit reasonably well by the optimal solution technique as evidenced by mean error of 10% or less for most. In addition, the solutions found for this set of 11 institutions with complete and consistent records were about 6% more accurate than those reported by Chatman in 1993.

Application of Instructional Efficiency Indexes

The ratio of IFTE generated by the model benchmarks to actual IFTE, times 100, yields an index that arguably reflects the efficiency with which instruction is delivered, the IEI. For the second part of this paper the normative, or benchmark standards, computed in the first part were applied to recent enrollment information for a sample public AAU institution that was not part of the research data base for this study. The institution in question is a large public research I university and AAU member.

To illustrate the computational technique used, instruction in mathematics will serve as a disciplinary example. In mathematics, the sample institution produced 20,494 SCHs at the lower division, 7,070 at the upper division, 1,259 at the masters level, and 1,438 at the doctoral level. There were 24 individual instruction SCH produced and 383 dissertation research hours. Applying the standards from Table 1 yields the following need for faculty. The 20,494 lower division SCHs created the need for 54.4 IFTE (20,494/377). Likewise, SCH production at the other levels created the need for 24.7 IFTE at the upper division, 6.7 IFTE at the masters, 17.8 IFTE at the doctoral, 0.2 IFTE for individual instruction, and 21.3 IFTE from dissertation hours. Together, there was a need for 125.1 IFTE. At this campus, there were actually 158.5 IFTE devoted to mathematics instruction. Based on the "normative" standards, this department was overstaffed by over 33 IFTE, an IEI of 127. In a similar manner, the IFTE requirements generated by SCH production in each discipline can be accumulated across disciplines to produce a campus total. For this campus, the total IFTE was 2,611. The actual IFTE was 2,749, an IEI of 105.

In many disciplinary areas, actual and predicted IFTE were within 10% (index values of 90 to 110). This was true in architecture, communications, engineering, foreign languages, health sciences, law, life sciences, multi/interdisciplinary, psychology, social sciences, and the visual and performing arts. The institution was apparently understaffed by more than 10% in area and ethnic studies, business and management, and public affairs. Compared with the standards developed from the group of 11 institutions, this institution was more likely to be overstaffed by more than 10% than understaffed. In eight areas, the IEI was greater than 110, suggesting overstaffing by more than 10%: education, letters, library sciences, mathematics, leisure sciences, philosophy, physical sciences, and agriculture and natural resources. It may prove true that what appears to be overstaffing may be a necessary condition of programs of comparative excellence or a simple by-product of instructional practices chosen with knowledge that they may be more costly.

The Composition of Instructional Faculty

The solution technique and the application method have assumed that three types of instructional personnel were equally productive, or more specifically, that credit hour production was not a function of faculty rank or classification. The technique has equated the FTE of tenure-track faculty (tenured or on-track), other faculty, and graduate teaching assistants. Knowing IFTE relative to a benchmark standard is the first step in providing efficient instructional delivery. The second step is to balance personnel costs and expertise in teaching assignments. Academic administrators must juggle the higher cost of core tenure-track faculty, the more moderate expense of practicing professionals teaching in an adjunct capacity, and the low cost of inexperienced teaching graduate students with the responsibility of providing high quality instruction. One frame of reference for the academic administrator is the relative distribution of these three teaching personnel classifications by discipline for these same 11 institutions. This information is presented in Table 2.

Insert Table 2 About Here

Table 2 displays the proportion of instructional full-time equivalent faculty that were tenure-track, other faculty, or teaching assistants. The proportions were based on the aggregate of faculty by discipline across institutions and are therefore weighted measures. For example, the total FTE of instructional personnel at these 11 public research universities in Letters was 50% tenure-track, 10% teaching assistants, and 40% other faculty. The distribution of instructional personnel types varied widely by discipline. Greatest reliance on tenure-track faculty was in agriculture and law where 81% were tenure-track. Least reliance on tenure-track faculty was in foreign language (46%) and multi- and inter-disciplinary (39%). Graduate teaching assistants contributed most in computer science (42%), letters (40%), mathematics (40%), and physical sciences (43%) but were a small part of law (5%) and medical technology (7%). The residual classification of "Other Faculty" was most important in medical technology

(26%) and in multi- and inter-disciplinary (29%) and least important in engineering (5%) and psychology (4%).

The ability to link a benchmark need for instructional faculty with a referenced distribution of instructional personnel creates the opportunity to begin to examine instructional personnel costs. If the predicted total need for instructional personnel, computed from Table 1, is distributed by the proportions shown on Table 2 and the resulting IFTE by instructional group is multiplied by the average salaries of those personnel at comparable institutions, then the resulting instructional personnel costs can be compared to actual costs as a second level of analysis.

