A Process View of Education

How process models can be used to diagnose and address the challenges facing school systems

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INTRODUCTION

Context

As our nation has increased the attention focused on the state of public education, there have been increasingly broad and intense efforts to evaluate educational performance, diagnose root causes, formulate solutions and implement changes.

While the specific opinions of students, parents, teachers, administrators, school boards, teacher unions, state and federal governments, foundations and other stakeholders vary substantially, two basic conclusions seem to be consistent: First, that too many students who enter public schools either don't graduate at all or graduate with insufficient preparation for jobs or continued education. Second, that educational costs have increased without commensurate results in the quality of student education.

This paper takes for granted that both of these conclusions are correct and attempts to explain the underlying factors that contribute to this result. The analytical method applied in this paper is called "process modeling," a method of evaluating, diagnosing and improving performance of a system.

Why talk about processes?

The notion of "processes" and the acceptance of "process management" as the way to improve the performance of an organization is widespread and well-established within the business world. In the interest of performance improvement, educators have been increasingly asked to run schools more like businesses – sometimes in valid ways and sometimes in ways that don't apply very well. Understandably, many educators now cringe when they hear the word "business" applied to any approach proposed for fixing education. It is important to understand that nothing about "processes" is specific to the business world – the business world is simply where many of the terms were first defined and applied.

I hope you will realize by the end of this paper that process models can help us illuminate and explain the performance and cost of educational systems. I hope the process-based thinking put forth here will also catalyze thinking and discussions about how best to approach diagnosing and improving educational performance.

THE BASICS OF PROCESSES

What are processes, and what are process models?

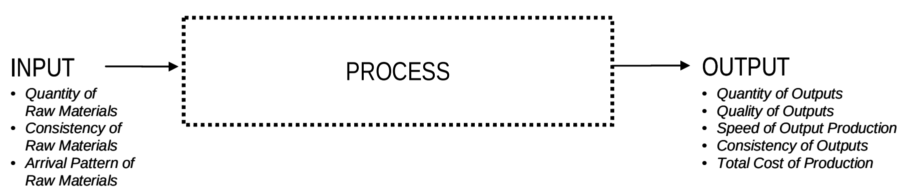
Processes are simply sets of associated activities that are designed to produce a particular outcome. One "business" example of a process is illustrated by operation of a mill that produces furniture. The process instructions for the milling operation specify what the outcome will be (a table leg, for example), the inputs required (raw wood), the equipment and other resources you will need (saws, lathes, etc.), how you will use the equipment to turn the inputs into a table leg (cut the lumber to length, shape it with a lather, etc.), and possibly the skills needed to execute the process well (milling and woodworking expertise, etc.).

In this example, the **process** is part that defines how the woodworkers will use the equipment to produce the table leg. Each individual step within the process is called an **activity**.

A **process model** is a way of describing the inputs to a process, the process steps, and the outcomes of the process. The diagram below depicts a basic, generic process model.

What are input and output specifications?

Each part of the process model (input, process and output) is defined by a set of characteristics that provides the detail necessary to fully describe the system. The following diagram provides a more detailed process model that better explains the nature of the inputs and the outputs.

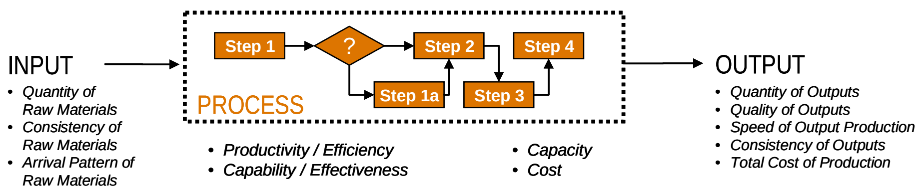


In describing inputs, a process model typically defines the quantity and arrival rate of raw materials that will be processed by the system. In our milling example, we might specify that a truckload of 10,000 linear feet of wood will be delivered to the mill for processing every morning at 7 a.m. The process model would also typically describe the types and consistency of the raw materials. For example, we might specify that the wood will be either pine or fir, and will have been pre-cut to lengths of 10 feet.

In describing outputs, a process model typically defines the specifications the outputs are expected to meet. In our milling example, we might specify that the table legs to be produced will be 36 inches tall, shaped with a particular spindle pattern, and sanded sufficiently to be ready for painting in a subsequent process. We might further specify the speed of production at 2,000 table legs per day, and that 95% of them will be within 1 mm of the desired shape and length.

What are process specifications?

