Understanding the Implications of Online Learning for Educational Productivity

U.S. Department of Education

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Office of Educational Technology

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Executive Summary

Educational systems are under increasing pressure to reduce costs while maintaining or improving outcomes for students. To improve educational *productivity,*[1] many school districts and states are turning to online learning.

In the United States, online learning alternatives are proliferating rapidly. Recent estimates suggest that 1.5 million elementary and secondary students participated in some form of online learning in 2010 (Wicks 2010). The term *online learning* can be used to refer to a wide range of programs that use the Internet to provide instructional materials and facilitate interactions between teachers and students and in some cases among students as well. Online learning can be *fully online,* with all instruction taking place through the Internet, or online elements can be combined with face-to-face interactions in what is known as *blended learning* (Horn and Staker 2010).

The purpose of this report is to support educational administrators and policymakers in becoming informed consumers of information about online learning and its potential impact on educational productivity. The report provides foundational knowledge needed to examine and understand the potential contributions of online learning to educational productivity, including a conceptual framework for understanding the necessary components of rigorous productivity analyses, drawing in particular on cost-effectiveness analysis as an accessible method in education. Five requirements for rigorous cost-effectiveness studies are described:

1) Important design components of an intervention are specified;

2) Both costs and outcomes are measured;

[1] As defined in this report, productivity is a ratio between costs and outcomes that can be improved in one of three ways: by reducing costs while maintaining outcomes, improving outcomes while maintaining costs or transforming processes in a way that both reduces costs and improves outcomes. Any improvements in productivity are likely to require initial investments, but successful efforts reduce costs over the long term, even after these initial investments are taken into account.

3) At least two conditions are compared;

4) Costs and outcomes are related using a single ratio for each model under study;

5) Other factors not related to the conditions being studied are controlled or held constant.

The report also includes a review of ways that online learning might offer productivity benefits compared with traditional place-based schooling. Unfortunately, a review of the available research that examined the impact of online learning on educational productivity for secondary school students was found to be lacking. No analyses were found that rigorously measured the productivity of an online learning system relative to place-based instruction in secondary schools.[2] This lack of evidence supports the call of the National Educational Technology Plan (U.S. Department of Education 2010a) for a national initiative to develop an ongoing research agenda dedicated to improving productivity in the education sector. The evidence summarized in this report draws on literature that addressed either costs or effectiveness. These studies typically were limited because they did not bring the two together in a productivity ratio and compare results with other alternatives.

Given the limitations of the research regarding the costs and effects of online instruction for secondary students, the review that follows also draws on examples and research about the use of online learning for postsecondary instruction. While there are many differences between higher education and elementary and secondary education (e.g., age and maturity of students), postsecondary institutions have a broader and longer history with online learning than elementary and secondary schools. The intention is to use the literature from higher education to illustrate concepts that may apply to emerging practices in elementary and secondary education. Findings from the studies of higher education should be applied with caution to secondary education, as student populations, learning contexts and financial models are quite different across these levels of schooling.

While rigorously researched models are lacking, the review of the available literature suggested nine applications of online learning that are seen as possible pathways to improved productivity:

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[2] Two research reports—an audit for the Wisconsin State Legislature (Stuiber et al. 2010) and a study of the Florida Virtual School (Florida Tax Watch Center for Educational Performance and Accountability 2007)—include data about costs and effects. These reports suggest that online learning environments may hold significant potential for increasing educational productivity. Both found that online learning environments produced better outcomes than face-to-face schools and at a lower per-pupil cost than the state average. However, these conclusions must be viewed cautiously because both reports lacked statistical controls that could have ruled out other explanations of the findings.

1) **Broadening access** in ways that dramatically reduce the cost of providing access to quality educational resources and experiences, particularly for students in remote locations or other situations where challenges such as low student enrollments make the traditional school model impractical;

2) **Engaging students in active learning** with instructional materials and access to a wealth of resources that can facilitate the adoption of research-based principles and best practices from the learning sciences, an application that might improve student outcomes without substantially increasing costs;

3) **Individualizing and differentiating instruction** based on student performance on diagnostic assessments and preferred pace of learning, thereby improving the efficiency with which students move through a learning progression;

4) **Personalizing learning** by building on student interests, which can result in increased student motivation, time on task and ultimately better learning outcomes;

5) **Making better use of teacher and student time** by automating routine tasks and enabling teacher time to focus on high-value activities;

6) **Increasing the rate of student learning** by increasing motivation and helping students grasp concepts and demonstrate competency more efficiently;

7) **Reducing school-based facilities costs** by leveraging home and community spaces in addition to traditional school buildings;

8) **Reducing salary costs** by transferring some educational activities to computers, by increasing teacher-student ratios or by otherwise redesigning processes that allow for more effective use of teacher time; and

9) **Realizing opportunities for economies of scale** through reuse of materials and their large-scale distribution.

It is important to note that these pathways are not mutually exclusive, and interventions intended to increase productivity usually involve multiple strategies to impact both the benefit side (pathways 1–4) and cost side (pathways 5–9).

Determining whether online learning is more or less cost-effective than other alternatives does not lend itself to a simple yes or no answer. Each of the nine pathways suggests a

plausible strategy for improving educational productivity, but there is insufficient evidence to draw any conclusions about their viability in secondary schools. Educational stakeholders at every level need information regarding effective instructional strategies and methods for improving educational productivity. Studies designed to inform educational decisions should follow rigorous methodologies that account for a full range of costs, describe key implementation characteristics and use valid estimates of student learning.

Even less is known about the impact of online learning for students with disabilities. Regarding potential benefits, the promise of individualized and personalized instruction suggests an ability to tailor instruction to meet the needs of students with disabilities. For example, rich multimedia can be found on the Internet that would seem to offer ready inspiration for meeting the unique needs of the blind or the hearing impaired. In fact, standards for universal design are available both for the Web and for printed documents. In addition, tutorial models that rely on independent study are well suited to students with medical or other disabilities that prevent them from attending brick-and-mortar schools. However, while online learning offerings should be made accessible to students with disabilities, doing so is not necessarily cheap or easy.

Any requirement to use a technology, including an online learning program, that is inaccessible to individuals with disabilities is considered discrimination and is prohibited by the Americans with Disabilities Act of 1990 and Section 504 of the Rehabilitation Act of 1973, unless those individuals are provided accommodations or modifications that permit them to receive all the educational benefits provided by the technology in an equally effective and equally integrated manner. The degree to which programs make such accommodations is not yet known. To address this need, the U.S. Department of Education recently funded the Center on Online Learning and Students With Disabilities, a five-year research effort to identify new methods for using technology to improve learning. Similarly, research regarding the degree to which current online learning environments meet the needs of English language learners and how technology might provide a cost-effective alternative to traditional strategies is just emerging.

The realization of productivity improvements in education will most likely require a transformation of conventional processes to leverage new capabilities supported by information and communications technologies. Basic assumptions about the need for seat time and age-based cohorts may need to be reevaluated to sharpen focus on the needs and interests of all students as individuals. And as a rigorous evidence accumulates around effective practices that may require institutional change, systemic incentives may be needed to spur the adoption of efficient, effective paths to learning.

Policymakers and educators do not yet have the needed rigorous evidence to answer some seemingly basic questions about when, how and under what conditions online learning can be deployed cost-effectively. More research is required to guide the deployment of online learning to its greatest effect. Research approaches should explicitly consider educational productivity. Organizational research is also needed to understand the incentives and barriers to employing the most cost-effective approaches to quality education for all students.

Introduction

The need to do more with less is an imperative for decision makers in nearly every economic sector. Education is no exception. State and local education systems face the dual challenges of improving outcomes while confronting budgetary declines. Reducing costs without sacrificing quality, or doing better with what is available, requires improvements in *productivity* (see Definition of Productivity sidebar).

Productivity improvements is one of the primary goals of the online learning systems that are rapidly proliferating in secondary education. This report is intended

- to summarize what we know to date about productivity as it relates to online learning and
- to offer guidance to policymakers who are faced with the decision of whether and how to implement this strategy.

Definition of Productivity

Productivity is defined as the relationship between program inputs (measured in terms of financial value or time) and outcomes and outputs (including both quantitative measures and measures of outcome quality). Productivity can be increased by

- reducing costs while maintaining outcomes relative to other alternatives,
- improving outcomes while maintaining costs or
- both reducing costs and improving outcomes.

Overview of Online Learning for Secondary Education

The available evidence suggests that schools are using information technologies with the intention of expanding access, improving instructional quality and reducing costs associated with traditional instruction. Many districts and states have turned to *online learning* (see Definition of Online Learning sidebar) to replace or supplement teaching in brick-and-mortar schools. For example, journal accounts indicate that some schools and districts are ending traditional summer school programs, instead providing instruction via the Internet (Krafcik 2010; Olster 2010). Schools are also contracting with online providers to deliver courses that they do not feel they could otherwise afford.

As of late 2010, online learning opportunities were made available to students in 48 states and Washington, D.C. These opportunities were offered by a number of different providers, including state virtual schools, multidistrict full-time online schools, single-district programs and programs run by consortia or postsecondary institutions (Watson et al. 2010). Companies in the private sector also provide online learning opportunities for secondary students.

According to survey-based estimates by the International Association for K-12 Online Learning (iNACOL), 1.5 million students took one or more online courses in 2010 (Wicks 2010). In these courses, students received all or part of their instruction over the Internet and interacted online with teachers, peers and digital learning content. Some states such as Alabama, Florida and Michigan have made the online learning experience part of their graduation requirements (Watson et al. 2010).

Online learning has become popular because of its perceived potential to provide more flexible access to content and instruction by

1) increasing the availability of learning experiences for those who cannot or choose not to attend traditional schools,

2) assembling and disseminating instructional content more efficiently, and

3) increasing student-instructor ratios while achieving learning outcomes equal to those of traditional classroom instruction.

Some proponents see technology as having potential beyond increasing efficiency in instructional delivery, for example, by providing a community of learners to support understanding of a complex body of knowledge (Riel and Polin 2004; Schwen and Hara 2004). Online technologies can expand and support such communities by promoting

Definition of Online Learning

"Online learning" refers to instructional environments supported by the Internet. Online learning comprises a wide variety of programs that use the Internet within and beyond school walls to provide access to instructional materials as well as facilitate interaction among teachers and students. Online learning can be fully online or blended with face-to-face interactions. Each of these approaches is described below.

Fully online learning is a form of distance education in which all instruction and assessment are carried out using online, Internet-based delivery (Picciano and Seaman 2009; U.S. Department of Education 2007). In this brief, both teacher-led instruction and resources designed to instruct without the presence of a teacher meet the definition of fully online learning if they include instructional environments accessed exclusively through the Internet.

Blended learning (also called hybrid learning) allows students to receive significant portions of instruction through both face-to-face and online means. Researchers see blended learning in the middle of the spectrum between fully face-to-face and fully online instruction (Graham, Allen, and Ure 2005; U.S. Department of Education 2007; Watson et al. 2010).

"participatory" education models rather than simply changing education delivery modes (Barab, Squire, and Dueber 2000; Barab and Thomas 2001).

Others argue that online learning can provide individualized and differentiated instruction (Archambault et al. 2010; Christensen and Horn 2008; Waldeck 2008; Watson and Gemin 2008) through multiple mechanisms that provide immediate formative feedback about a student's performance (Dennen 2005; Rice et al. 2008) or through modularized content that enables learning the same content at a different pace or to achieve different learning goals.

