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PUBLIC K-12 EDUCATION AS AN INDUSTRIAL PROCESS: THE SCHOOL AS A FACTORY

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ABSTRACT. In this paper we argue that public education in the United States is essentially an industrial process organized to produce a finished product. Rising government spending on public education, and the lack of an established rubric to evaluate school performance or accountability deems our analysis relevant and timely. Viewing education as an industrial process will allow policy-makers to obtain more accurate measures of costs and develop appropriate funding mechanisms. Furthermore, regulators may use managerial accounting concepts, particularly activity based costing, to establish future school performance evaluation rubrics.

INTRODUCTION

The funding of public elementary and secondary education has reached a crisis point throughout the United States. Increased federal government involvement in local school funding has come with a significant cost, given the enactment of the No Child Left Behind Act of 2001. There seems to be little agreement about what the costs of education are, how expenditures are related to outcomes or how either outcomes or costs should be measured. According to

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the National Center for Education Statistics, total education expenditures were $972 billion in the 2006-07 school year, of which 62 percent was spent by elementary and secondary schools (Zhou, 2008). Furthermore, total expenditures for education represented approximately 7.4 percent of gross domestic product in 2006-07 (Zhou, 2008). Considering the magnitude of education spending, a continued lack of an established relationship between costs and outcomes will further hinder educational efficiency. Furthermore, failure to view education spending as a process hinders efficiency and does not hold legislators accountable for the billions of tax dollars spent on education.

In this paper we argue that public education in the United States can be modeled as an industrial process organized to produce a finished product. We believe the finished product of any school system is essentially a diploma-earning graduate. This product is manufactured in a factory called a school, which in every way resembles a factory that makes any kind of long-lived durable good. As horrifying as this characterization may be to professionals in the education industry, there are some significant advantages to taking this perspective.

First, and from our point of view, most important, using an industrial model allows us to apply many of the concepts that have been learned in recent years about measuring and controlling costs. In particular, the techniques grouped together under the rubric of activity-based costing (ABC) can be applied to the educational enterprise. The use of an ABC rubric may assist federal and state regulators in developing a model to measure and evaluate school performance and efficiency. Secondly, when we understand the costs of education in the context of an industrial production model, we can develop more realistic funding mechanisms. Most of the funding mechanisms in place at the state and local level are archaic, inefficient and do not gain the maximum product for the resources consumed in production.

Third, by having a better understanding of the activities that generate costs in education, we can identify several pertinent activities, including value-added, business-value-added, and non-value added activities. Value-added activities are those that actually contribute to the production of the product, while business-value-added activities are those that must be done to meet the legal and

practical operating requirements of the entity. Non-value added activities are those activities that consume resources but provide no value at any level. Of course, once these latter activities are identified, they can be eliminated, freeing resources to enhance value-added activities.

Finally, the knowledge of how activities affect costs will provide a clear picture of what products are subsidizing what other products. Once the true cost of some products is known, the policy makers who decide how educational resources are used will be better able to choose among alternative uses of scarce resources. Debates surrounding public school funding will continue so long as legislators fail to understand the cost process of education. Establishing a model of the education process will allow for greater efficiency of tax expenditures. Furthermore, the increased efficiencies produced by understanding costs of the educational process may lead to an increased production of quality students.

The remainder of the paper is organized as follows: Section 1 discusses school funding literature, and section 2 begins the discussion for modeling the school as a factory. Sections 3 and 4 address what researchers can learn from applying process costing in the education factory; and section 5 provides concluding remarks.

SCHOOL FUNDING LITERATURE

The No Child Left Behind Act of 2001 has heightened public awareness of the relationship between public education and government expenditures for furthering student education and development. The issue of public school funding is relevant to academic researchers for many reasons, particularly given the lack of established models to measure educational performance and outcomes. Furthermore, increased government spending and involvement in the area of education has heightened the awareness of policy makers and taxpayers alike.