Once the inputs and outputs have been specified, the next challenge is to describe the process that will convert those inputs to the outputs. The following diagram shows more detail about the process portion of the process model.



The output requirements for the process have strong influence on the design of the process expected to meet those requirements. The process model typically defines the requirements for the process in terms of the efficiency of the process system, the capacity, the capabilities and the cost constraints for the process system. It is these specifications that influence the design of the process steps and the selection of the people and technologies that will execute those process steps. In our milling example, we might specify that the process must yield 250 table legs an hour over an 8-hour day with a very low error rate, and this may dictate that we will need highly-skilled woodworkers utilizing state-of-the-art woodworking tools – sophisticated tools and dies, high-speed lathes, etc.

In describing the process itself, the process model describes the steps to be performed and how process resources (people and technology) interact to execute those steps. Some processes are executed exclusively by people (think of the process of setting a dining room table, for example), some are executed exclusively by technology (think of checking your checking account balance via an automated phone or internet system), and some are executed by a combination of people and technology (think of using a screw and screwdriver to join two objects). The diagram above shows a "process flow diagram" that describes process steps. The diamond shape in the diagram shows a decision point in the process where a decision is made regarding what step should happen next.

In our milling example, we might specify that the first step is for a person to assess the readiness of each piece of wood for the next step, cutting. The next step depends on the decision made during the first step. If the wood is of high enough quality, it will be loaded into an automated cutting machine. If not, it will be sent to another person for further preparation and hand cutting.

KEY LESSONS LEARNED ABOUT PROCESS MODELS

Alignment is key

The design of a process model is not a serial, one-way process. As you might imagine, there are extensive interdependencies between the inputs, the process and the outputs. Generally speaking, the definition of the process model starts with the output specifications and works backward through the process design to the specifications for the inputs. For the process model to meet all of the desired requirements, the inputs, process design and capabilities of people and technologies must all be aligned.

If, in our milling example, we require table legs that are consistently of exceptionally high quality, we will likely need to design a process that incorporates several quality assurance steps. We will probably need highly-experienced woodworkers and high-quality equipment, as well as a supply of wood that is of consistently very high quality. Given these implications, it is likely that the final cost of producing a table leg will be high compared to a less demanding quality requirement.

Alternatively, if cost is more important than quality, we might be able to include fewer quality assurance steps and utilize less experienced workers and more automated equipment. We might use lower-quality wood and require that it arrive pre-cut to lengths that can be fed directly into the automated equipment. This system might produce cheaper table legs with less consistent (although acceptable) conformity to quality requirements.

Either of these approaches can make sense depending on the desired output specifications. What's important is to make sure that all of the input, process and resource decisions make sense on the whole and meet those output specifications.

One big process is more efficient than two or more smaller ones

Because each process model has its own resource (people and technology) requirements, it almost always requires lower investments to set up one process model than to set up two. It is usually cheaper to operate a single process model, too. If you run two processes side by side, feeding half of the inputs through one process and half through another, it is possible that one of the processes will finish faster and leave one set of people and technology idle. (Think of standing in supermarket check-out lane and having to move a few lanes away to take advantage of a free checker.) A single process avoids this inefficiency by focusing all resources on processing the same set of inputs. (Think of a single airport check-in line where everyone is served by the next available agent.)

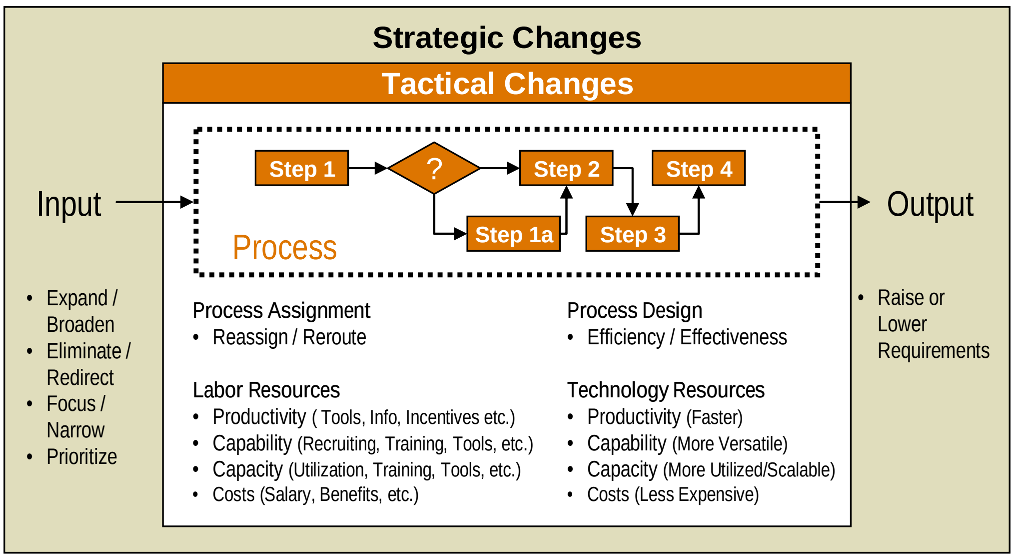
High variation in inputs hinders efficiency and effectiveness