The distinction between fully online and blended learning is important in part because it helps set the standard for comparing costs and outcomes (Watson et al. 2010; U.S. Department of Education 2010b). To be viewed as a success, online programs that provide access to courses or programs that would otherwise be unavailable need to be *as effective as* traditional alternatives. Blended approaches are typically perceived as quality improvements that *enhance and improve* traditional instruction but as such need to demonstrate gains in learning quality or rate of learning to justify the additional expenses. Although the terms *fully online* and *blended* are commonly used and conceptually useful, blended learning itself can take many forms, and models of blended instruction are still emerging. If either fully online or blended instruction can transform instructional processes, there is an opportunity to improve quality as well as reduce costs.[3]

Purpose of this Report

Because online learning is serving increasing numbers of secondary students, it is essential to understand whether, when and how particular implementations of online learning are equally or more productive than other forms of instruction. The purpose of this report is to support educational administrators and policymakers in becoming informed consumers of information about online learning and its potential impact on educational productivity. The report provides foundational knowledge needed to examine and understand the potential productivity contributions of online learning and reviews the research that describes how online learning might offer productivity benefits compared with traditional brick-and-mortar schooling.

[3] The literature describes "traditional" designs as offering the online equivalent of simple didactic instruction (e.g., programs in which the system provides content to read and a quiz at the end), whereas "transformational" designs provide a fundamentally different student experience. See Watson et al. [2010] for a more detailed description of transformational practices in one state virtual school.

This report includes

- a framework for understanding general principles associated with systematic productivity analyses in education;
- a summary of claims regarding how online learning could affect educational productivity;
- a review of the literature that informs understanding of the costs and effects of online learning relative to traditional face-to-face instruction;
- a discussion of the implications of the findings; and
- brief summaries of specific resources for readers wanting to learn more about topics addressed (appendix).

Ultimately, the hope is that this information can be used to help educators realize productivity improvements in the future.

Introduction to the Measurement of Educational Productivity

A number of publications describe formal analytic procedures for estimating the productivity of countries (e.g., Organisation for Economic Co-operation and Development [OECD] 2008), industries (e.g., Colecchia and Schreyer 2001) and firms (e.g., Brinkerhoff and Dressler 1990). In education, productivity is typically understood as a ratio of the cost of inputs per output, with outputs often measured in terms of student academic attainment (Cohn and Geske 1990; Levin and McEwan 2001). The academic literature provides at least three frameworks for analyzing educational productivity. Levin and McEwan (2001) present a series of detailed frameworks for the rigorous analysis of costs and outcomes specific to educational interventions. Rumble (1997) and Kaestner (2007) apply similar frameworks specifically for distance learning and online learning. With rare exceptions, productivity analyses typically require that at least one other alternative to the option under study be examined because cost-effectiveness and similar ratios are relative.

As suggested above, there are several methodologies used to measure productivity. These methods all measure costs and are often classified by the type of outcome measure used. This report focuses primarily on what is known as a cost-effectiveness approach because effectiveness data are in many cases available in education and because these outcome measures, such as test scores, retention rates and school attendance, are considered meaningful and consequential in educational contexts, especially in K–12.[4] Cost-benefit approaches, which calculate monetary value for outcomes of interest in order to create a dollars-to-dollars comparison, are often used to support decisions about government programs because they allow comparison of projects across industries (e.g., health and education). However, this type of study can be particularly challenging in education, both because of the difficulties associated with assigning monetary value to many educational outcomes (such as test scores) and because measurements of the types of outcomes that are more readily monetized (such as impact on wages and income over time) would rely on data not currently collected or readily available.

Cost-effectiveness studies often have two goals: (1) to inform decisions about a particular program under way in a particular location and (2) to inform other stakeholders as they consider undertaking new programs of their own. To accomplish these goals, studies must

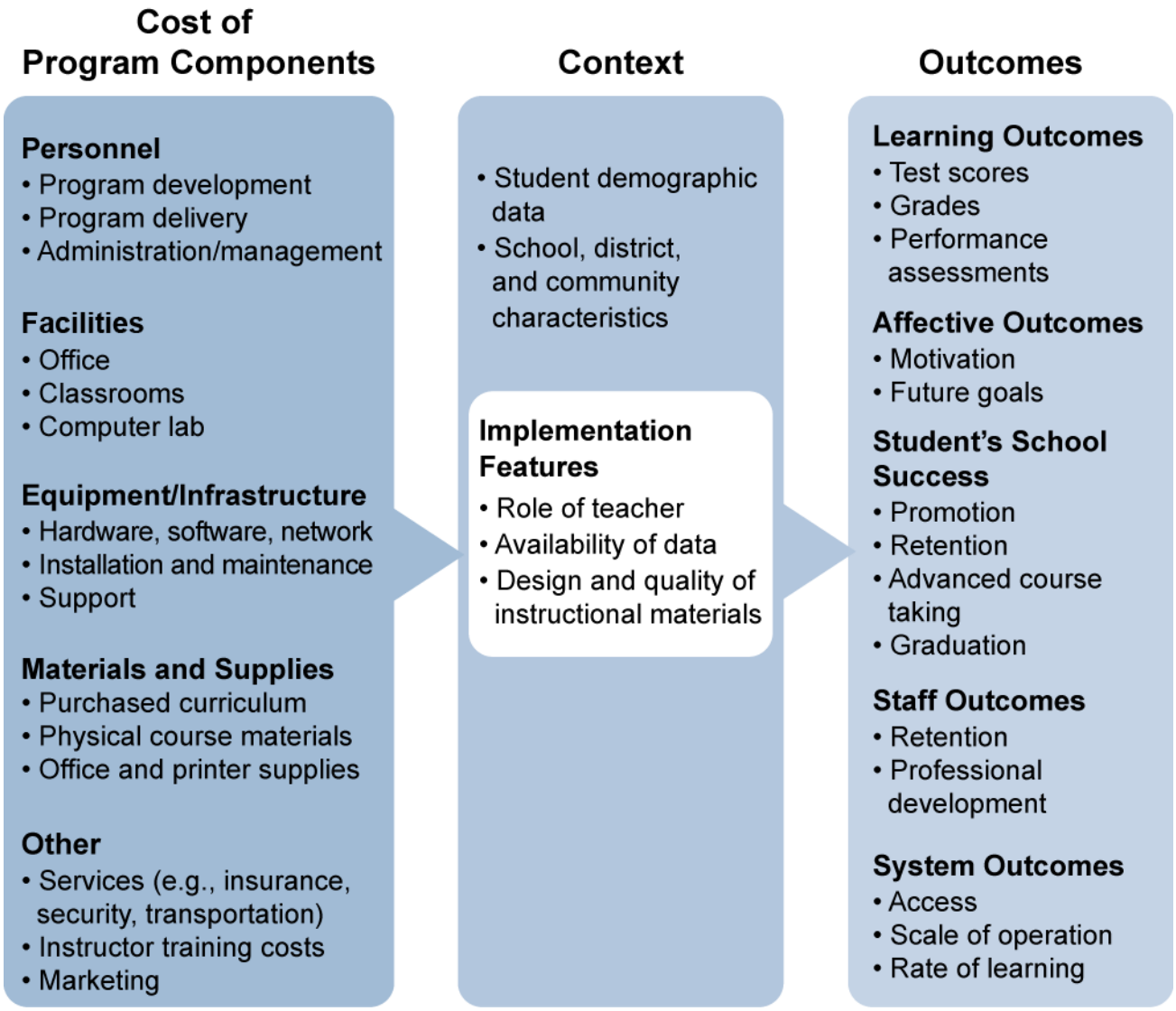
[4] Educational attainment measures are consequential in the sense that they are used to determine grade progression, college attendance, etc.

both measure the productivity of the online learning intervention relative to other alternatives and describe key elements of the intervention that will be needed for replication of the program elsewhere. Cost-effectiveness ratios are helpful only in the context of comparable ratios based on realistic alternatives, which in turn suggests the need for consensus among analysts regarding the comparability of those alternatives. For example, a cost-effectiveness study might look at the cost of a range of alternatives for raising student achievement in math by an average of 10 points per student. When the results of the analysis are expressed this way, they can be used to compare similar costs and outcomes across design alternatives. Studies such as these can inform a host of decisions related both to currently operational and to planned online learning environments. For example, educational administrators could ask

- Would online learning help us serve more summer school students at less cost without sacrificing outcomes?
- Over the last 3 years, has our online learning system been more or less productive than our traditional brick-and-mortar alternatives in terms of the cost per completer, average grades or test scores? Is this ratio likely to change over the next three years?
- How do blended and strictly online versions of a given course compare in terms of the cost to improve students' learning outcomes?

Clearly, depending on the question to be answered, different sources of data will be needed. Although the costs and outcomes for any online learning system will vary according to its design and scope, both costs and outcomes in education generally fall within a common set of categories that can be used to guide cost and outcome measurement (Exhibit 1).

Exhibit 1: Components of Educational Productivity Analyses



Note: The bullets provided in each category in this exhibit are representative rather than comprehensive.

Exhibit reads: Several different kinds of costs account for final cost estimates developed in educational productivity studies.

Estimating Program Costs

The "ingredients" approach to specifying costs adapted from Levin and McEwan (2001) suggests determining all the types of costs associated with developing and running a program and assigning a value to each (see appendix for additional resources that look at this approach more deeply). Although specific costs will vary by program, they can be summarized using the categories in Exhibit 1.

- *Personnel costs* include the time of teachers, teaching assistants, developers, administrators and any others involved in creating or running the online learning system.

- *Facilities costs* include the costs of buildings, classrooms, office space and furniture for administrative and instructional purposes as well as for housing computers.

- *Equipment and infrastructure costs* include the resources required to implement needed technology, support its operation and maintain the equipment and infrastructure in working order.

- *Materials and supplies costs* include purchased online curricula or textbooks, as well as other physical goods or processes (e.g., the costs associated with printing and copying).

- The *other* category varies by implementation model but usually includes general operational services and student supports required for the successful and legal operation of the program or school. If productivity analyses of online and other instructional practices are to become more routine, accounting systems at every level of education need to better identify costs in each of these categories.

A few basic considerations for cost analyses are as follows:

- *Rigorous cost analyses include the costs or value of all resources essential to an intervention as well as its most realistic alternative, and the same types of costs are included for each alternative so that apples are compared with apples.* For example, the initial costs associated with program planning and curriculum development are often important considerations for new online systems. Similarly, investments in technology such as hardware and connectivity are often required before starting an online learning program. On the other hand, facilities costs can be sizable for more traditional instructional approaches. In estimating the costs of each alternative, costs of planning, curriculum development and

facilities should be treated similarly across alternatives.[5] Significant mismatches across cost estimates can lead to erroneous conclusions.

- *All components of a program, regardless of the source of funding, should be included.* For example, teachers' time may be covered by their contracts and therefore not entail an additional cost incurred by the online learning program. However, if teachers spend time providing online instruction, the system incurs an "opportunity cost" for other possible uses of those hours that are lost. The same is true of shared resources such as computer labs, even if the computers were not purchased specifically for the online learning program.

- *Available time, data and budgets for cost-effectiveness research will also shape the precision of cost estimates and the rigor of outcomes research.* In most circumstances, it would be prohibitively expensive to arrive at a fully accurate cost, and it is often difficult to obtain accurate records of each component cost. Accordingly, most studies include some level of estimation. The balance of actual and estimated costs is a function of many factors, including the time and funding available for the productivity study, the accuracy of available records, the research team's access to cost data that may be proprietary and the goals of the study. Precision is more important for some purposes than for others. Specific line items in the framework may require a combination of actual and estimated costs; for example, it is relatively easy to identify hourly teacher salaries, but individual teachers may not have tracked the hours they spent in developing curriculum for an online learning program. Similarly, information about student motivation is often considered on an ad hoc basis if at all. Questions about systems currently being implemented should be supported by data on actual costs and outcomes; analyses of future or planned systems will necessarily rely on estimates based on historical spending and on costs/outcomes for similar systems.