The responsibility for primary and secondary education in the United States predominantly lies with state governments. While the federal government provides significant funding, that funding is primarily programmatic, and governed by strict performance requirements. The general funding of education is left to state and local sources. Local sources of funding are primarily ad valorum

property taxes, sales or use taxes or some combination of those. For fiscal year 2006, the federal government provided approximately $47.5 billion to local education agencies for public elementary and secondary education (Zhou, 2008).

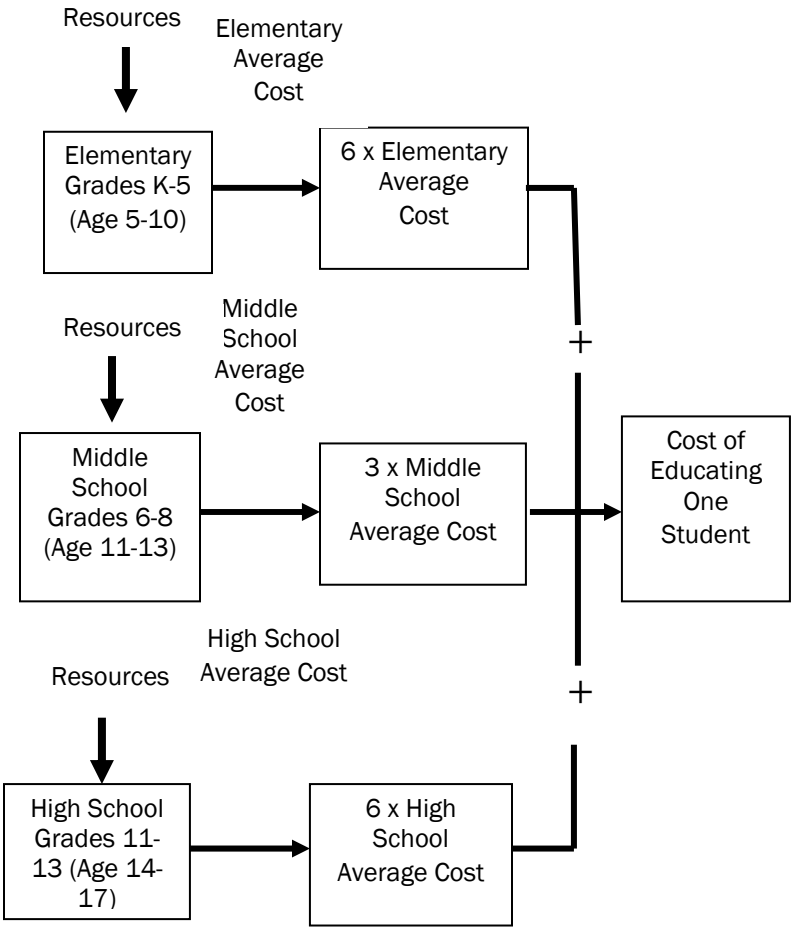
State funding, the largest source of money for public schools, is generally taken from general revenue sources and is allocated on the basis of some formula, called formula or foundation funding. This approach, which is used in the vast majority of states, allocates a base amount with increments for special circumstances or needs. The use of local property tax revenue for school funding is currently under tremendous debate (Snyder, 2003). It is frequently argued that because not all communities are equally property rich, schools in property-poor districts receive less than adequate support. Alternative financing mechanisms have developed over the years, including education vouchers and wealth transfer approaches such as the "Robin Hood" system used in Texas (Waring, 1996; Janssen, 2000; Benson & Marks, 2005). The Robin Hood system is an alternative funding technique whereby property tax funds from property- wealthy school districts are recaptured in order to supplement activities of poorer districts.

Intertwined with the issue of school funding is that of accountability and performance. Considering the size of expenditures for school funding and the increasingly constrained fiscal condition of states and local school districts, there is an ongoing call for these funds to be allocated and used in an efficient manner. Stakeholders, including parents, teachers, and legislators, argue methods should be developed to hold administrators accountable. Rubin (2004) illustrates that there is no concise method of reporting the performance of schools. The Government Accounting Standards Board (GASB) studied school performance accountability issues over a decade ago (Hatry et al., 1989). According to the report, several factors are necessary in order to properly evaluate education services. Necessary input measures are financial (i.e. expenditures) and labor (number of personnel). Outputs should be based on the number of students served, while efficiency measures include cost per student and cost per outcome.

