An Instructional Theory for the Post-Industrial Age

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Contributing Editor

This article describes instructional theory that supports post-industrial education and training systems—ones that are customized and learner-centered, in which student progress is based on learning rather than time. The author discusses the importance of problem-based instruction (PBI), identifies some problems with PBI, overviews an instructional theory that addresses those problems, and describes the roles that should be played by the teacher, the learner, and technology in the new paradigm.

Introduction

One of the few things that practically everyone agrees on in both education and training is that people learn at different rates and have different learning needs. Yet our schools and training programs typically teach a predetermined, fixed amount of content in a set amount of time. Inevitably, slower learners are forced to move on before they have mastered the content, and they accumulate deficits in their learning that make it more difficult for them to learn related content in the future. Also, faster learners are bored to frustration and waste much valuable time waiting for the group to move on—a considerable squander of talent that our communities, companies, and society sorely need. A system that was truly designed to maximize learning would not force learners to move on before they had learned the current material, and it would not force faster learners to wait for the rest of the class.

Our current paradigm of education and training was developed during the industrial age. At that time, we could not afford to educate or train everyone to high levels, and we did not need to educate or train everyone to high levels. The predominant form of work was manual labor. In fact, if we educated everyone to high levels, few would be willing to work on assembly lines, doing mindless tasks over and over again. What we needed in the industrial age was an educational system that *sorted* students—one that separated the children who should do manual labor from the ones who should be managers or professionals. So the "less bright" students were flunked out, and the brighter ones were promoted to higher levels of education. This is why our schools use norm-referenced assessment systems rather than criterion-referenced assessment—to help sort the students. The same applied to our training systems. We must recognize that the main problem with our education and training systems is not the teachers or the students, it is the *system*—a system that is designed more for sorting than for learning (see Reigeluth, 1987, 1994, for examples).

Elsewhere, I have presented visions of what a post-industrial education system might be like—a system that is designed to maximize learning (Reigeluth, 1987; Reigeluth & Garfinkle, 1994). With minor adaptations, that vision could be applied to our training systems as well. The purpose of this article is to describe instructional theory that supports such post-industrial education and training systems. In particular, it will:

- discuss the importance of problem-based instruction (PBI);
- identify some problems with PBI;
- overview an instructional theory that addresses those problems; and
- describe the roles that should be played by the teacher, the learner, and technology in the new paradigm.

Problem-Based Instruction

Student engagement or motivation is key to learning. No matter how much work the teacher does, if the student doesn't work, the student doesn't learn. The quality and quantity of learning are directly proportional to the amount of effort the student devotes to learning. The industrial-age paradigm of education and training was based on extrinsic motivation, with grades, study halls, detentions, and in the worst cases repeating a grade or flunking out.

In contrast, for a variety of reasons, intrinsic motivation is emphasized in the information-age paradigm. Reasons include the importance of lifelong learning and therefore of developing a love of learning, the decline of discipline in the home and school, and the lower effectiveness of extrinsic motivators now than 30 years ago.

To enhance intrinsic motivation, instructional methods should be learner-centered rather than teacher-centered. They should involve learning by

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doing, utilize tasks that are of inherent interest to the learner (which usually means they must be "authentic"), and offer opportunities for collaboration. This makes PBI* particularly appropriate as a foundational instructional theory for the information-age paradigm of education and training.

Furthermore, given the importance of student progress being based on learning rather than on time, students progress at different rates and learn different things at any given time. This also lends itself well to PBI, because it is more learner-directed than teacher-directed.

It seems clear that PBI should be used prominently in the new paradigm of education and training. But there are problems with PBI. I explore those next.

Problems with Problem-Based Instruction

In my own use of PBI, I have encountered four significant problems with it. Most PBI is collaborative or team-based, and typically the whole team is assessed on a final product. This makes it difficult to assess and ensure that all students have learned what was intended to be learned. I have found that often one student on the team is a "loafer" and doesn't learn much at all. I have also found that teammates often work cooperatively rather than collaboratively, meaning they each perform different tasks and therefore learn different things. In my experience, it is rare for any student to have learned all that was intended. For a system in which student progress is based on learning, it is important to assess and ensure the learning of each and every student on the team. Yet it is rare for this to happen in PBI. This may not be as widespread a problem for higher levels of education, but it is a big problem for lower levels.