- *In estimating costs, the same parameters should be used across conditions so that estimates are comparable.* In studies that compare an online learning system with a traditional model, state per-pupil education expenditures are a common proxy for the per-pupil costs of the traditional condition. However, that proxy should be used with care, because neighborhood schools typically include a wide

[5] Cost analysts use mathematical procedures to develop annual costs for investments that may be purchased in one year but used across several years. For example, if a computer is purchased, the annual cost of the hardware would be based on the initial cost divided by the estimated life of the computer (often considered three years) and may include additional adjustments. Ongoing costs like computer maintenance should also be considered. A more detailed treatment of costing procedures is beyond the scope of this report, but related resources are provided in the appendix for the reader interested in learning more.

range of school services not normally provided through online instruction. For example, public schools are required to provide services for students with special needs, and they support facilities such as gymnasiums and cafeterias. A state's average per-pupil funding may be a good starting point for estimating the cost of traditional schooling, but a more in-depth analysis will also need to consider the specific costs for parallel services associated with online and brick-and-mortar schooling.

Documenting Context and Implementation

Specifying essential design components of both an intervention and its alternatives is particularly important. Fundamental elements of educational implementation include teachers, materials and students (Cohen and Ball 1999). Lovett, Myers and Thille (2008) attributed their positive results with online learning in a university statistics class to design features based on learning science research. Those features include clear organization and structure of online materials, frequent opportunities for students to practice new knowledge or skills, immediate and targeted feedback, and effective media use. Other fully online implementations may realize different learning outcomes if they do not incorporate these characteristics. Costs may also differ as a result. Similarly, blended learning programs that use teacher time effectively are likely to produce stronger cost-effectiveness results than blended learning programs that use the time poorly. Multiple cost-effectiveness ratios would be needed to capture significant variation in or different models of implementation. Given that the research base is evolving, policymakers and administrators should carefully consider the applicability of findings from particular studies to other contexts. For example, study findings that conclude that an implementation of online learning was effective in a specific context should not be extrapolated to suggest that all forms of online learning are effective for everyone. (The appendix lists reference to additional resources that provide quality guidelines for online learning.)

Measuring Program Outcomes

Any given program is likely to have a range of possible outcomes. Selecting the most salient outcome or outcomes to measure is a case-by-case decision. Exhibit 1 lists several types of possible outcomes.

- *Learning outcomes* are most often measured at the student level, although they may be aggregated at the classroom, school or district level. Stakeholders might be particularly interested in scores on standardized tests; some studies also look at

grades or alternative assessments that are more sensitive to the types of skills to be developed through innovative instruction. It is particularly important to consider not just numerical outcomes (e.g., graduation rates and test scores), but also the quality of those student outcomes.

- *Affective outcomes* relate to factors such as student motivation, academic engagement and future goals. These outcomes are often measured through student surveys.

- *Student school success* includes grade promotion, retention and graduation. At secondary schools, advanced course taking such as Advanced Placement (AP) course enrollment and dual enrollment in college are also considered important student success measures as they reduce the time and money required to graduate from college (Greaves et al. 2010).

- *Staff outcomes* include retention of teachers and other staff members as well as improving quality of instruction through professional development.

- *System outcomes* from an online learning program may also be desired. These might include increases in (1) student access to instruction and qualified teachers, (2) scale of operations and (3) rate of student learning. Qualitative improvements can also be achieved.

The *rate of learning*, which is based on time necessary for students to reach a given level of mastery, is an outcome not often used in K–12 education. As the old proverb goes, "Time is money," and savings are possible if students need less time to meet instructional goals. A similar issue relates to opportunities to increase students' time on task (Cavanaugh 2009a). Increases in time on task have been associated with improved student outcomes. Two examples of ways to increase student time on task are homework (to increase time on task outside the classroom) and increased engagement (so that students are thinking more deeply in the classroom and willing to spend more of their personal time on academic tasks). Evaluating both will be important as technology changes the types of evidence available for documenting student learning and the ways in which that evidence can be used to improve and inform instructional environments (U.S. Department of Education 2010a).[6]

[6] The appendix provides pointers to additional documents that include conceptual frameworks and empirical evidence associated with online learning for the reader interested in learning more.

As with any type of effectiveness study, estimating outcomes for productivity need to follow commonly accepted guidelines for program evaluation (e.g., see Frechtling and Sharp 1997). The outcomes selected to measure and report should be the most important to the intervention and attributable specifically to the program. For example, if the program is a single mathematics class that students can take either face to face or online, gains in mathematics test scores for participating students at the end of the year could be evaluated; however, it may be difficult to draw clear connections between a specific program and larger academic outcomes (e.g., graduation) that could be influenced by a host of factors outside the scope of the mathematics class. A study also may take into account multiple outcomes as is common in cost-benefit or cost-utility studies (Levin and McEwan 2001).

Cost-Effectiveness Research Requirements

The above productivity framework suggests a number of requirements for sound studies of online learning productivity that are offered here to help guide literature analysis.

1. *Specify important design components of the intervention.* Because the costs and outcomes of different programs can vary widely, simple comparison of ratios will do little to elucidate the factors that contributed to productivity gains. For study results to suggest design features worthy of replication, the study must describe important variations between the treatment and control conditions. In some studies, the only salient differences are related to technology and delivery systems. However, well-designed online learning interventions generally include modifications in pedagogy and curricular materials and other enhancements that take advantage of the technology platform. These factors may not be included in a productivity ratio, but including them in research reports is important for supporting the interpretation of reported productivity ratios.

2. *Compare at least two conditions.* On its own, a ratio of per-pupil program cost per unit of outcome is not meaningful. An online and control condition (e.g., comparing the ratio of costs and test scores in an online academy with that in a brick-and-mortar school teaching the same content) can be used to measure changes in productivity ratio across conditions. Analysts should also consider blended alternatives, not just contrasts between fully online learning and fully face-to-face instruction.

3. *Measure both costs and outcomes.* Both costs and outcomes can vary widely across implementations, suggesting that both factors must be measured for each intervention under study. The study should use the same cost framework for the two conditions so that all relevant costs—and the same costs—are compared. Similarly,

any relevant outcomes can be selected as long as the same outcomes are measured for both conditions.

4. *Relate costs and outcomes using a single ratio for each model under study.* Following Levin and McEwan (2001) and other research, the framework presented here describes productivity as a ratio of costs and outcome (e.g., cost per additional graduate of a high school program). This ratio allows the comparison of online learning systems with other alternatives under consideration.

5. *Control or hold constant other factors not related to the online learning-supported intervention.* Factors such as student population, curriculum content, course duration and the amount of time students spend engaged in learning can strongly affect the outcomes in each condition. As is the case for any high-quality research, these factors must be held constant so that the only predictable variation across conditions is the design feature under study. This includes controlling for prior student achievement and other important factors. For example, if students in an online program score higher on achievement tests than their peers in traditional instruction, a more effective learning environment online could have influenced that result; alternatively, the online environment may simply have attracted a higher achieving group of students or other specific student subgroup.

The measurement of educational productivity requires systematic consideration of the costs and outcomes of an intervention compared to a range of alternatives. Analyses should also document implementation features of the intervention so that it can be appropriately replicated elsewhere and so that readers understand how costs were transformed into outcomes. A review of the research conducted for this report found that the available literature base regarding the productivity of online learning is fragmented and spotty at best. For example, no rigorous analyses were found that illustrated the guidelines for cost-effectiveness research described above. Studies that compared two conditions typically did not look at parallel costs or did not control for student characteristics.[7]

[7] Two research reports—an audit for the Wisconsin State Legislature (Stuiber et al. 2010) and a study of the Florida Virtual School (Florida Tax Watch Center for Educational Performance and Accountability 2007)—include data about costs and effects. Both found that online learning environments produced better outcomes than face-to-face schools and at a lower per-pupil cost than the state average. However, these conclusions must be viewed cautiously because both reports lacked statistical controls that could have ruled out other explanations of the findings.

The Productivity Potential of Online Learning

The use of technology as a productivity tool has a much longer history in business than in education. Research from industry generally suggests that information and computer technologies can play an important role in improving productivity. These gains, however, have typically been realized only when technology is coupled with fundamental organizational changes that re-engineer business processes, taking advantage of the affordances of the tools to work smarter and more efficiently (Athey and Stern 2002; Atkinson and McKay 2007; Brynjolfsson and Hitt 2000). For example, case studies of eight industries suggest that service industries such as hotel and retail banking made significant investments in information technology, but initially enjoyed more modest payoffs than other industries, in part because they often missed opportunities to use automatically generated data about customers and purchases to inform business decision making (McKinsey Global Institute 2000).

To understand the potential for educational productivity offered by online learning opportunities, it is similarly necessary to look at the pedagogical and practical affordances through which productivity gains might be realized. Online learning is often suggested as a means for improving educational outcomes, expanding access at lower costs than conventional approaches or allowing talented teachers to focus on what they do best by automating or offloading more routine tasks (Christensen and Horn 2008; Christensen, Johnson, and Horn 2008; Moe and Chubb 2009; Olster 2010; Wilson 2010; Wise and Rothman 2010).

A review of the literature was conducted to gather empirical research that provides evidence of actual productivity impacts when online learning is compared with place-based instruction in secondary schools. However, the available research base was found to be lacking because studies did not adopt rigorous methodologies or did not provide comparable information about alternatives. Given the limitations of the research specifically regarding the costs and effects of online instruction for secondary students, the review that follows also draws on examples and research about the use of online learning for postsecondary instruction.

Information about practices in postsecondary education is provided as illustrations and suggestions of principles that may help inform the development of emerging practices in secondary education. For example some studies have shown that universities that use online learning enjoy significant savings (Buzhardt and Semb 2005; Cohen and Nachmias 2006); Gordon, He, and Abdous 2009; Twigg 2003a) and can increase student rates of learning

(Lovett, Meyer, and Thille 2008). The sidebar describes the National Center for Academic Transformation's efforts to use online learning as a component in its redesign of postsecondary courses. Nonetheless, findings from studies in higher education should be applied with caution to secondary education, as student populations, learning contexts and financial models are quite different across these levels of schooling.[8]

A review of this extended literature base suggests nine different pathways through which online learning might contribute to improved productivity. These nine pathways are not necessarily mutually exclusive. They are illustrated here through examples in order to demonstrate the kinds of tools and trade-offs needed to realize productivity gains. Five address improving educational access and effectiveness, and four relate more directly to potential cost reductions.

[8] Wide variations in student motivation, technological fluency and developmental stages imply that different considerations need to be made in designing online learning content (e.g., customizability for a broader range of students including students with learning disorders) and support structures (both behavioral and academic; e.g. instruction on how to study independently and manage time) for online learning in higher education and K-12. For example, K–12 students in general are likely to be less prepared than college students to undertake independent learning and thus require more support. Differences between higher education and K–12 in teacher professional development practices, scale of operation, availability of analytic support and funding methods may also necessitate different approaches to designing online learning infrastructure. Decentralized operations of colleges and universities, for example, pose a particular challenge to implementing technology-based learning environments to increase productivity in higher education (Miller 2010).

The National Center for Academic Transformation Course Redesign Initiatives

The National Center for Academic Transformation (NCAT) works with postsecondary institutions to improve learning while reducing costs by redesigning large-enrollment introductory courses through technology. NCAT's first course redesign program yielded an average 40 percent cost reduction among all 30 participating institutions, which in NCAT's estimation translated to a total of $3.6 million saved each year (Twigg 2003b).* Additionally, 22 of the 30 projects supported by the Pew Charitable Trust-funded program showed statistically significant increases in student learning as measured by course exams, while the other eight showed learning equivalent to that in traditional formats (Twigg 2004a). Since then, NCAT has been scaling up its course redesign efforts, with six redesign models (see below) and 70 completed projects.