The prevailing way to measure cost per student or cost per outcome is to compute a simple average cost. This does not provide a measure of an education for a student, but the much less useful

cost of an average year at a particular grade level. When the cost of educating a student dictates the cost object, the component costs do not all occur in a single year but are the accumulation of costs over the entire production cycle which is thirteen years. The proxy that would have to be used for the cost of a student under the existing costing regime would be weighted average cost of all grade levels in a year. Figure 1 depicts how this prevailing concept of the cost of education, with a focus on an average cost, would generate an estimate of the cost to educate a student.

FIGURE 1
Prevailing Concept of the Cost of Education



The issue of efficiency in school funding is under constant debate and scrutiny. Garner (1998) illustrated that greater efficiency may be obtained through more medium -sized school districts. Using six cost categories (classroom instruction, support services, classroom supplies and textbooks, total administrative services, operation and maintenance of physical facilities, and total cost per pupil), he determined that New Jersey's larger school districts were not always the most efficient. His findings support the argument of White et al. (1980) that at some point, efficiency is no longer profitable.

The establishment of a processing system for education costs is relevant and timely. Existing literature merely documents various levels of efficiencies for various school systems. The importance of accountability should not be overlooked, and viewing education as an industrial process is a first step to attempt to accurately measure and evaluate the costs of educating students. It will also shift the focus from the current emphasis on an annual average cost to an emphasis on the aggregate cost of an education.

THE SCHOOL AS A FACTORY

Given the vast amount of literature addressing school funding, to our knowledge this is the first paper to analyze public education in an industrial process. It is an unfortunate fact of life that in the United States the connotations that accompany the idea of a factory are highly negative. Factories are dirty, tedious, noisy and mind-numbing places that continuously generate units of products that are essentially sterile, lacking either originality or style. Equally unfortunate is that this is the way many people would describe public schools in the United States. However, it is not on this kind of specious comparison that we say schools are like factories. It is in a more substantial way. Just as factories have replaced crafters because there developed a demand for goods in amounts that could not efficiently be produced by hand, the public school has developed as a mechanism for efficiently and cost effectively producing a large number of formally educated people.

The similarities between factories and schools do not end there. In a factory, raw materials are entered into a production. These materials proceed through a series of processes, each of which prepares the unfinished product (called work in process) for the next process. When all processes have been traversed, the product is

completed and is transferred out of the production process as a finished good. The time accumulated from the introduction of the raw material through to the discharge of the finished good is called the cycle time.

In a very similar manner, a production process takes place in school. The raw material is the entering kindergartener who may have undergone some preprocessing at home or in a preschool center. This raw material is then channeled through thirteen separate processes which are called in schools, grades, which are sequentially numbered 1-12 with the initial process designated as K, thus we have K-12 education.

There is often confusion about what the product produced by a K-12 school system really is. Teachers and administrators argue that the product is education. Researchers, particularly, those who study school efficiency, treat scores on standardized tests as the product. However, the true product is defined by the customers who pay for the product. They are the taxpayer and their representatives, the legislators and education regulators. Almost universally, these customers define a unit of product as a graduate with a diploma. Therefore, consistent with these observations, we will define a school district as a multidivisional, single product company, our educational enterprise. This company has two major divisions, elementary and secondary. The secondary division produces the single product, one unit of which is a graduate with a diploma. The elementary division accepts the raw material, an entering kindergartener, into production. This division produces only intermediate products that have no market value and are transferred to the secondary division for further processing.