The most efficient process models are those that start with inputs that are nearly identical. This is because a single process will produce highly consistent outputs if the inputs are essentially identical. If the inputs vary too much, you can only meet output requirements by processing the inputs in different ways, which implies different process models and less efficiency. (Think of the delay you experience when you are in a supermarket express lane behind a person who uses 8 coupons and writes a check – the checker has to shift to a different process, and efficiency suffers.) As we observed above, multiple process models are less efficient (and are more costly) than a single process model.

APPLYING PROCESS MODELS TO IMPROVEMENT EFFORTS

Organizations don't apply process models simply for the sake of explanation and design; they do it to enable process improvements in terms of both effectiveness (how well the inputs and process generate the desired results) and efficiency (how much it costs in time, money and other resources to produce the results).

Approaches to Process Improvement



When companies seek to make process improvements, they typically consider two types of approaches: strategic approaches and tactical approaches. **Strategic approaches** involve making high-level decisions about whether or not a process should be executed, with what resource and output constraints, and by whom. **Tactical approaches** take the strategic choices as inputs, then focus specifically on making the process meet those strategic requirements.

Strategic approaches

There are four basic strategic approaches to improving process performance:

1. **Stop doing the process altogether or do the process less**
   If the process is not creating enough value to cover its costs, stop doing it. If it doesn't need to be executed as often as it is, don't do it as often. For example, a company might stop providing products and services that are not profitable. Or it might offer a particular service only to higher-end customers who can pay enough to make the process model profitable.

2. **Relax, tighten or trade-off the output specifications for the process**
   If the quality of process outputs is insufficient or is unnecessarily high, change the requirements for the process. For example, allowing more costly production methods might be warranted if quality improvements are necessary. Or it might be acceptable to route customer inquiries quickly to a lower-skilled team rather than to have them wait for help from higher-skilled staff.

3. **Change the inputs to the process**
   If the process is inefficient due to input factors (in terms of consistency, quality/readiness and arrival rate), change the inputs to the process. For example, a company might procure inputs that are closer to their final form and need less processing. Or it might purchase raw materials of higher quality and consistency to enable easier, more consistent manufacturing processes.

4. **Assign the process to a different set of resources**
   If one facility or team can't produce sufficient quality or cost efficiency, assign the process to a different one. For example, stop providing account balances via human resources and instead do it via websites or automated telephone systems. Or reassign production of a complex part to the people with the most expertise.

Tactical approaches

There are five basic tactical approaches to improving process performance:

1. **Improve the design of the process itself**
   Re-design processes for better effectiveness and efficiency. This typically means changing process steps in ways that improve quality, remove bottlenecks and/or eliminate unnecessary steps. For example, eliminate inspections of raw materials if the probability or impact of a defect is low.

2. **Change the mix of human and technology resources**
   Change the assignment of process steps to human and technical resources. This typically means assigning process steps to the people or systems that can handle those steps best or most efficiently. For example, have the phone system collect the caller's account number before the call is given to a call center agent. Or have complex manufacturing steps completed by hand rather than by a machine.

3. **Improve the effectiveness and efficiency of human resources**
   Give people the knowledge, skills and motivation they need to do their jobs better and with higher efficiency. Improving effectiveness typically means providing them with better guidance, training, information and other resources. For example, improve staff training around product features and give them better information around pricing options and inventory levels. Improving efficiency usually involves enabling people to spend more time doing necessary tasks and making them more efficient while they do them. For example, a company might implement dispatch methods that reduce service technician travel times and ensure they have the tools and parts they need to provide service. Improving both effectiveness and efficiency can also involve

providing people with clearer goals or more directed incentives. For example, a company might improve quality of customer service by defining what good service means and by evaluating (and rewarding) people based on customer satisfaction ratings.