Course Redesign Models

1) **Supplemental Model**: Supplements the traditional course with technology-based, out of class activities. Active learning may be also promoted in a large lecture hall setting.
2) **Replacement Model**: Reduces the number of in-class meetings. Some in-class time is replaced with out-of-class, online, interactive learning activities. Significant changes may be also made to the remaining in-class time.
3) **Emporium Model**: Replaces lectures with a learning resources center model featuring interactive computer software and on-demand personalized assistance.
4) **Fully Online Model**: Eliminates all in-class meetings and moves all learning experiences online, using Web-based commercial software that provides automated assessments and feedback, multimedia resources, and alternate staff models.
5) **Buffet Model**: Customizes learning for each student based on background, learning preference, and learning goals and offers an assortment of individualized paths to reach the same outcomes.
6) **Linked Workshop Model**: Remedial /developmental instruction by linking workshops that offer students just-in-time supplemental academic support to core college level courses.

Source: http://www.thencat.org/PlanRes/R2R_ModCrsRed.htm

* As with any reported costs, it is important to be aware of how costs are calculated— what estimates include and what they do not. NCAT's costing methodology does not include development or transition costs, focusing primarily on savings associated with the reallocation and use of instructional staff time (e.g., full-time faculty, adjuncts, teaching assistants). NCAT also focuses on percentage changes rather than total or per-student costs. NCAT argues that it actually underreports cost savings because its methodology also excludes savings associated with higher course retention and lower course repetition rates (Twigg 2003c). Independent review of the data suggests that the savings may be closer to $2.4 million (Miller 2010).

Increasing Educational Access and Effectiveness

Many online learning programs for secondary students have been evaluated, but little experimental or quasi-experimental research is available regarding the effect of these programs on student learning outcomes. A recent meta-analysis (U.S. Department of Education 2010b) looked at rigorous research in online learning generally and found that students tended to perform better in blended learning courses than in traditional face-to-face classes.[9] Learning outcomes for purely online instruction were equivalent to those of purely face-to-face instruction. The meta-analysis results also suggest that the effectiveness of online learning is quite stable across different content and learner types. Effectiveness did not vary significantly with learner age or content area.

However, a relatively small number of studies addressed secondary students, suggesting caution in attempts to generalize findings to secondary school populations. Only five of the 45 studies included in the meta-analysis focused on K–12 students, and those five studies looked exclusively at blended online learning programs. None of the K–12 studies addressed fully online academic courses or students in fully online degree programs. Four of the five studies found that students in the online condition performed as well as or better than their peers in traditional courses. The exception was a study of online Spanish instruction in West Virginia (Rockman et al. 2007), which found modest to moderate advantages for face-to-face students compared with their online counterparts. Given this limited base, it is particularly difficult to make statements regarding the suitability of online learning as currently designed for a range of students with disabilities, English language learners or others with risk factors that might discourage course completion or graduation.

In fact, online learning represents many different purposes and practices (e.g., Cavalluzzo 2004), just as face-to-face learning represents a range of practices. For example, in face-to-face education, teachers may lecture, encourage small group activities or, most likely, adopt a range of practices in a single course. Not surprisingly, emerging evidence indicates that some online learning programs are more effective than others. It is also important not to generalize fingings across programs with differing designs. As noted above and by other researchers (e.g., Cohen and Nachmias 2006), factors such as course organization and pedagogy can significantly affect productivity. Given that the research base is evolving, policymakers and administrators should carefully consider how applicable the findings of particular studies are to specific contexts. For example, study findings that conclude that an

[9] The meta analysis included only studies of Web-based instruction with random-assignment or controlled quasi-experimental designs (i.e., using statistical controls for possible differences between the treatment and control groups in terms of prior achievement) that examined effects for objective measures of student learning, discarding measures related to student or teacher perceptions of learning or course quality, student affect, etc.

implementation of online learning was effective in a specific context or for a specific subgroup of students should not be extrapolated to suggest that all forms of online learning are effective for everyone.

The following discussion and examples illustrate five ways that online learning could increase educational productivity by improving learning opportunities:

1) Broadening access to resources and experiences;
2) Engaging students in active learning;
3) Individualizing and differentiating instruction;[10]
4) Personalizing learning; and
5) Maximizing teacher and student time.

Consistent with the lack of available rigorous research on educational productivity, the descriptions of potential productivity improvements of online learning that follow the examples below are based on commonly espoused visions for online learning for which more rigorous research is warranted.

1. Broadening Access to Resources and Experiences

Online learning can broaden student access to courses taught by qualified teachers in schools that could otherwise not afford to provide these courses because of relatively small student demand locally or the costs associated with recruiting teachers with the necessary skills and credentials. In particular, rural schools and districts sometimes have difficulty justifying the expense of adding teachers who would serve relatively few students. Online learning environments might increase productivity by broadening access to certified teachers without incurring the cost of hiring highly qualified teachers at each site. Generally speaking, this could result in more educational opportunities being made available to a larger pool of students.

[10] This report adopts the definitions of individualized, differentiated and personalized that were used in the National Education Technology Plan (U.S. Department of Education 2010a). Individualized instruction adjusts the pace of learning to meet the needs of individual students. Differentiated instruction draws from a variety of instructional approaches to meet the student's needs. Personalized learning provides content that is tailored to individual student interests (U.S. Department of Education 2010a).

Example: The West Virginia Virtual School offers Spanish courses to seventh- and eighth-grade students, using a blended model of instruction that combines face-to-face and virtual instruction as well as paper and pencil and Web-based activities (Rockman et al. 2007). These students attend schools in remote areas and would not otherwise have access to Spanish instruction by certified teachers. The program was delivered by a three-member teacher team that included a lead teacher (a certified Spanish teacher) who was responsible for the design and delivery of the daily lesson plan and weekly phone conversations with each class, an adjunct teacher (a certified Spanish teacher) who provided content-related feedback by means of e-mail and voicemail and who graded student tests and products, and a classroom facilitator (a certified teacher but not a Spanish teacher) who guided students on site to ensure that they stayed on task and completed assignments on time. A three-year evaluation study with a matched design at the school level found that students in the blended condition did as well as those in the traditional face-to-face condition on a multiple-choice test, including subtests on oral and written comprehension of Spanish. The study also reported that the blended learning course motivated students to continue learning Spanish in high school.

The blended Spanish course increased access to instruction provided by certified teachers, especially those who would not otherwise have such opportunity. This was particularly important in West Virginia, which had made two years of foreign language instruction a requirement for all middle school students but had been experiencing a serious shortage of licensed Spanish teachers. Additionally, the course provided a variety of opportunities for students to be exposed to and practice Spanish. These activities included listening to Spanish through CDs and Wimba tools and communicating in Spanish with a native speaker or instructors during or after school hours. Moreover, the program enabled teacher teams to build a professional community where teachers in different roles could learn from one another.

2. Engaging Students in Active Learning

Online learning has a potential to improve learning outcomes by replacing lecture time with group and individual work that engages students more actively in learning, enabling greater motivation and deeper learning (Twigg 2003a, 2003b). These activities include online discussions, continuous assessments with immediate feedback and increased computer lab hours where students can get one-on-one support based on the work they have done from the online learning system, the online teacher or the face-to-face teacher. Additionally, simulations and visualizations that make challenging abstract concepts more accessible to students represent one demonstrated advantage of computer-based resources (see Cavanaugh 2008; Kearsley and Shneiderman 1998). Some online programs are game based, facilitating

situated understandings, multiple perspectives and transfer through immersive experiences and activities (Dede 2009; Gee 2006).

> **Example:** In Vermont, Middlebury College and K12 Inc. have recently developed interactive language programs that provide authentic experiences for K–12 students through immersive technologies such as 3D games and social networking (Ash 2010). For example, 3D games require students to use a foreign language in contexts such as taking orders from customers as a waiter or dialing a virtual phone and leaving a voice message. Embedded social networking elements allow students to practice the language with others, including native speakers. These activities help to deepen learning by increasing student interest and motivation and encouraging student conceptual understanding. As a result, students may invest more time and effort in their learning.

3. Individualizing and Differentiating Instruction

Online learning environments are often described as highly individualized and differentiated (Archambault et al. 2010; Christensen and Horn 2008; Waldeck 2007; Waldeck 2008; Watson and Gemin 2008). Some are designed to support the learning needs of a variety of students such as English language learners, students with disabilities and gifted students, while others are designed to enable flexible scheduling in order to accommodate family travel, athletics, performances or other time-specific commitments or because a student was hospitalized or homebound. Modularization of online course content and persistent access to learning materials allow students to progress toward different goals or at different paces.

Effective use of multimedia, hypertext, and other design features can increase accessibility and comprehensibility of course content for different kinds of learners—including students with disabilities and English language learners—and help students acquire multiple literacies (Bosseler and Massaro 2003; Morse 2003; O'Hara and Pritchard 2009; Proctor, Dalton, and Grisham 2007; Rose and Meyer 2000). For example, mathematics and science vocabulary can be challenging for any student, especially students learning English as a second language. The use of hypertext to provide easy access to definitions and the use of graphics and simulations to enhance or reinforce text descriptions can make content more accessible to English language learners (Prichard and O'Hara 2011). Prichard and O'Hara (2011) have found:

> "… environments that support linking graphics, sound and video elements in addition to text elements … provide students with multiple opportunities for

> language production, task engagement and academic vocabulary development …. Not only can various language development needs be addressed simultaneously by promoting the use of visually engaging and language rich technologies, the ability to use these environments encompasses many of the technology skills students need as they graduate from high schools and work toward future careers" (p.19).

Online learning environments can also offer multiple mechanisms to provide rich feedback and communication about student performance (Dennen 2005; Rice et al. 2008; Swan 2004). Online assessments allow efficient data collection and analyses about individual and group performance that would be more difficult to collect in traditional classroom environments. By incorporating accessibility features and scaffolding, universally designed computer-based assessments may yield more valid measurements of knowledge and skills for students with disabilities and English language learners (Almond et al. 2010; Kopriva 2009; Rose and Meyer 2000; Russell, Hoffmann and Higgins 2009a, 2009b). Online assessments also allow for the collection of new kinds of information about student knowledge, skills and abilities through embedded assessments and assessment of student performance on authentic tasks. This rich data about student performance can inform how teachers use their time and which instructional strategies they use for particular students. The data can also be used by developers of online content in the service of continuous improvement efforts (e.g., Cen, Keodinger, and Junker 2007). Immediate feedback loops established in online learning environments can also support the customization of learning content for individual students.

> **Example:** The *Cognitive Tutor®,* Web-based instructional software, provides a highly individualized blended approach to online learning.[11] The tutoring program uses artificial intelligence to identify weaknesses and strengths in each student's mastery of mathematical concepts; it adapts to each student by pacing the curriculum, selecting problems appropriate to the student's skill level and providing immediate feedback. This suggests a reorganization of instruction, with student performance on computer-based formative assessments driving instruction. Pedagogically, the *Cognitive Tutor* focuses on real-world problem-solving through the use of multiple representations and tools, including online chat and virtual whiteboards. Students use the *Cognitive Tutor* three days a week to work independently and with teachers or with other students during the remaining two days. The effectiveness of the standalone computer-based version of the *Cognitive Tutor* is well documented, including a randomized controlled trial that investigated the effectiveness of *Cognitive Tutor Algebra I®* with more than 400 ninth-graders in Oklahoma (Ritter, Anderson, Koedinger & Corbett 2007). Cen, Koedinger

[11] New York City's *School of One* provides another model of individualize and differentiated learning, but *Cognitive Tutor* was selected as the primary example because it has well-documented gains.

and Junker (2007) found that students using the tutor could reach the same level of performance in 12 percent less time than their peers who did not use it.[12]

This type of online learning might improve productivity by using instructional resources such as books and computer-based materials as well as teachers and peers more effectively. Productivity gains can results from focusing on specific student needs in order to improve learning or from using student time more effectively, as students are not constrained by the collective pace of the class. In addition, flexible scheduling and other forms of individualization might help retain students who are otherwise at risk of dropping out of school (Repetto et al. 2010), offering the wide range of individual and social gains that have been well documented as outcomes of high school completion (Levin and Belfield 2009).