PROCESS COSTING IN THE EDUCATION FACTORY

Education is viewed inappropriately as a discrete process occurring over a single year. A more appropriate way of viewing education at the primary and secondary level is as a production process lasting thirteen years from the beginning of kindergarten to graduation. In process, the product is a student with a diploma. A direct input is the five –year- old child beginning kindergarten. The production is a classic example of process costing in which the child is processed through thirteen discrete processes each of which takes one academic year. Each grade is viewed as a process, and

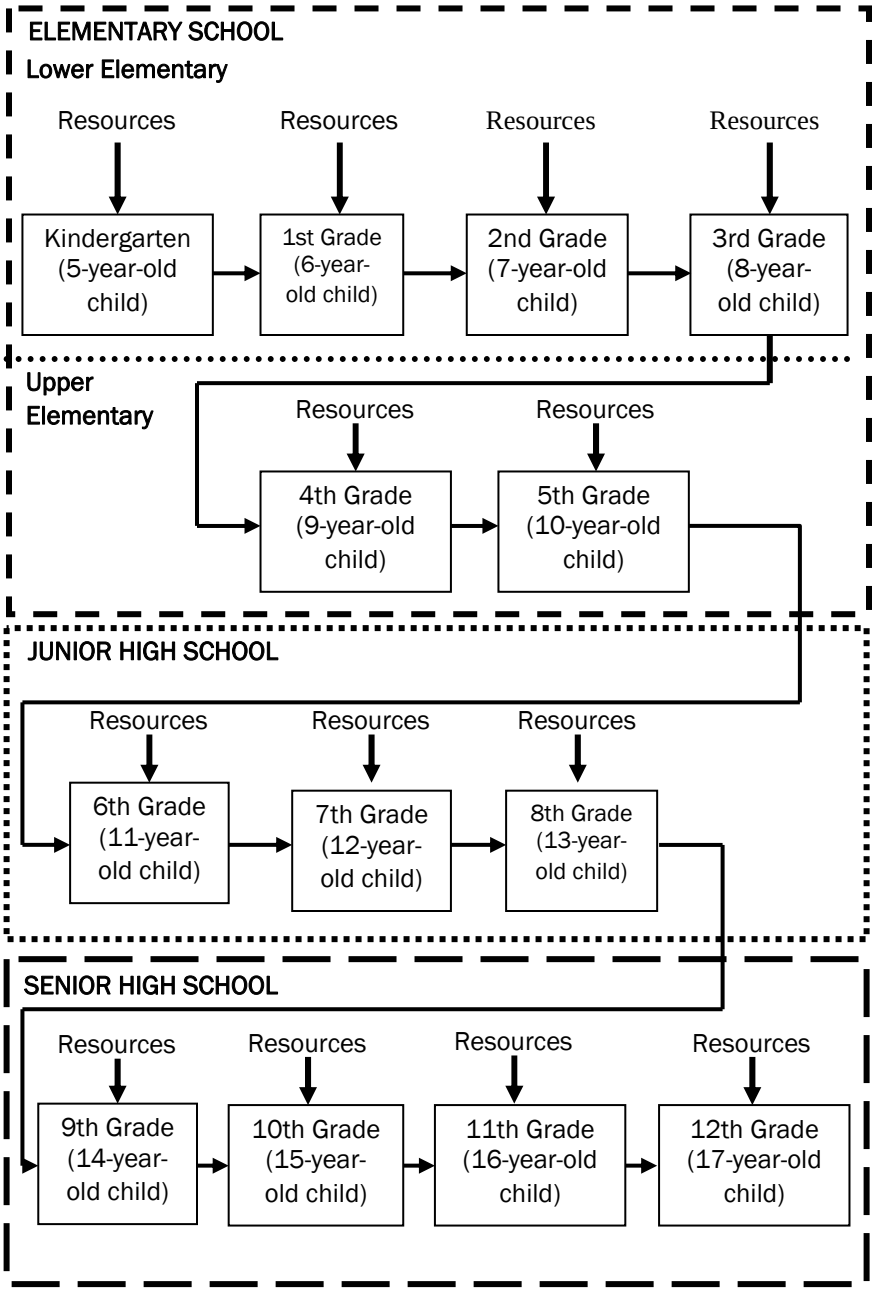
additional direct costs (including books and standardized tests) are added to "convert" the child (work-in-process) to enter the next process or grade. In addition there are processes that run in parallel with grades and add costs to the product. Extracurricular and special education are examples of these kinds of processes. Indirect costs that are added at each process include teachers' salaries, facilities and administration costs. Figure 2 graphically presents the process costing of primary and secondary education.