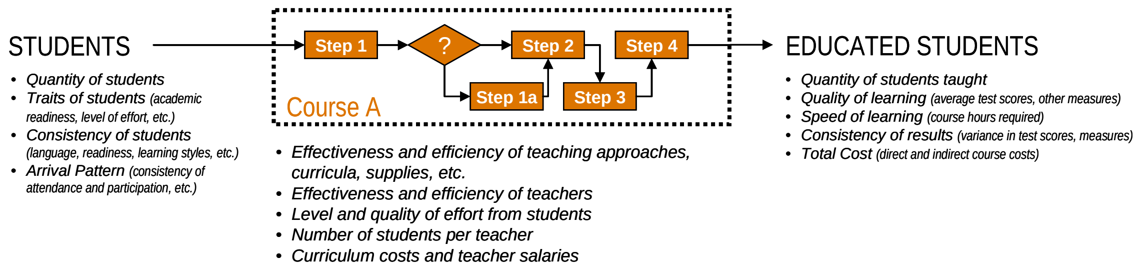
4. **Improve the effectiveness and efficiency of technical resources**
   Get the most possible out of technical resources. Improving effectiveness typically means improving its functionality and precision and using the technology correctly. For example, upgrade manufacturing equipment to models that complete more of the manufacturing process or that have lower error rates. Improving efficiency might mean improving the flexibility or capacity of the equipment and making sure it's operating at full capacity. For example, give technicians diagnostic equipment that completes analyses in 10 minutes instead of two hours.

5. **Provide more resources to execute the process**
   Provide more people or technology resources to improve performance. For human resources, this typically means providing more or better-skilled people. For example, hire three new claims processors or only employ underwriters who can price both life and property policies. For technology resources, this typically means adding more machinery or utilizing higher-capacity machinery. For example, if a particular machine is a manufacturing bottleneck, get another one or replace it with a higher-capacity machine.

APPLYING PROCESS MODELING TO EDUCATION

A basic process model for education

Now that we have described processes and process models from the business perspective, the next step is to apply this thinking to processes in the educational arena. The simplest way to do this is to focus on a basic educational process, preferably one that represents the core unit of work in education. The diagram below applies the model we used earlier to a fundamental educational process – the execution of a particular class.



While this adaptation is certainly not perfect, it does begin to present a very process-based way of looking at a critical educational process. It provides a basis for understanding what drives the quality, consistency and efficiency of teaching outcomes, and also for thinking about what might be done to improve results.

In the model depicted above, students are the inputs. The nature of the students can be described in several ways: the number of students, the average readiness of the students, the variability in the readiness of the students, and the level of participation and effort put forth by the students.

The outputs of the model are educated students. Success can be measured in several ways: the number of students educated, the average level of competency achieved by those students, the variability in the level of competency achieved by the students, the amount of time it took to educate the students, and the total cost of educating the students.

The process component of the model is the set of steps utilized to educate the students. The specific design of the process is typically determined by the curricula and teaching approaches selected. As explained in the previous sections, the performance of the process is measured in terms of both effectiveness and efficiency. Process effectiveness is driven by factors like the quality of curricula and teaching approaches, the availability and quality of necessary materials and supplies, the level and quality of effort put forth by students, the knowledge and skills of teachers, and the level of attention given to each student. Efficiency is driven by factors including the efficiency of curricula, the efficiency of teacher instruction, the speed of student learning and the cost of educational resources (curricula costs, salary and benefit costs, facilities costs, etc.).

As mentioned previously, it is important to note and account for the heavy interdependency of inputs, outputs and processes. The nature of students has a large impact on the processes required to achieve desired learning outcomes. Similarly, output requirements around education quality, consistency and cost place demands and constraints on process design and execution. The art of process management lies in the ability to establish process systems that balance desired outcomes with input and resource constraints.

Sample questions and considerations

Now that we have discussed the basic principles of process models and established a basic process model for education, we have a basis for applying process-based thinking to the analysis of specific education systems.

The questions and considerations provided below are intended to spark analysis and discussion of the input, process and output factors that drive education performance.

Student (input) considerations

Student readiness: What is the average readiness of students entering the class? Has the readiness of students (inputs) significantly changed over time? Do students display higher or lower levels of language competency, basic skills development, etc. than they did in the past? If so, these differences may explain the need to adopt new and more intensive processes for getting students to a standard proficiency level, as well as the tendency toward higher teaching costs. What can we do to ensure students are better prepared for class?