4. Personalizing Learning

Personalized learning draws on individual students' specific interests. Using the definition provided in the National Education Technology Plan (U.S. Department of Education 2010a), personalized learning not only encompasses the individualization and differentiation described above, but also allows students to draw on their personal interests to direct learning objectives and content. Personalized learning can tap students' innate curiosity and help them deepen their learning.

Example: The Ohio State University (OSU) introductory statistics course, enrolling over 2,500 students, was redesigned based on what is called the "buffet model" (Twigg 2003a). As the name suggests, students are offered options for types of lectures and labs they receive (e.g., large group lecture, small group problem-solving, online individual work) based on their learning styles as measured by an online pre-course questionnaire (Acker et al. 2003). In fall 2002, the course was delivered with three customized tracks and demonstrated that learning gains could be achieved while reducing costs (National Center for Academic Transformation 2003a; Twigg 2004b). Students in the redesigned course had greater success on common exams than daytime students in the traditional course and about the same scores as students in the evening class, which had smaller class sizes and older students and had previously outperformed the daytime class. Additionally, failures were reduced from 7 percent to 3 percent, withdrawals from 11 percent to 8 percent and incompletes from 2 percent to 1 percent, resulting in 248 more

[12] *Cognitive Tutor* now offers a Web-based delivery option, especially for higher education institutions, going beyond stand-alone software delivery model (http://www.carnegielearning.com/higher-ed-curricula/implementations). The majority of research on the product thus far, including those studies cited here, has been on the stand-alone software rather than the Web version.

students successfully completing the course compared with the traditional course (National Center for Academic Transformation 2003a). In addition to improving outcomes, cost savings were reported by replacing individually held office hours with a help room where students can work collaboratively on difficult problems and concepts. The help room is open for all students taking any statistics course and is staffed with teaching assistants, adjuncts, and full-time faculty throughout the day. By making this change, OSU saved one additional teaching assistant position. Additionally, OSU found that students prefer Web-based problem-solving sessions to in-class sessions, leading to a reduction of the in-class session from five times to three times a week.

5. Maximizing Teacher and Student Time

There are at least two uses of online learning to improve the use of teacher and student time. Visualizations of learning progressions and student development made possible through learning management systems and other online data systems may offer an opportunity to make the educator's workload lighter by providing targeted input to lesson planning and attempting to address individual student needs. Students may also benefit from reflecting on their learning progress. In addition, some online learning models are designed to transfer certain routine activities, such as skills practice and test preparation, from teacher-based whole- or small-group instruction to activities that students can conduct independently on a computer. Proponents of these models claim that this use of online learning allows class time to focus on activities and discussions that take greater advantage of teacher skills and real-time interaction with students. The National Center for Academic Transformation has reported replacement of routine in-class activities with online activities is particularly notable in foreign language instruction in postsecondary settings.[13] In the redesigned courses, grammar instruction, practice exercises, testing, writing and small-group activities are typically moved to the online environment. This not only reduces in-class meeting time, but also frees teachers to focus on complex activities that require face-to-face interactions such as developing and practicing oral communication skills during the in-class time (Twigg 2007).

Example: To graduate from high school, students in New York must pass five Regents exams. The NYC iSchool—a small high school that opened in fall 2008—uses online learning to prepare students for the Regents exams, as well as to allow practice of basic skills. The self-paced online test-prep courses are primarily accessed during a scheduled class period. The online course does not require an online teacher; rather, the teacher is

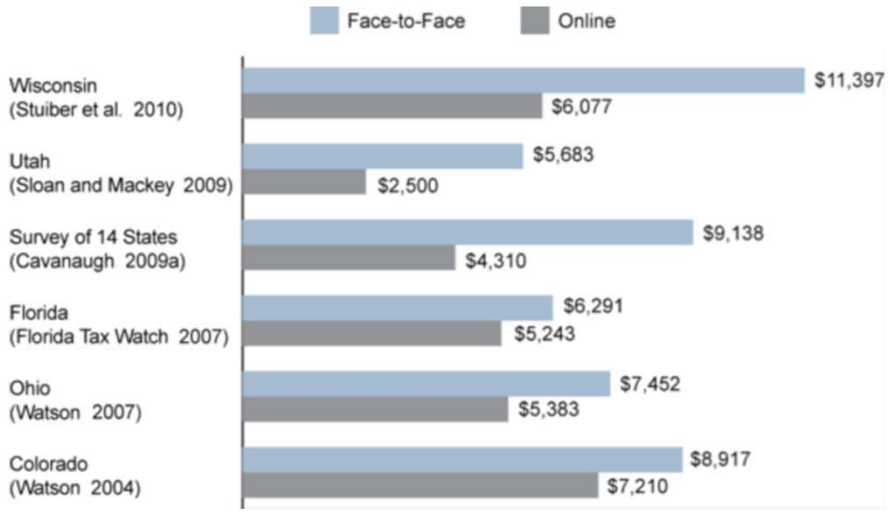
[13] Again, examples from postsecondary education can suggest possible opportunities for efficiency in secondary education, but gains should not be assumed to transfer across contexts.

present in the classroom and students can seek additional face-to-face help during office hours. This enables students and teachers to spend more classroom time on learning projects and on solving real-world problems. Since the school is still relatively new, published research is limited. Journalistic accounts suggest that iSchool student attendance is higher than the city average and limited seats are in high demand (Stansbury 2009). Productivity gains might come from reducing teacher time required for routine tasks and reallocating it for higher value activities that require teacher expertise such as spending personal time with students and providing detailed and complex feedback that cannot be automated by technology.

Opportunities to Reduce Educational Costs Through Online Learning

The previous section described potential gains in educational effectiveness that may result from the use of online learning. This section focuses on potential cost savings in particular. Studies that examine the costs of online learning programs in comparison with face-to-face instruction have consistently found savings associated with online learning, although the costs of both forms of education vary considerably. Exhibit 2 provides estimates of per-pupil spending for online and place-based secondary instruction from six different studies. These studies used different methods to calculate per-pupil spending. They also drew on different data sources. Some of the data were self-reported by school leaders (Cavanaugh 2009b) or estimated (Watson 2004). In other cases, data were verified by an external auditor (Stuiber et al. 2010). It is important to note that none of these studies appeared in a peer-reviewed journal.

Exhibit 2: Comparison of Per-Pupil Spending



A recent report estimated the average per pupil costs of various models of online learning (Battaglino, T.M., M. Haldeman, and E. Laurans (2012). *The Costs of Online Learning.* Washington, DC: The Thomas B. Fordham Institute.) and found that virtual schools are likely to cost less than blended models. Based on expert opinion, the report found that the average per pupil cost of virtual schools ranged from $5,100 and $7,700, and the average per pupil cost of blended school models cost between $7,600 and $10,200.

Exhibit reads: According to Stuiber and colleagues (2010), the average per-pupil spending for face-to-face education in Wisconsin was $11,397, compared with only $6,077 per pupil for online learning.

None of the studies in Exhibit 2 compared the actual costs of both development and delivery of parallel educational services for online and face-to-face instruction.

The idea that online learning can reduce costs has intuitive appeal (Christensen and Horn 2008; Christensen, Johnson, and Horn 2008). Some cost studies have found online learning to be less expensive, and it is noteworthy that this collection of studies consistently found cost savings associated with online learning. However, it is important for readers of these studies to be aware that most did not include rigorous control of the costs and program scope being compared. For example, they often compared the costs of online learning programs (either actual costs or allocated funding) with per-pupil allocations in the state, which cover the broader array of services provided by traditional public schools, e.g., cafeterias, transportation. None of the studies in Exhibit 2 compared actual costs of both development and delivery of parallel educational services for online and face-to-face instruction.

Nevertheless, literature about online learning more generally suggest at least four ways that online learning might contribute to cost reduction:

1) Increasing the rate of student learning by increasing motivation and student time on task and helping students grasp concepts and demonstrate competency more efficiently;

2) Reducing salary costs by redesigning processes to allow for more effective use of teacher time, increasing teacher-student ratios or transferring some educational activities to computers;

3) Reducing facilities costs by leveraging home and community spaces in addition to traditional school buildings;

4) Realizing economies of scale by leveraging initial development costs as broadly as possible.

1. Increasing the Rate of Learning

This is a potentially powerful pathway because it could change the value of student time (Watson et al. 2010). Traditionally, course credit and other measures of educational attainment have been tied to seat time—that is, how many hours the student spends in a classroom with a certified teacher. It does not matter if the student could master the required material more quickly or not. Although time is money, the value of student time and its effective use is often ignored in decisions about elementary and secondary education. A focus on identifying what students already know and what they need to know and tailoring instruction based on this information to meet student needs may make instruction more efficient, allowing students to learn content more quickly or more deeply. For example, Lovett, Myer and Thille (2008) found that college students learned statistics online about 50 percent more quickly than students in traditional large lecture courses. In looking primary at studies of learning in the military, Fletcher and Chatham (2009) found efficiency gains of about 30 percent for a variety of types of online training for the military in a study of:

Lovett, Myer and Thille (2008) found that college students learned statistics online about 50 percent more quickly than did students in traditional large lecture courses. Fletcher and Chatham (2009) found efficiency gains of about 30 percent for a variety of types of online training for the military.

> "several hundred studies comparing standard classroom instruction (e.g., lectures, text- and work-books, and some hands-on laboratory experience) with the use of technology-based instruction (Fletcher 1997, 2004, 2009). Research suggests that this finding results from the capability of computers (i.e., those who program computers) to tailor the pace, content, and sequence of instruction to the needs of each learner. Absent computer technology, such a capability has long been viewed as desirable, but unaffordable" (pp. 19-20).

No similar studies involving elementary or secondary students could be located at the time of this review. Research has not yet demonstrated whether similar learning gains per unit of time can be realized for younger students.

2. Reducing Total Salary Costs

The Southern Regional Education Board (2006) found that the largest cost component for both traditional brick-and-mortar schools and state virtual schools was personnel, with typical school expenditures ranging from 70 to 80 percent of operating budget and possibly higher for virtual schools. But cost estimates vary widely depending on the type of online learning program (Watson et al. 2009).

Some have pointed to online learning's potential for increasing the number of students served by a teacher (Moe and Chubb 2009). For example, the cost savings reported by the National Center for Academic Transformation's course redesign work, as mentioned earlier, were primarily derived from decreased time spent by instructional personnel (e.g., faculty, graduate students) and substitution of less expensive personnel (Twigg 2003b). Analysts have also suggested that some teacher tasks can be handled by technology, as is the case when online learning is used for supplementary purposes in classrooms. Teachers in fully online programs also suggest that more of their time is spent directly on instruction rather than ancillary duties of school-based teachers such as classroom management and hall and lunch duty. Focusing teacher time on instruction is one way teachers may serve more students and ultimately reduce the number of teachers needed to maintain comparable student outcomes (Moe and Chubb 2009). Although such a change might seem to threaten teachers' job security, increasing student-teacher ratios are one way of compensating for the teacher shortages projected in the near future (Committee on Science, Engineering, and Public Policy 2005; Ingersoll 2000; Murphy, DeArmond, and Guin 2003).[14]

[14] The National Educational Technology Plan (2010a) describes a future in which there are many differentiated roles for teachers, suggesting the need for more educators rather than fewer, even if there is an increase in student-teacher ratios related directly to instruction.