The standard cycle time for the production of one unit of product is thirteen years in the United States. Other elements of this scenario include rework costs and lost units. Rework occurs when a unit that has been completed by a process does not pass an inspection and must be recycled through a process. In schools, rework occurs when a student fails a grade or class. Lost units occur in a manufacturing process when more raw materials enter a production process than are reflected in the number for finished products produced. In our context, lost units are students who drop out of school and do not receive a diploma. A contentious issue with lost units in a manufacturing context is what constitutes normal lost units and what lost units are abnormal. As we will see this same question has considerable relevance in education as well.

What Can We Learn From the Factory?

The primary motivation for viewing the school as a factory is to apply the lessons learned by industry in product costing to the education enterprise. In a factory, with a much shorter cycle time than that in education, the cost of a unit of product like the one produced in the educational enterprise is measured using a form of accounting called process costing. In the most involved, but most useful form of process costing, standard costing, a standard price and standard quantity is determined for each input to the process. The cost of a unit of product is the standard cost (defined as the product of the standard price and the standard quantity) of each input used to produce one unit in a particular process summed across all processes from the beginning of production to the end. Costs in this system are of two types, direct and indirect. Direct costs are traced to a unit of product (i.e. a student) and indirect costs are allocated based on some systematic allocation scheme. Significant

FIGURE 2
Process Costing Model of K-12 Education



deviations from standard cost, called cost variances, are to be either eliminated or explained depending on whether the variances are controllable or noncontrollable. Such a system allows for control of costs throughout the entire production process. It also results in each unit of product (a student with a diploma) that has proceeded through the same set of processes (i.e. the same grades, courses and activities) to be cost at the same amount.

There are several elements of this model that are relevant to the discussion of education costs. The first is to clarify what is meant by the cost of a unit of product. Regularly we see the cost of education eliminated or explained depending on whether the variances are controllable or noncontrollable. Such a system allows for control of costs throughout the entire production process. It also results in each unit of product (a student with a diploma) that has proceeded through the same set of processes (i.e. the same grades, courses and activities) to be costed at the same amount. defined as the average cost per student per year within a particular school district. The factory model clearly points out the fallacy of such a measure. Since, in any one year, the students in a school are scattered throughout at least thirteen different processes. Many of these students are also receiving various kinds of special processing which also distorts the measurement of cost. The average cost per student is meaningless for anything other than polemic.

The standard processing cost system demonstrates that a unit of product is a student with a diploma. At a minimum, a standard cost system would allow for consistent comparisons across schools and districts since variances from standard would be the metric of comparison rather than mean expenditures per student. Schools that overspend would be expected to have unfavorable variances and schools that underspend would have favorable variances. An additional benefit would be identifying the processes that are significantly out of control, (i.e. that have highly unfavorable variances) instead of hiding those costs behind the blind created by the mean cost per student.

A second thing we discovered from viewing education as a production process is that there are very few direct costs, those costs that are traceable to the student, in the education process. An example of a direct cost would be the cost of a workbook that was issued to each student in a class, used during the school year and

discarded at the end of the year. Such a workbook would be traceable to each student in the class and is, therefore, considered a direct cost. On the other hand, the teacher's salary for that class is not a direct cost because the teacher's salary is not dependent on the number of students in the class. This is quite different from a typical manufacturing environment where there are ,generally, significant amounts of direct costs. In the education enterprise not even materials are a direct cost. The major input analogous to materials is the incoming student but the cost of the student is borne by the family, not the school. Recognition of the fact that most costs are allocated at the product level will be a significant incentive for using activity-based costing to determine the cost of a diploma.

A third item to note, although only anecdotally, is that there are large differences in cost per unit across the different processes or grades. Elementary classes are smaller, but at the same time require less sophisticated and less costly resources than do secondary classes. When we use average cost per student as a measure of cost, this difference is hidden in the averaging process.