Student diversity and variability: Are the students entering the class largely similar or largely dissimilar in basic characteristics and needs? Is there more variability among students now than there used to be? If so, these differences may explain the need to utilize more (and more customized) processes in order to get all students to a standard proficiency level, which also tends to drive higher costs. What can we do to get more kids sufficiently prepared? Is it better to group kids by similarity of needs or is it better to keep them mixed?

Number of students: What is the average number of students in a class? Is the number higher or lower than in the past? Given the level and consistency of student readiness, is the optimal student-to-teacher ratio changing? If class sizes are getting smaller, this might explain rising costs. What is the right size for classes, and does it vary depending on the readiness and consistency of the students?

Learning time: How long is the average class, and how many times does it meet (how much time do students actually spend learning)? How is student attendance affecting learning time? If learning time is rising, this might explain rising costs. If school attendance is lower and/or more erratic, this might explain declining results. What is the right amount of time to dedicate to learning, and does it depend on the course and the students?

Teaching (process) considerations

Effectiveness and efficiency of teaching approaches: Is the teaching approach/curriculum appropriate given the desired results and the characteristics of the students? Do the teachers have the materials and supplies they need to execute the approach/curriculum? Does the curriculum make the best possible use of classroom time and teacher skills? Can a single approach/curriculum be successfully utilized with all of the students given their differences in learning styles, culture, readiness, etc.? Are current teaching approaches the best available? What can we do to improve the effectiveness of the curriculum?

Effectiveness and efficiency of teachers: Are teachers executing the chosen approaches/curricula well? Do they have the necessary experience and skills to teach the course well? Does the style of the teacher fit the nature of the students? Do the teachers have the ability to execute the curriculum in the prescribed amount of time? Is the nature of the students (needs, discipline, etc.) causing excessive time to be required to teach the class? What can we do to aid the effectiveness and efficiency of the teachers? Have we established clear expectations for teachers, and are we monitoring their performance against those expectations? Do we need to make changes to our recruitment, training and evaluation practices? Are we assigning the right teachers to the right classes?

Level and quality of effort from students: Are students putting forth sufficient effort in the classroom? If some are and some are not, what is the difference between the groups? If students are not putting forth sufficient effort, why not – are there problems with the curriculum, the teacher, the differences in student needs? What are the main factors driving student effort? What can we do to get better effort from the students?

Number of students per teacher: Is the student-to-teacher ratio appropriate given the nature of the course, the desired results and the characteristics of the students? Would having fewer students per teacher substantially improve learning? Can teachers take on more classes, or can we afford to bring in more teachers?

Curriculum costs and teacher salaries: Given the level of available funding, are we getting the best curricula we can afford? Are we paying the right amount for curricula? Are we getting good teacher performance for the money we are spending? Are we paying the right amount of money and getting the right types and quality of teachers? How can we fully utilize the curricula and teachers we have?

Learning (outcome) considerations

Quality of learning: Are we getting the results we want? Have we established clear learning goals for the class? Are they the right goals? Are our measurement and assessment systems aligned with these goals, and do they accurately measure the quality of learning? Have the right people bought into the goals and the measurement systems? What can we do with respect to the inputs and process to improve performance? Is it more important to us to work on elevating average student performance or on reducing variability in results?

Speed of learning: Are we getting the results we want in a reasonable amount of time? Is it taking too long to get all or some of the students to desired levels of proficiency? Are we allowing too little time to achieve the desired results?

Consistency of results: Is the level of proficiency achieved by students erratic? Are some students doing very well while other students are doing poorly? What is similar about the students who are doing well and about those who are doing poorly? Is the root cause traced to characteristics of the students, the nature of the teaching approaches, the style of the teacher, or some combination of these? What can we do to bring up the trailing groups? Do we need separate classes, different curricula, different teachers or some other change?

Total cost: Are we getting the right level of student proficiency given our expenditures on curricula, teachers and other educational costs? Do we need more funding in order to get our desired results? What is the most cost-effective change we can make to improve performance? What can we do to provide more financial and non-financial resources?

SUMMARY

The purpose of this paper is to apply process-based thinking to educational systems in the hope that doing so will help parents, students, educators and other stakeholders better diagnose and solve educational performance issues.

Process-based thinking does not provide answers to the most difficult questions around educational performance. It can, however, help people think more comprehensively about what factors drive performance and ensure proposed solutions take all of these factors into proper account.

If you have questions, comments or suggestions regarding this paper, please send them to greg@educationmap.org.