Although somewhat controversial, some higher education programs are reported to have successfully reduced personnel costs without needing to cut full-time positions (Twigg 2003a, 2003b). These substitutions include technology-assisted instructional activities (e.g., online quizzes with automated scoring instead of hand grading) and lower priced labor such as undergraduate learning assistants or newly appointed positions such as course assistants, preceptors, and course coordinators who assume specific roles within the course, enabling faculty to concentrate on tasks that require high-level expertise and experience. In practical terms, these cost reduction strategies often translated into reducing the number of sections and face-to-face meetings with full-time faculty as well as increasing the number of students served per section or instructor.

For example, Florida Gulf Coast University (FGCU) redesigned a required course called Understanding the Visual and Performing Arts into a fully online course. The purpose of the redesign was to address the challenges caused by rapid enrolment growth, including difficulty in finding qualified instructors and inconsistency in how the course was taught by part-time instructors (Wohlpart et al. 2006). The redesign process reportedly led to a reduction in the number of class sections from 31 to two while increasing enrollments from 800 to 1,200 (National Center for Academic Transformation 2002b). In the redesigned course, several preceptors with undergraduate degrees in English served as teaching assistants and were responsible for monitoring small group online discussions. Each preceptor supported up to 60 students (10 teams of six each), which was twice the number of students served by an instructor in the traditional model (30 students per section). The redesigned course curriculum became more coherent and consistent through the use of a common syllabus, textbook, set of assignments and course Web site (National Center for Academic Transformation 2003b; Wohlpart et al. 2006). Technology was used to offload labor-intensive activities, such as presenting course content and grading exams and papers.

The reported cost per student was reduced from $132 in the traditional format (enrolling 800 students) to $81 in the first year of redesign implementation while enrollment was increased to 950. In the second year of implementation, the cost per student was reduced further to $70 while enrollment was increased to 1,200. FGCU reported that that this was achieved without compromising instructional quality. Savings were realized by both increased student-staff ratios and lower salaries for staff with lesser credentials. Comparisons of student learning in the redesigned course and the traditional course showed that students performed better than those from the traditional course on common tests of content knowledge and critical thinking skills (National Center for Academic Transformation 2003b).

3. Reducing Facilities Costs

Compared with traditional brick-and-mortar education, online learning can reduce the need for physical space (e.g., when students take courses at home). Although online schools typically have few or no costs associated with physical infrastructure (e.g., instructional facilities, student transportation, meals), they have higher costs for technology and instructional development. (Technology infrastructure costs may decrease with emerging information technology solutions such as cloud computing, but development and management costs constitute nontrivial expenses that are expected to persist.) In addition to the costs of hardware, software, program development and maintenance/support for central technology services, state and district programs must ensure that all students have equitable access to the hardware and software needed to participate (Anderson et al. 2006).

Physical space costs are an important cost driver of traditional schooling. By substituting classroom instruction with online instruction, the need for physical space can be reduced. In fact, the University of Central Florida that implemented course redesign with the National Center for Academic Transformation reported cost savings from delivering portions of American government course online, reducing the amount of physical space required for the course (Twigg 2003a).[15,16]

4. Realizing Economies of Scale

A few studies in postsecondary education have found online learning to be an expensive alternative because of the initial development costs and the personnel costs for delivering instruction, especially when the online learning program is designed to equal or exceed the quality of face-to-face instruction (Jones 2001; Ramage 2005; Smith and Mitry 2008). Establishing an infrastructure that can support scale can incur significant costs as well.

To achieve overall productivity gains in these situations, it is important that some of the financial investments associated with online learning are leveraged across many students by reusing digital course materials. Once an online course is developed, digital resources can be reused at a relatively low marginal cost, the term economists use to refer to the change in total cost when the quantity produced changes by one unit—in this case, the cost of adding

[15] Additional empirical analyses are required to understand better the trade-offs associated with reductions in facilities costs and costs associated with the research and development of online programs, particularly in institutions creating home-grown content.

[16] Although this is not online learning per se, a recent estimate shows that by providing a laptop computer to each student, schools across the country can potentially save $825 million (or $15 saving per student per year) in physical space costs because fewer dedicated computer labs and physical space at the back of the regular classroom would be necessary in a one-to-one mobile computing model (Greaves et al. 2010).

the next student to a program. Similarly, costs of Internet-based distribution seem to be relatively low in settings where an adequate technical infrastructure is already installed. Although the continuous improvement of courses will require some curator costs over time to make sure materials are relevant and dynamic, these costs may be minor relative to publishing new bound editions of books, especially when distribution costs are included. Moreover, by conducting a bulk of learning activities online, costs associated with copying materials (e.g., paper, ink, teacher time) and paperwork can be greatly reduced. According to one estimate, for copying materials alone, online learning can potentially achieve a saving of $2.2 billion per year at the national level, based on an estimate that schools save $40 per student each year (Greaves et al. 2010).

Scale is important in any study of educational productivity and no less so for online learning. Compared with conventional instruction, online learning may incur higher start-up costs associated with developing a new program and perhaps for developing curriculum and digital resources. Although online course content can be expensive to develop, once created it has the potential to be distributed to large numbers of students (e.g., Adsit 2003; Christensen et al. 2008; Watson 2004). However, course development may constitute only a small portion of total costs depending on the instructional model (Anderson et al. 2006). For example, an online course that requires teachers to replicate traditional lecture formats and deliver the bulk of instructional content verbally to passive listeners at the same teacher-student ratios—but does so online—will incur ongoing costs per student that may exceed the cost of instructional materials per se. Additionally, critics of the economics of scale logic assert that large-scale delivery of courses would reduce student opportunities for social and affective experiences that are particularly important for developing soft skills (e.g., Bauman 1997).

Implications

Determining whether online learning is more or less cost-effective than other alternatives does not lend itself to a simple yes or no answer. Educational stakeholders at every level need rigorous information regarding effective instructional strategies and methods for improving educational productivity. Comparison of relative productivity requires attention to a host of factors, including the students served, the subject domain, scale, budget and design factors such as the role of the teacher and the level of blending of online and face-to-face components (Liu and Cavanaugh in press). The framework presented in this report is intended to serve as a resource for stakeholders' use in assessing available research. It can also be used as a guide for designing future research. As the spread of online learning alternatives continues, educational stakeholders will need to invest in productivity research that includes comparisons of the cost-effectiveness of instructional alternatives and builds knowledge of how best to define and measure student, teacher and system outcomes.

Studies designed to inform educational decisions should follow rigorous methodologies that account for a full range of costs, describe key implementation characteristics and use reliable estimates of student learning. Unfortunately, no studies were found in this review that rigorously analyzed the productivity of online learning for elementary and secondary students, although the available evidence suggests that online learning *might* improve educational productivity if properly deployed.

With respect to costs specifically, institutions need to consider both total costs and per-student costs of online learning relative to conventional instruction. Relatively high total costs may be more palatable if courses can be leveraged across a wider student audience. Moreover, cost drivers in an online environment differ from those in face-to-face environments, suggesting a crossover point for student enrollment numbers at which one format becomes more cost-effective than the other. Institutions must also consider whether

alternatives truly save costs or if costs are allocated to another revenue source. For example, online programs that assume students have home access to a computer, the Internet and a printer are essentially reallocating some costs to students and their parents. Doing so, in turn, raises concerns about equitable access to online learning that districts must carefully address.

With regard to the effectiveness of online learning, evidence indicates that online learning *can* be as effective as or more effective than traditional instruction, and blended approaches may be superior to others. However, as the section on future research below suggests, questions remain about the types of student skills and attributes (e.g., meta-cognitive skills, organizational ability, motivation) that may influence or predict student success in online formats (Cavanaugh 2007). This is particularly important in the public schooling context, where universal designs and access affordances must be used to offer quality online learning opportunities to the full range of students served by the system. More research is required to understand when, how and under what conditions online learning can produce the greatest productivity gains for all students.

The Need for Transformation

Transforming American Education: Learning Powered by Technology, the most recent U.S. educational technology plan, has set the goal for all levels of the educational system to redesign processes and structures to leverage "the power of technology to improve learning outcomes while making more efficient use of time, money, and staff" (U.S. Department of Education 2010a, 63). The goal suggests that more vigorous efforts are needed to both (1) design and build key constructs and measures that will support increasingly real-time, integrated learning analytics for students, teachers and administrators and (2) develop the technical and human infrastructure needed to plan and implement productivity analyses and use their results appropriately.

To use online learning to its fullest potential, developing online equivalents of existing teaching practices is unlikely to be sufficient (Twigg 1992). Instead, educational decision makers should heed the lessons of other industries and redesign core educational processes. The purpose of the transformation is to sharpen focus on the needs and interests of students as individuals. To the degree possible, instruction should be tailored to meet student goals at their desired pace of learning. Online learning supports diagnostic assessments and frequent and individualized feedback, which may in turn suggest a move toward competency-based systems. In this model, once students demonstrate a desired level of mastery they can move on to new topics and new skills, and savings of time and money can result if they do so at an

accelerated pace. Interventions such as these require a fundamental rethinking of the basic parameters of educational systems, but they promise opportunities for significant improvements in productivity.

Suggestions for Future Research

The limitations of the research identified for review in this report underscores the need identified in the National Educational Technology Plan (U.S. Department of Education 2010a) for a national initiative to develop an ongoing research agenda dedicated to improving productivity in the education sector. The complexity of implementations and the relative novelty of online learning generally, and particularly with children, calls for additional research designed to identify the conditions and practices in which online learning can be used effectively in secondary schools. Such research would help inform which combinations of technological affordances, subject domains, roles of adults and instructional and assessment approaches work best for particular types of students. Indeed, the very multitude of emerging implementations calls for a program of study that spans a variety of sites. Diverse students and content could be considered either within a site or across sites.

Underserved, at-risk students and students with special needs deserve special attention. There is emerging evidence that prevalent online learning models do not meet the needs of all students (Barbour & Reeves 2009; Keeler et al. 2007; Rice 2006). For example, students may need Internet access, technical aptitude, independent learning skills or adult supervision to engage fully in learning online. At the same time, there is emerging interest in the use of online learning for credit recovery and to meet the needs of students at risk of dropping out of school (Davis 2011; Sturgis et al. 2010; Watson and Gemin 2008). Many programs that address these populations of learners are popping up across the country. But questions remain regarding which implementation characteristics are associated with success for at-risk students and students with disabilities and the degree to which access to technology and learning content present barriers for student participation and success in online learning programs.

The role of adults varies considerably across online learning models. Salary costs are a sizable portion of most educational endeavors, and finding ways to use human capital to maximum advantage is an important component of increasing productivity. However, the available research does not speak to guidelines for practitioners regarding how and under what circumstances teachers, mentors or facilitators can best be deployed through online interactions rather than face to face. The issue of appropriate teacher credentials and teacher-student ratios is far from resolved, and more research is needed regarding appropriate roles for teachers given particular students and content. What types of services do instructors and

moderators provide online, and are some more effective than others? What is the cost-effectiveness of materials developed to support student learning without adult support relative to other models that leverage adults for a variety of purposes, including instruction, feedback and local support?

Finally, educational leaders need to focus on research and development that fuels innovation and continuous improvement. What barriers slow the adoption of innovation in schools and districts? What strategies do leaders employ to overcome these barriers? What incentives can be provided to encourage innovation? Answers to these questions may make it more likely that future investments in online learning will live up to their potential for improved productivity for systems and improved learning opportunities for all students.

Appendix A: Additional Resources

This appendix provides a variety of resources addressed in this document for the reader who would like to learn more. Resources are organized by the following topic headers:

- General Productivity in Education,
- Productivity and Educational Technology,
- Conceptual Frameworks, Empirical Evidence,
- Cost of K-12 Online Learning,
- Effectiveness of K-12 Online Learning, and
- Key Resources on Types and Prevalence of Online Learning, and Quality Standards for Online Learning Programs.

Brief descriptions of purpose, methods and findings are provided for each resource. Often text is quoted directly from the work itself. In these cases, the text follows the standard of providing quotation marks and page numbers.