There are two large departments in the education factory, primary (elementary) and secondary, each of which is composed of a number of different processes. As noted above, there are differences in costs between the two departments that arise because of differences in the amount and sophistication of resources used in each department. But another point we should note is that each of these departments is composed of a number of processes. There are major differences in the nature of the processes in primary or secondary education.

Primary education is essentially a set of linear processes beginning with kindergarten and progressing grade by grade through the rest of the elementary grades. At the secondary level, however, the grade level is almost meaningless. The processes are the classes in which students earn credit. While students typically progress through four grades, the real measure of completion is the earning of the necessary credits from their classes to graduate. We might view this as a series of parallel processes rather than a linear process. Two students who earn their diplomas together might well experience dramatically different costs depending on which set of processes they proceed through.

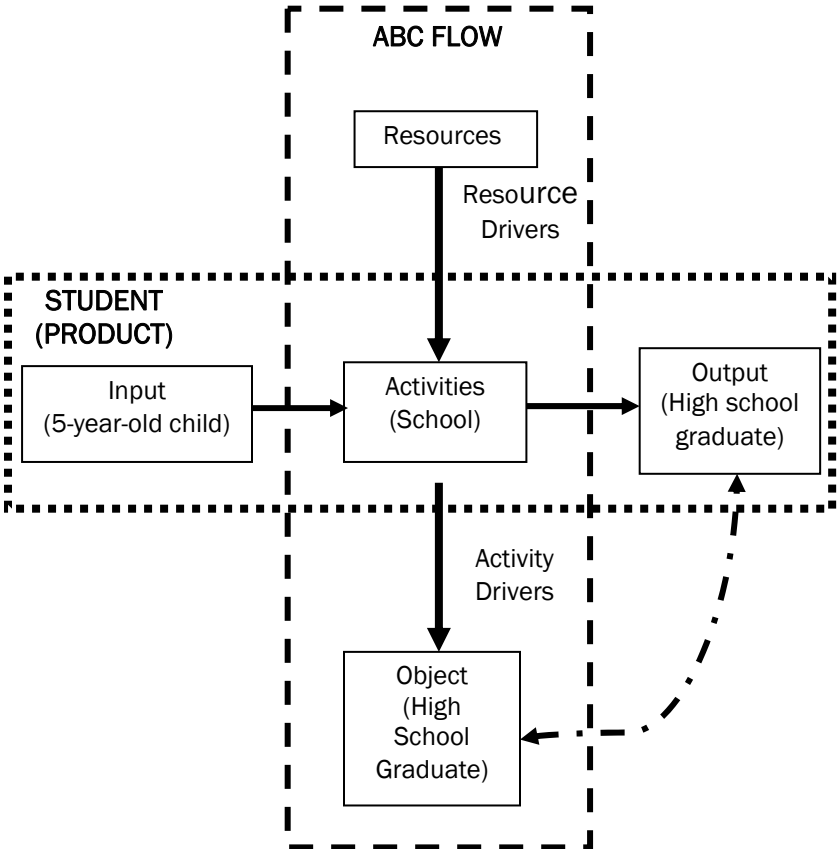
ACTIVITY BASED COSTING IN THE SCHOOL FACTORY

As we have stated, education costs are currently measured on a unit basis as the cost of one unit of the cost object. The cost object, the object for which we want to determine the cost, is a single fulltime equivalent student. The average cost per unit of production is defined as a student with a high school diploma. Over the last two decades many firms in the corporate setting have discovered that such a method of measuring product costs is not just inaccurate, but worse than meaningless. Using unit level product costing in an environment in which substantial amounts of product diversity exist seriously distorts the actual unit cost by shifting costs from high cost/low volume production to low cost/high volume production. This cross-subsidization produces cost information that distorts decision making and results in suboptimal resource allocations. Beginning with the work of Cooper and Kaplan (1988), these distortions were highlighted and a cost allocation method called activity-based costing or ABC began to be widely used to mitigate the effects of these distortions. More importantly, the larger the proportion of allocated costs, the more useful ABC became. Because of the dramatic affect implementation of ABC has had in business organizations and particularly in production environments, we used it to illustrate our thesis that treating the school as a factory will allow us to apply techniques that have proven useful in industrial contexts to the school setting. Figure 3 illustrates the ABC model as it would apply to the school factory.