Conclusions

If instruction is the primary mission then SCH is the principal product and the relationship between SCH production and the personnel resources required to produce them is central to any realistic discussion of public accountability. Instruction is the single largest expenditure. But, this discussion cannot proceed without asserted standards. It is true that occasionally the relationship between SCH production and IFTE expenditure is expressed as a student-to-faculty ratio and is offered as an accountability measure, but even then, the definitions of both students and faculty are subject to many interpretations and there is no recognition of commonly accepted workload distinctions by discipline, student level, and course type. For these and other reasons, institutional student to faculty ratios are inaccurate and misleading.

This paper asserted two sets of production standards, collections of benchmark standards, based on data shared by AAU public institutions. One set of benchmark standards was based on four-variable solutions within disciplines where the four levels were lower division, upper division, masters and professional, and doctoral. The second set of benchmark standards was based on six-variable solutions that separately identified individual instruction and dissertation hours. The four- and six-variable production benchmarks were derived through an iterative process that found the set of standards that best described the relationship between SCH and IFTE within discipline for 11 public, research, AAU institutions. Both the four- and six-variable models were more accurate than state formula funding standards and both the four- or six-variable models were reasonably accurate though the six-variable models were on average more accurate (about 1% less error).

As described previously, the relationship between actual IFTE and the IFTE suggested by the benchmark standards can be expressed as the IEI. The computation of the index was illustrated using the data for a public research I institution that was not a part of the research data base. For the sample institution, optimal productivity benchmark standards were applied to SCH figures by discipline to produce needed IFTE. Of the 22 disciplinary areas reported by the campus, three were more than 10% understaffed, eight were more than 10% overstaffed, and 11 were within 10% of the computed IFTE need. Overall, the campus was within 5% of predicted need according to the model (IEI = 105).

At this point, instructional characteristics associated with low or high IEI values remain unclear. As alluded to earlier, high IEIs might be required for comparable excellence and low IEIs with comparative mediocrity. But that remains unknown. All that can be clearly stated at this time is that disciplinary areas within an institution with low or high IEIs are apparently using IFTE differently than the collective norm. The result of doing so may be greater student learning at greater cost for high IEIs or less cost with equivalent levels of learning for low IEIs, but no conclusion can be made here to link learning with the IFTE/SCH relationship. Instead, this paper has assumed that the mean learning outcome by discipline for this set of 11 public AAU institutions was acceptable. The paper also assumed that disciplinary composition within two-digit CIP was equivalent or that differences were inconsequential.

Instructional full-time equivalence is one piece of the instructional cost puzzle. A second piece is the judicious use of less expensive teaching assistants and other faculty. The paper reported a method to compute benchmark instructional personnel costs by linking predicted IFTE and the known distribution of IFTE among these institutions with benchmark salary information. It was shown that the proportion of IFTE that were tenure-track, teaching assistants, and other faculty varied with discipline for these 11 public AAU institutions.

Should a decision about whether to fill a vacancy in a department be based on these standards alone? Should instructional personnel costs resulting from the distribution of the IFTE standard be used to decide whether to fill a position with an adjunct instead of a tenure-track faculty member? The answer to either of these questions, or to any question based solely on the use of these standards, is of course not. But should we ignore the information gained from the use of these standards? What standards would be used instead? The best use of this information would probably be to begin the discussion of standards and to modify record keeping processes so that IFTE and SCH can be clearly linked and the appropriate distribution of IFTE discussed openly. In the mean time, the *instructional efficiency index* and the relative distribution of instructional personnel by type can be used as one of several measures of performance. To an administrator a low IEI might support a request to hire more faculty or to fill vacant positions. A high IEI might flag a department for further study, especially if there were no special or extenuating circumstances. Similarly, a department whose tenure-track faculty constitute a much larger proportion of instructional personnel than is typical for that discipline may give cause for further study. However, taking decisive action based on these initial results would be inappropriate for two reasons. First, 11 institutions is a limited sample. Second, the standards did not fit some disciplines well.

Before production standards are routinely used in academic processes, the standards should be measured against actual instructional practice for these institutions and others. The iterative process used to find the optimal solution may not have produced a reasonable solution at all, just one that happened to fit the data well. Take the standards for individual instruction in home economics as an example. The benchmark solution suggests that 1,095 individual instruction SCH were required to produce the need for one IFTE. Perhaps that is reasonable. Maybe individual instruction in home economics is essentially borne without additional IFTE. Perhaps not. To determine whether the standard for individual instruction in home economics is a statistical anomaly or a reasonably accurate reflection of instructional practice requires validation through descriptive studies. The results presented here show that normative benchmarks exist that are more accurate than other published standards. In addition, the accuracy of these results argues in support of the effort required to determine descriptive standards.