General Productivity in Education

Hill, P., and M. Roza. 2010. *Curing Baumols disease: In search of productivity gains in K–12 schooling*. White Paper 2010_1. Seattle, WA: Center on Reinventing Public Education.

- **Purpose:** "While education differs in important ways from other service sectors, this paper posits that improvement in productivity in other economic sectors may hold important lessons for understanding how the education system can become more efficient and effective" (p. 1).

- **Methods:** A white paper from the Center on Reinventing Public Education. "This paper first explores the past and future outlook for education absent productivity gains" (p. 1). The authors then discuss several areas in which labor-intensive businesses have improved productivity: information technology, deregulation, redefinition of the product, increased efficiency in the supply chain, investments by key beneficiaries, production process innovations, carefully defined workforce policies and organizational change. They conclude with a five-step agenda for finding the cure for Baumol's disease in public education.

- **Findings:** "Schools are highly labor intensive and getting more so, due to pressures for class size reduction and increasing use of specialist teachers. Yet on average schools are producing at best only slightly better results than at earlier times; thus, given increased costs, they are literally becoming less productive" (p. 1).

Levin, H., and P. McEwan. 2001. *Cost-effectiveness analysis: Methods and applications.* 2nd ed. Thousand Oaks, CA. Sage Publications.

- **Purpose:** "To provide a diverse audience—evaluators, educational administrators, and graduate students—with a systematic introduction to the use of cost analysis in educational evaluation" (p. 3).

- **Methods:** "Cost analysis in education refers to the use of a broad set of techniques for evaluation and decision making, including cost-effectiveness, cost-benefit, cost-utility, and cost-feasibility. Each type of analysis will be developed separately for consideration" (p. 4). These are collectively called cost analysis.

Miles, K., and S. Frank. 2008. *The strategic school: Making the most of people, time, and money*. A Joint Publication with the American Association of School Administrators and the National Association of Secondary School Principals. Thousand Oaks, CA: Corwin Press.

- **Purpose:** The book is intended for school and district administrators who are charged with improving student performance but lack the ability to devote more financial resources to doing so (xiii). It addresses the question of how schools can best use the resources they already have. "The purpose of this book is to provide school leaders and the administrators who support them with a deep understanding of how strategic schools leverage their available people, time, and money to impact student learning" (p. xiii).

- **Methods:** A conceptual piece that explores the link between purposeful resource allocation and academic achievement based on "extensive reviews of the literature, in-depth case studies, and district analysis" and the authors' "experience in partnering with urban schools and districts across the country" (p. xiii).

- **Findings:** Demonstrates how educational leaders can develop successful and strategic schools by assessing how well they use all available resources (people, time, and money) and by creating effective alternatives to meet goals.

Productivity and Educational Technology

Cavalluzzo, L. 2004. *Organizational models for online education: District, state, or charter school?* Policy and Planning Series #109. Alexandria, VA: CNA Corporation.

- **Purpose:** "This paper describes some of the organizational models that have been developed to provide online education to public school students, including their key strengths and challenges. The review is intended to help state and local school officials weigh such issues as cost, finance, access, and effectiveness as they consider alternative organizational models for delivering online education to their students" (p. 1).

- **Methods:** Reviewed extant literature on online learning.

- **Findings:** ATEC "found that many states and school district officials have the impression that the adoption of non-classroom-based programs translates into lower overhead costs and savings on a host of services that otherwise support

traditional classroom instruction. Policymakers need to look beyond the prospect of reducing per-pupil expenditures" (Foreword). "Few [articles] could be categorized as 'independent research.' Moreover, hardly any focused on the overall costs and consequences for maintaining and operating alternative state-sponsored models" (Foreword).

Fletcher, J. D., and R. Chatham. 2009. Measuring return on investments. In Paul O'Connor and Joseph Cohn (Eds.), *Human performance enhancement in high-risk environments*. Santa Barbara, CA: Greenwood Publishing Group.

- **Purpose:** To answer the question "How, in quantitative terms that are comparable to the returns … calculate[d] for investments in materiel, ordnance, supplies and the like, should … increases in system and operational effectiveness that are effected by investments in training [be assessed]?" (p. 2).

- **Methods:** The authors present a brief discussion of return on investment (ROI) analysis and then offer specific examples where satisfactory data were available to assess ROI (p. 3).

- **Findings:** "Human performance measures are typically more variable and less precise than those of equipment performance, but they can lend themselves to the cost and effectiveness trade-offs that are an inevitable and proper component of managerial and administrative decision-making" (25).

Levin, H., G. Glass, and G. Meister.(1987. Cost-effectiveness of computer-assisted instruction. *Evaluation Review* 11(1):50-72.

- **Purpose:** "To assist decision makers in considering different approaches to improving mathematics and reading performance of elementary school children" (Abstract).

- **Method:** "The authors conduct a cost-effectiveness study of computer-assisted instruction (CAI) and three additional interventions" (Abstract).

- **Findings:** "The authors find that peer tutoring is more cost-effective than CAI, and both are more cost-effective than reducing class size or increasing the length of the school day" (Abstract).

Conceptual Frameworks

Cavanaugh, C. 2009. *Getting students more learning time online: Distance education in support of expanded time in K–12 schools.* Washington, DC: Center for American Progress.

- **Purpose:** "This report outlines the rationale for and steps toward making distance education courses uniformly available to expand school learning time. It also outlines some of the urgent needs in American education today and explains how school districts and educators can use K-12 distance education to address them" (p. 3).

- **Methods:** A review of existing literature, including a survey conducted by the author.

- **Findings:** "A survey of the directors of 20 virtual schools in 14 states found that the average annual cost for a full-time online student was $4,310 in 2008, while the U.S. average per-pupil expenditure in public schools was $9,138, as of 2006" (p. 12). "Thirty percent of school leaders in a 2008 national survey stated that online and blended courses are financially beneficial in their schools" (p. 13).

Christensen, C., C. Johnson, and M. Horn. 2008. Disrupting class: How disruptive innovation will change the way the world learns. New York: McGraw-Hill.

- **Purpose:** The purpose of the book is "to introduce the innovation disruptively—not by using it to compete against the existing paradigm and serve existing customers, but to target those who are not being served" (p. 1).

- **Methods:** This widely cited book represents an important contribution to the conceptual framework about productivity and educational technology (including online learning). Its data sources include some anecdotal evidence from individual schools, the authors' expert opinion and existing literature from the field.

- **Findings:** "Disrupting what actually happens in the classroom by instituting student-centric technologies is vital to customize learning for each individual student and to improve motivation for all" (p. 214).

Kaestner, Richard. 2007. *A report and estimating tool for K–12 districts. Value of investment.* Wisconsin VOI Case Study Online Learning. Consortium for School Networking (CoSN).

- **Purpose:** To consider the "comparative value of having district teachers develop and offer online classes (in-house development) versus purchasing courses and instruction from a coop or vendor and using school personnel in a mentor role (outsourcing)" (p. 4).

- **Methods:** "The VOI methodology is being used by the district to help assess the value of online learning in terms of district goals and mandates and determine the relative costs of alternative approaches" (p. 4). "The VOI tools helped highlight the differences in per-student cost between in-house and outsourced options. Four scenarios were analyzed with regard to costs" (p. 5).

- **Findings:** "The ongoing in-house core courses are expected to cost the district approximately $178 per student, while the outsourced non-core courses for the ten students are expected to cost approximately $1,560 per student ($1,200 of which is estimated as external service provider costs). This data helped confirm for district planners the idea that online courses with anticipated high demand (core courses) made sense to develop in-house based on current face-to-face curriculum" (p. 5).

Wise, B., and R. Rothman. 2010. *Issue brief: The online learning imperative: a solution to three looming crises in education*. Washington, DC: Alliance for Excellent Education.

- **Purpose:** "Explains how online learning can solve three problems in U.S. public education: attainment of 21st century skills, budget shortfalls, and teacher shortage" (p. 1).

- **Method:** An issue brief from the Alliance for Excellent Education. Draws from previous reports.

- **Findings:** "For states and school districts striving to raise student outcomes without additional dollars, there is steadily growing evidence of the cost-effectiveness of online learning" (p. 7). Efficiencies include: schools can offer courses that many local schools could not previously afford to offer. "Schools can now meet the unique interests and needs of students and parents who previously would have been shut out. Spreading similar costs over multiple learning sites" (p. 7). "With online learning, one teacher in a complex subject can be 'shared' across many schools" (p. 8). "The experience of online education

suggests that the use of this technology also has the potential to accelerate learning … Students can learn at their own pace, receiving the individual attention and feedback that is critical to understanding" (p. 9).

- **Recommendations:** The authors recommend "restructuring secondary school classrooms so that the traditional model of one teacher in front of twenty-five students no longer applies" (p. 8).

Empirical Evidence

Jung, I. 2005. Cost-effectiveness of online teacher training.
***Open Learning* 20(2):131–146.**

- **Purpose:** "This study aims to compare the cost-effectiveness of an online teacher training method with a face-to-face training method in teaching 'ICT integration in the school curriculum.' In addition, the study explores the possibilities of a school-based voluntary training method in supporting other approaches to ICT teacher training" (p. 131).

- **Methods:** "The analyses of various quantitative and qualitative data showed that online teacher training was more cost-effective than face-to-face teacher training, mainly due to the lower opportunity cost of the participants" (p. 131).

- **Findings:** "The voluntary teacher training revealed the possibility of providing cost-effective training, especially in the actual application of ICT in classrooms. Based on the results of the study, factors affecting cost-effectiveness of the teacher training approaches are discussed and further research areas suggested" (p. 131).

Lovett, M., O. Meyer, and C. Thille. 2008. The Open Learning Initiative: Measuring the effectiveness of the OLI Statistics Course in accelerating student learning. *Journal of Interactive Media in Education*.

- **Purpose:** "To test the OLI-Statistics course's effectiveness via an accelerated learning hypothesis" (p 8).

- **Methods:** During Spring 2007, about 200 students were already registered for Introductory Statistics at Carnegie Mellon. The researchers invited these students to participate in the accelerated learning study using online learning for instruction instead of the traditional classroom environment. Sixty-eight students volunteered, and 22 students were randomly selected to use the OLI-Statistics

course in hybrid model. Forty-two students served as the primary control group" (p. 8).

- **Findings:** "OLI-Statistics students learned a full semester's worth of material in half as much time and performed as well or better than students learning from traditional instruction over a full semester" (p. 1).

Stuiber, P., K. Hiorns, K. Kleidon, A. La Tarte, and J. Martin. 2010. *An evaluation of virtual charter schools*. Wisconsin Department of Public Instruction.

- **Purpose:** "An evaluation of virtual charter schools in Wisconsin, mandated by the state legislature" (p. 1).

- **Methods:** "Reviewed budgets and enrollments at 15 virtual charter schools from 2005 through 2008" (p. 3). "Analyzed test scores on the Wisconsin Knowledge and Concepts Examination for all students for the three-year period from 2005-06 through 2007-08" (p. 6). "Surveyed parents and guardians, teachers, and high school pupils at 15 virtual charter schools" (p. 17-18). "Reviewed licensing data to ensure that all virtual charter school teachers were properly licensed" (p. 4).

- **Findings:** "In the 2007–08 school year, 15 virtual charter schools enrolled 2,951 full-time students. In the same year, 8 of the 15 virtual charter schools' per pupil expenditures were less than $6,007 per full-time open enrollment student. On statewide assessment tests, virtual charter school students in general scored higher than other public school students in reading but lower in mathematics" (p. 1).

Cost of K-12 Online Learning

Anderson, A., J. Augenblick, D. DeCesare, and J. Conrad. 2006. *Costs and funding of virtual schools*. A report prepared for the BellSouth Foundation. Denver, CO: Augenblick, Palaich, and Associates.