Activity -based costing recognizes that each unit of production, in this case a student progressing toward graduation, consumes resources by requiring activities to be performed to complete the production process. The significant difference between ABC and the processing costing model described earlier is that in ABC a two-step process is used in which costs are first accumulated by activity; then those costs are allocated to the cost object by how much of that activity the cost object consumes. The vehicle used to relate the consumption of activities by cost drivers is called a cost driver. By analyzing cost drivers we can have a much clearer picture of what causes costs in the education process (Bjornenak, 2000).

In process costing the costs are accumulated by each process (grade) and each person in the class is allocated the same proportion

FIGURE 3
Modeling Activity Based Costing in Education



of the costs allocated to that class. Thus all students in a particular first grade class would be assigned the same cost. While this is better than the prevailing method which is to assume that all children in a particular elementary school cost the same to educate without regard to the size of the class or the grade level, this method still fails

to recognize the important fact that there are significant differences among the costs of students within the same classroom.

Consider this common example. A student in an elementary classroom requires speech therapy. The student is removed from the class for one hour a week for a therapy session. Under the prevailing approach, speech therapy is simply a cost associated with the elementary school and would be averaged over all of the students in the school, i.e. part of the average cost per student.

There are two possible approaches under the process costing model to address this speech therapy example. First, the cost of the speech therapist might simply be divided by the number of classrooms and that average amount charged to each classroom. Unless every classroom has exactly the same number of students, this method will result in a higher cost for speech therapy for classrooms with smaller- than- average populations and lower costs for ones with higher- than -average enrollments. A more refined approach would be to divide the therapist's salary by the number of students who receive speech therapy, then allocate costs to classrooms based on the number of students who receive therapy in a particular classroom. This adjustment results in a more accurate measurement of costs but ignores differences in the amount of time the therapist spends with each student.

In contrast to these approaches, activity- based costing would view speech therapy as an activity. The cost of this activity would be the sum of the therapist's salary and benefits, the allocated cost of facilities such as a dedicated classroom, the cost of any equipment used in speech therapy and any other costs associated with delivering speech therapy in the elementary school. Once we have identified the activity, we need to identify a cost driver that is something that clearly measures the amount of the activity used by a unit of production. In the case of speech therapy, the most obvious candidate is time spent delivering therapy to students. A rate equal to the estimated total costs of delivering therapy divided by the estimated number of hours available to deliver therapy would be the ABC rate for speech therapy. Then each student would be allocated costs equal to the product of the ABC rate and the actual time spent in therapy.

While this approach would be highly useful for measuring the actual costs of educating each student at the primary level, the impact would be much more dramatic at the secondary level. At the secondary level, virtually ever class would become an activity. So, for example, there would be dramatic differences in the cost of delivering a basic level science course and delivering an Advanced Placement physics course,. Furthermore, each extracurricular activity would become an activity as well. The cost of educating any particular student in a year would be the sum of the activity costs of all the classes, special services and extracurricular activities the student employed during the academic year.

Such a method of costing would provide valuable information to administrators about the costs of continuing existing programs or adding new ones. It would inform parents of the real cost of educating their children. It would also help explain to school patrons the reasons for rising education costs and maybe, most importantly, it would allow school districts to argue for school funding formulas that are tied to the real costs of delivering state and federally mandated services.

SUMMARY AND CONCLUSIONS

Determining the cost of education is an important and necessary step in funding schools as well as for measuring their performance. The traditional approach is to compute an average cost per student for a period by dividing expenditures by fulltime equivalent students. This cost per student is not associated with any goal or outcome and ignores both the cross-temporal and cross student differences in providing an education.