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Table 1: Solution Ratios by Discipline, Level, and Course Type

Discipline	#	Model	FTE LD	FTE UD	FTE MA	FTE PhD	FTE II	FTE Diss	SCH LD	SCH UD	SCH MA	SCH PhD	SCH II	SCH Diss	Mean Accuracy
Universal Model		6-Variable	23	16	15	5	8	3	348	246	175	55	127	37	
Agriculture	5	Formula Funded	18	14	7	5			270	210	84	60			45%
		4-Variable	18	16	12	12			276	237	142	142			8%
		6-Variable	18	18	13	6	11	11	277	267	160	67	166	129	7%
Architecture	9	Formula Funded	17	13	7	5			255	195	84	60			30%
		4-Variable	27	18	8	2			399	271	98	25			7%
		6-Variable	23	15	12	3	7	2	341	222	149	33	105	22	13%
Area & Ethnic	7	Formula Funded	22	17	9	6			330	255	108	72			40%
		4-Variable	23	17	4	4			345	256	53	53			35%
		6-Variable	25	18	13	5	9	0	375	267	161	63	131	5	32%
Business	11	Formula Funded	22	18	10	7			330	270	120	84			30%
		4-Variable	26	26	10	10			397	397	116	116			10%
		6-Variable	28	28	9	9	38	15	414	414	104	104	568	181	11%
Communication	10	Formula Funded	20	16	9	7			300	240	108	84			16%
		4-Variable	31	17	5	5			459	254	60	60			12%
		6-Variable	31	18	4	4	11	7	465	271	46	46	160	88	11%
Computer Science	11	Formula Funded	20	14	8	5			300	210	96	60			12%
		4-Variable	24	9	12	7			363	142	142	81			10%
		6-Variable	23	10	12	9	8	6	349	144	144	111	127	66	10%
Education	11	Formula Funded	20	17	9	7			300	255	108	84			16%
		4-Variable	14	14	18	6			211	211	211	75			11%
		6-Variable	23	17	15	6	9	5	349	249	179	70	131	57	12%
Engineering	10	Formula Funded	17	12	6	5			255	180	72	60			14%
		4-Variable	14	9	12	12			216	140	140	140			5%
		6-Variable	23	10	12	7	9	7	339	146	146	82	135	88	6%
Foreign Language	11	Formula Funded	19	13	8	5			285	195	96	60			14%
		4-Variable	22	14	4	3			333	216	42	34			11%
		6-Variable	20	13	14	3	8	1	304	188	166	32	116	13	11%
Health Sciences	11	Formula Funded	13	10	6	5			195	150	72	60			30%
		4-Variable	26	12	6	5			397	180	67	58			26%
		6-Variable	16	16	7	2	9	3	236	236	81	22	133	38	21%
Home Economics		Formula Funded	20	14	8	6			300	210	96	72			17%
		4-Variable	23	12	15	15			347	174	174	174			15%
		6-Variable	148	9	11	11	73	100	2,215	135	135	135	1,095	1,205	12%
Law	9	Formula Funded	23	19	12	11			345	285	144	132			63%
		4-Variable	22	19	24	14			336	285	285	171			12%
		6-Variable	23	19	24	15	7	3	339	287	287	183	109	37	10%
Leisure	6	Formula Funded	24	17	9	6			360	255	108	72			31%
		4-Variable	29	29	13	11			435	435	159	134			31%
		6-Variable	24	18	14	3	20	0	355	273	171	31	297	4	30%
Letters	11	Formula Funded	21	16	9	6			315	240	108	72			13%
		4-Variable	34	9	11	6			507	133	133	66			7%
		6-Variable	21	12	14	5	7	5	314	179	164	60	111	57	8%