- **Purpose:** "To examine issues related to cost and funding of virtual schools, including the cost of operating and the funding mechanisms to support such schools" (p. 4).

- **Method:** "The authors used the Professional Judgment (PJ) approach as the primary data collection method for the research. The authors brought together two PJ panels, one of representatives of state-led supplemental programs and the other of representatives of full-time programs" (p. 4).

- **Findings:** "There are two types of costs: start-up costs and ongoing costs. There are five broad categories of ongoing costs for online programs: management, instruction, course development, technology set-up, and technology personnel. Operating costs range between $3,650 and $8,300 per full-time equivalent (FTE) student. The operating costs of online programs are approximately equal to the operating costs of a traditional brick-and-mortar school" (p. 4).

Cavanaugh, C. (2009). Online course funding: The influence of resources on practices. In J. Watson and B. Gemin (Eds.), *Keeping pace with K–12 online learning: A refiew of state-level policy and practice* (pp. 39–40). Vienna, VA iNACOL.

- **Purpose:** This overview "outlines the factors that influence budgets, costs and prices, and then discusses potential impacts on the student experience" (p. 39).

- **Methods:** Presents a framework for categorizing the major costs of an online program.

- **Findings:** "Funding for online courses is an economic, political and educational issue that includes the budgeting process enabling course providers to operate, the actual costs of producing and offering courses, and the price at which courses are provided to students" (p. 39).

Rumble, G. 1997. *The costs and economies of open and distance learning.* Open and distance learning series. London: Routledge.

- **Purpose:** "This book aims to provide its readers with both the necessary technical tools to undertake costing, and information on the behavior of costs in open and distance learning systems" (pg. 3).

- **Methods:** Provides a framework for the analysis of the costs of online learning, primarily at the level of postsecondary education.

- **Findings:** "The first part of the book provides an introduction to the basic concepts of costs and costing. The second part looks at the costs of designing, producing and distributing materials, and of supporting students… The third part of the book looks at particular aspects of the economics of distance and open learning (cost efficiency, cost effectiveness, cost benefit, and the issues around funding, demand and price), and the lessons that have been learnt over the years" (pg. 3).

Southern Regional Education Board (SREB). 2006, August. Cost guidelines for state virtual schools: Development, implementation, and sustainability. Atlanta, GA: SREB Educational Technology Cooperative.

- **Purpose:** "This report focuses on the costs to create and sustain a state virtual school" (p. 4).

- **Methods:** "The scenarios in this report identify the costs associated with the creation and implementation of a state virtual school at three levels of implementation" (p. 1). "The cost guidelines in this report can help states determine a level of funding to ensure quality and success in meeting state student achievement goals" (p. 4).

- **Findings:** "Although the first several years require greater funding, economies of scale should benefit states in funding state virtual schools over time. The costs to acquire courses, maximize efficiencies in technology use, and reduce per pupil costs are the longer-term factors to consider once a state virtual school is well-established" (p. 4).

Effectiveness of K-12 Online Learning

Englert, C. S., Y. Zhao, K. Dunsmore, N. Y. Collings, and K. Wolbers. 2007. Scaffolding the writing of students with disabilities through procedural facilitation: Using an Internet-based technology to improve performance. *Learning Disability Quarterly* 30(1):9-29.

- **Purpose:** "To understand the potential of web based programs to support and scaffold the writing performance of students with disabilities" (p. 9).

- **Methods:** Quasi-experiment. "An experimental and control group of students planned and organized their ideas in order to write expository papers about self-selected topics. The experimental group used a web-based environment that scaffolded performance by prompting attention to the topical organization and structure of ideas while students were in the situated act of composing their papers. Control students used similar writing tools, but in traditional paper-and-pencil print formats" (p. 9).

- **Findings:** "Students in the web-based scaffolding condition produced lengthier pieces and received significantly higher ratings on the primary traits associated with writing quality" (p. 9). "These findings suggest the web-based software can be designed to offer universally available supports to improve the performance of struggling writers" (Abstract).

Rockman, S., K. Sloan, T. Akey, B. Farr, M. Pereira-Leon, J. Shapiro, and L. Clark. 2007. *ED PACE final report*. Submitted to the West Virginia Department of Education. San Francisco: Author.

- **Purpose:** "The focus of the ED PACE research, conducted by Rockman et al. from October 2003 through October 2006, was the implementation and impact of West Virginia's Virtual School Spanish program" (p. 1).

- **Methods:** "The study of student achievement used a quasi-experimental design [matched samples] to determine how achievement among Virtual School Spanish students compared to that of students who received instruction in face-to-face Spanish classes, and whether participation in Virtual Spanish affected overall student performance on West Virginia's standardized achievement test" (p, 3).

- **Findings:** "Students in virtual classes performed as well as those in face-to-face classes on the Spanish Assessment" (p. 71). "On the Spanish proficiency assessment, students in virtual classes perform as well as their face-to-face peers

on the multiple-choice assessment, and lower than their face-to-face peers in oral fluency and, to a lesser degree, writing" (p. 30).

U.S. Department of Education. 2010. *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. Washington, DC: Author.

- **Purpose:** "The goal of the study as a whole is to provide policy-makers, administrators and educators with research-based guidance about how to implement online learning for K–12 education and teacher preparation" (p. xi).

- **Methods:** "The findings presented here are derived from (a) a systematic search for empirical studies of the effectiveness of online learning and (b) a meta-analysis of those studies from which effect sizes that contrasted online and face-to-face instruction could be extracted or estimated" (p. xi). "The meta-analysis included 51 study effects, 44 of which were drawn from research with older learners" (p. xiv).

- **Findings:** "Few rigorous research studies of the effectiveness of online learning for K–12 students have been published… Students who took all or part of their class online performed better, on average, than those taking the same course through traditional face-to-face instruction… Instruction combining online and face-to-face elements had a larger advantage relative to purely face-to-face instruction than did purely online instruction" (p. xiv).

U.S. Department of Education. 2008. *Evaluating online learning: Challenges and strategies for success*. Washington, DC: Author.

- **Purpose:** "This guide is designed as a resource for leaders and evaluators of K–12 online learning programs" (p. 1).

- **Methods:** The guide used a combination of case study methodology and benchmarking of best practices as the primary research methods. "The steps of the research process were: defining a study scope; seeking input from experts to refine the scope and inform site selection criteria; screening potential sites; selecting sites to study; conducting site interviews, visits, or both; collecting and analyzing data to write case reports; and writing a user-friendly guide" (p. 63).

- **Findings:** "The guide features seven evaluations that represent variety in both the type of program or resource being evaluated, and in the type of evaluation. These evaluations were selected because they offer useful lessons to others who are planning to evaluate an online learning program or resource" (p. 1). "The

featured evaluations include a wide range of data collection and analysis activities—from formative evaluations that rely primarily on survey, interview, and observation data, to scientific experiments that compare outcomes between online and traditional settings" (p. 2).

Key Resources on Types and Prevalence of Online Learning

Center for Digital Education. 2009. *Online learning policy survey: A survey of the States*. Folsom, CA: Author.

- **Purpose:** "Examines the status of online learning policy across the United States" (p. 2).
- **Methods:** "The Online Learning Policy Survey conducted a survey of state department of education officials, to evaluate the current landscape of online learning. Forty-four of 50 states participated in the survey" (p. 2). .
- **Findings:** "CDE's findings reveal that there are a variety of obstacles that states face when trying to move forward with online education and that many of those are funding related" (p. 7). "Nine states with state-led virtual schools fund their online institutions using the same formula that traditional schools use to receive funding" (p. 3). "The greatest variety in funding strategies within online programs resides within states that allow district-run online programs" (p. 3).

Picciano, A., and J. Seaman. 2009. *K-12 online learning: A 2008 follow-up of the survey of U.S. school district administrators*. Needham, MA: Sloan Consortium.

- **Purpose:** "To replicate the original 2005-06 study; collect data and compare fully online learning to blended learning (part online and part traditional face-to-face instruction) in K-12 schools" (p. 1).
- **Methods:** "The study used descriptive analysis based on a survey modified from the original study. Approximately 10,000 randomly-selected school districts were sent a survey about their use of online learning. Eight hundred and sixty-seven (*N* = 867) out of a total universe of 16,000 school districts in the United States responded to this survey, representing 5.4 percent of all school districts of interest" (pp. 7, 8).
- **Findings:** "The overall number of K-12 students engaged in online courses in 2007-2008, is estimated at 1,030,000. This represents a 47 percent increase since 2005–2006" (p. 1).

Watson, J. 2007. *A national primer on K–12 online learning.* International Association for K–12 Online Learning (iNACOL).

- **Purpose:** "Provides a comprehensive overview of online learning by examining the basics—teaching and learning, evaluating academic success, professional development, technology and other topics" (p. iv).

- **Methods:** A review of the extant literature and policy on online learning.

- **Findings:** "Online programs vary significantly by grade level, type of students served, and whether the program is primarily full-time or supplemental. Despite the variations, most programs share common characteristics of using highly qualified teachers, learning management software, and digital course content to deliver education to meet a range of student needs" (p. 1).

Watson J., A. Murin, L. Vashaw, B. Gemin, and C. Rapp. 2010. *Keeping pace with K–12 online learning: An annual review of policy and practice.* Evergreen, CO: Evergreen Education Group.

- **Purpose:** "*Keeping Pace* has several goals. First, it strives to add to the body of knowledge about online education policy and practice and make recommendations for advances. Second, it serves as a reference source for information about programs and policies across the country, both for policymakers and practitioners who are new to online education and for those who have extensive experience in the field. Third, because there has been so much online education activity in the past year, the report attempts to capture new activity" (p. 4).

- **Method:** "We first identified the largest district in each state based on student population, meaning that we have 50 districts when Washington DC is included.11 For each district, we reviewed the school district website and whenever possible interviewed administrators in the district. We used existing studies, including the Keeping Pace program survey, and also contacted the state virtual schools in many states to determine if the largest district in their state used the state virtual school. In addition, we spoke with major content and software providers to determine if any of the largest districts were among their users" (p. 36).

- **Findings:** "State virtual schools, or state-led online learning initiatives, now exist in 39 states … Together, the state virtual schools had about 450,000 course enrollments in 2009–10. This was an increase of nearly 40 percent over the previous year" (pg. 6). "As of fall 2010 the level of online learning varies significantly among districts, which fall into four categories: Established (11 districts, 22 percent); Maturing (13 districts, 26 percent); Early development (22 districts, 44 percent); Absent (4 districts, 8 percent)" (p. 36).

Quality Standards for Online Learning Programs

International Association for K–12 Online Learning. 2007. *National standards of quality for online courses*. Vienna, VA: Author.

- **Purpose:** "To provide states, districts, online programs, and other organizations with a set of quality guidelines for online course content, instructional design, technology, student assessment, and course management" (p. 2).

- **Methods:** "The initiative began with a thorough literature review of existing online course quality standards followed by a survey offered to representatives of the iNACOL network to ensure the efficacy of the standards adopted" (p. 2).

- **Findings:** "As a result of the research review, iNACOL has chosen to fully endorse the work of the Southern Regional Education Board (SREB) Quality Online Course Standards as a comprehensive set of criteria" (p. 2).

Pape, L., and M. Wicks. 2009. *National standards for quality online programs.* Vienna, VA: International Association for K-12 Online Learning.

- **Purpose:** "To provide the comprehensive and overarching set of standards program leaders need to guarantee a high-quality online program" (p. 4).

- **Methods:** "The initiative began with a thorough literature review of existing online program standards, including accreditation standards, a cross-reference of standards, followed by a survey to iNACOL members and experts to ensure the efficacy of the standards adopted" (p. 4).

- **Findings:** Provides four types of standards: institutional, teaching and learning, support and evaluation.

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