In this paper we suggested that schools be viewed as factories that produce products using a process costing model where grade levels are processes. Using this model, we argued that the cost object is a student with a diploma which forces a cross-temporal view of the education process because the production cycle is thirteen years not a single year. We then argued that well- understood industrial techniques such as process costing, standard costing and activity- based costing can be applied to the educational enterprise. Using several examples, we showed that more accurate cost measurement would be possible if the factory model were used.

Having more accurate cost data in larger amounts will allow for better management of schools, a clearer basis for patrons to judge school performance and better tools for funding of education by funding authorities. While these benefits alone would make it worthwhile to redefine our view of the education enterprise, a further advantage is that this view would open education up to the vast amount of constantly evolving knowledge about costing that takes place in the industrial environment.

A little recognized difference between the industrial environment and the education environment is the difference in the level of diversity between the two sectors. Education from kindergarten to graduation is an industry composed of thousands of virtually identical firms. Essentially none of these firms have the discipline of the market or the incentive to take risks that exist for the firms in the industrial sector. In contrast, the industrial sector is composed of thousands of highly diverse firms, each of which is competing to be successful in the market place. Not only is risk -taking possible, but it is also rewarded. Therefore, industrial firms are constantly experimenting with all aspects of their businesses including cost and performance measurement. Successful ideas rapidly spread from firm to firm and industry to industry.

If managers of the education enterprise recognized the parallels between their firms and other industrial firms they could, with relatively small cost and with minimal risk, take the best ideas emerging from this constant ferment and apply them to education with potentially large returns both to the students and to the taxpayers who are the ultimate funders of education. Shrinking funding, coupled with the lack of an establish paradigm to view the education enterprise as an industry, heightens the need for policy makers to obtain more accurate measures of costs in order to enhance educational efficiency. The use of activity- based costing concepts within the educational domain is a new and alternative approach. The potential use of an established rubric to evaluate school performance will assist regulators in the near future, when they are faced with potentially decreased funding availability.

REFERENCES

Benson, E.D., & Marks, B.R. (2005). "'Robin Hood' and Texas school District Borrowing Costs." *Public Budgeting and Finance*, *25* (2): 84-105.

Bjornenak, T. (2000). "Understanding Cost Driver Differences in the Public Sector-A Cost Driver Approach." *Management Accounting Research*, *11* (2): 193-211.

Cooper R., & Kaplan, R.S. (1988, September). "Measure Costs Right: Make the Right Decisions." *Harvard Business Review, 66* (5): 96-103.

Garner, C.W. (1998). "A Cost Efficiency Analysis of School Districts: Is Larger More Efficient?" *Journal of Public Budgeting, Accounting and Financial Management*, *10* (4): 513-526.

Hatry, H.P., Alexander, M., & Fountain, Jr., J.R. (1989). *Service Efforts and Accomplishments Reporting: Its Time Has Come: Elementary and Secondary Education*. Norwalk, CT: Government Accounting Standard Board.

Janssen, J.J. (2000). "Public School Finance, School Choice, and Equal Educational Opportunity in Texas: The Enduring Importance of Background Conditions." *Review of Litigation*, *19* (1): 1-24.

Rubin, M.A. (2004). "Improving the Current Status of School Performance Reporting." *Journal of Public Budgeting, Accounting & Financial Management*, *16* (2): 147-170.

Snyder, N.M. (2003). "The Property Tax and Public Education: Are State-Initiated Tax Cuts Sustainable?" *Journal of Public Budgeting, Accounting & Financial Management*, *15* (4): 593-621.

Waring, J. (1996). "Educational vouchers: the case for public choice reconsidered." *Public Budgeting and Finance*, *16* (3): 63-73.

White, M.J., Ross, C., Myrtle, R., Siegel, G., & Rose, A. (1980). *Managing Public Systems: Analytic Techniques for Public Administration*. North Situate, MA: Duxbury Press.

Zhou, L. (2008). *Revenues and Expenditures for Public Elementary and Secondary School Districts: School Year 2005–06 (Fiscal Year 2006)* (NCES 2008-345). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S.

Department of Education. [On-line]. Available at http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2008345.