Table 1: Solution Ratios by Discipline, Level, and Course Type -- Continued

Discipline	#	Model	FTE LD	FTE UD	FTE MA	FTE PhD	FTE II	FTE Diss	SCH LD	SCH UD	SCH MA	SCH PhD	SCH II	SCH Diss	Mean Accuracy
Library Science	4	Formula Funded	20	16	9	6			300	240	108	72			23%
		4-Variable	20	16	11	6			301	242	136	74			11%
		6-Variable	23	16	13	4	8	3	347	243	152	44	124	33	11%
Life Science	11	Formula Funded	20	14	7	5			300	210	84	60			15%
		4-Variable	39	7	9	9			585	107	107	107			12%
		6-Variable	38	7	9	4	8	58	568	110	110	51	116	696	10%
Mathematics	11	Formula Funded	22	15	8	6			330	225	96	72			44%
		4-Variable	26	26	16	3			383	383	191	35			10%
		6-Variable	25	19	16	7	8	2	377	286	187	81	125	18	9%
Medical Technology	4	Formula Funded	13	10	6	5			195	150	72	60			21%
		4-Variable	13	10	6	5			195	150	72	60			21%
		6-Variable	23	5	6	3	9	3	339	74	74	34	141	30	18%
Multi/Interdisciplinary	6	Formula Funded	23	17	9	6			345	255	108	72			45%
		4-Variable	25	16	21	11			381	246	246	132			35%
		6-Variable	25	17	18	13	16	4	376	251	218	155	233	53	34%
Philosophy	11	Formula Funded	22	17	9	6			330	255	108	72			12%
		4-Variable	22	14	12	12			331	217	146	146			12%
		6-Variable	22	16	14	4	9	12	337	233	173	48	140	146	11%
Physical Science	11	Formula Funded	20	13	7	5			300	195	84	60			5%
		4-Variable	19	14	9	4			292	203	105	50			5%
		6-Variable	20	12	13	3	8	7	296	185	157	30	115	81	6%
Psychology	11	Formula Funded	24	17	9	6			360	255	108	72			18%
		4-Variable	43	16	11	5			641	245	129	56			13%
		6-Variable	40	24	17	7	6	2	597	365	199	78	89	20	12%
Public Administration	5	Formula Funded	21	17	9	6			315	255	108	72			32%
		4-Variable	21	17	9	9			310	254	113	113			25%
		6-Variable	15	15	8	8	69	4	226	226	101	101	1,034	48	16%
Social Science	11	Formula Funded	24	17	9	6			360	255	108	72			18%
		4-Variable	47	24	17	2			699	357	201	25			8%
		6-Variable	30	22	17	7	12	2	449	330	201	80	185	23	11%
Visual Arts	11	Formula Funded	16	12	7	5			240	180	84	60			8%
		4-Variable	16	11	7	3			236	167	84	33			5%
		6-Variable	21	9	11	3	9	2	311	134	134	32	130	18	5%
Vocational/Technical	3	Formula Funded	20	14	8	6			300	210	96	72			20%
		4-Variable	17	17	21	5			248	248	248	65			10%
		6-Variable	17	17	21	4	17	4	249	249	249	53	255	43	10%
Unweighted Mean		Formula Funded	20	15	8	6			301	224	99	71			24%
		4-Variable	25	16	12	7			370	237	138	86			14%
		6-Variable	29	15	13	6	16	10	429	229	156	70	234	123	13%

Terms: IFTE is instructional full-time equivalent appointments and is a measure of that part of all appointments supported by departmental instructional accounts. It includes graduate teaching assistants and others providing instruction but excludes that part of appointments supported by restricted accounts, principally externally supported or separately budgeted research. Lastly, IFTE was distributed across the departments where faculty taught according to the credit hours of course assignments. SCH is student credit hour and carries the usual meaning of enrollment times course credit hour value. The student level labels were: LD was lower division, UD was Upper Division, G1 was masters and professional, G2 was doctoral, II was individual instruction, and Diss was dissertation hours.

Table 2: Distribution of Instructional Faculty by Discipline and Type

	Percentage Distribution		
Discipline	Tenure-Track Faculty	Teaching Assistants	Other Faculty
Agriculture	81%	12%	7%
Architecture	70%	16%	15%
Area & Ethnic	59%	26%	15%
Business	64%	25%	11%
Communication	53%	30%	17%
Computer Science	50%	42%	8%
Education	66%	22%	12%
Engineering	69%	26%	5%
Foreign Language	46%	41%	12%
Health Sciences	64%	17%	19%
Home Economics	63%	23%	14%
Law	81%	5%	14%
Leisure	68%	20%	12%
Letters	50%	40%	10%
Library Science	57%	25%	18%
Life Science	59%	33%	8%
Mathematics	53%	40%	7%
Medical Technology	67%	7%	26%
Multi/Interdisciplinary	39%	32%	29%
Philosophy	60%	31%	8%
Physical Science	53%	43%	4%
Psychology	60%	34%	6%
Public Administration	67%	13%	20%
Social Science	64%	29%	8%
Visual Arts	67%	22%	11%
Vocational/Technical	76%	13%	10%
Total	61%	29%	10%