Second, the skills and competencies that we teach through PBI are usually ones that our learners will need to transfer to a broad range of situations, especially for complex cognitive tasks. However, in PBI learners typically use a skill only once or twice in the performance of the project. This makes it difficult for them to learn to use the skill in the full range of situations in which they are likely to need it in the future. Many skills require extensive practice to develop to a proficient or expert level, yet that rarely happens in PBI.

Third, some skills need to be automatized in order to free up the expert's conscious cognitive processing for higher-level thinking required during performance of a task. PBI does not address this instructional need.

Finally, much learner time can be wasted during PBI, searching for information and struggling to learn without sufficient guidance or support. It is often important, not just in corporate training, but also in K–12 and higher education, to get the most learning in the least amount of time. Such efficiency is not typically a hallmark of PBI.

Given these four problems with PBI—difficulty ensuring mastery, transfer, automaticity, and efficiency—does this mean we should abandon PBI and go with direct instruction? To quote a famous advertisement, "Not exactly." I now explore this issue.

A Vision of the Post-Industrial Paradigm of Instruction

Project and Instructional Spaces

Imagine a small team of students working on an authentic project in a computer-based simulation. Soon they encounter a learning gap (knowledge, skills, understandings, values, attitudes, dispositions, etc.) that they need to fill to proceed with the project. Imagine that the students can "freeze" time and have a virtual mentor in the form of an avatar appear and provide customized tutoring to develop that skill or understanding individually for each student.

Research shows that learning a skill is facilitated to the extent that instruction tells the students how to do it, *shows* them how to do it for diverse situations, and gives them practice with immediate feedback, again for diverse situations (Merrill, 1983; Merrill, Reigeluth, & Faust, 1979), so the students learn to generalize or transfer the skill to the full range of situations they will encounter in the real world. Each student continues to practice until she or he reaches the standard of mastery for the skill. Upon reaching the standard, the student returns to the "project space" where time is unfrozen, to apply what has been learned to the project and continue working on it until the next learning gap is encountered, and this learning-doing cycle is repeated.

Well-validated instructional theories have been developed to offer guidance for the design of both the project space and the instructional space (see Reigeluth, 1999; Reigeluth & Carr-Chellman, 2009, for examples). In this way we transcend the either/or thinking so characteristic of industrial-age thinking and move to both/and thinking, which is better suited to the much greater complexity inherent in the information age—we utilize instructional theory that combines the best of behaviorist, cognitivist, and constructivist theories and models. This theory pays attention to mastery of individual competencies, but

*I use the term "problem-based instruction" rather than "problem-based learning" because the latter (PBL) is what the learner does, whereas the former (PBI) is what the teacher or instructional system does to support the learning. Furthermore, I use the term PBI broadly to encompass instruction for project-based learning and inquiry learning.

it also avoids the fragmentation characteristic of many mastery learning programs in the past.

Team and Individual Assessment

One of the problems with most PBI (identified earlier) is that students are assessed on the quality of the team product. Team assessment is important, but you also need individual assessment, and the instructional space offers an excellent opportunity to meet this need. Like the project space, the instructional space is performance oriented. The practice opportunities (offered primarily in a computer simulation for immediate, customized feedback and authenticity) continue to be offered to a student until the student reaches the criterion for number of correct performances in a row required by the standard. Formative evaluation is provided immediately to the student on each incorrect performance. When automatization of a skill (Anderson, 1996) is important, there is also a criterion for speed of performance that must be met.

In this manner, student assessment is fully integrated into the instruction, and there is no waste of time in conducting a separate assessment. Furthermore, the assessment assures that each student has attained the standard for the full range of situations in which the competency will be needed.

When a performance cannot be done on a computer (e.g., a ballet performance), an expert has a hand-held device with a rubric for assessment, the expert fills in the rubric while observing the performance, provides formative evaluation when appropriate during the performance, allows the student to retry on a substandard performance when appropriate for further assessment, and the information is automatically fed into the computer system, where it is stored in the student's record and can be accessed by the student and other authorized people.

Instructional Theory for the Project Space

There is much validated guidance for the design of the project space, including universal and situational principles for the project space (see, e.g., Barrows, 1986; Barrows & Tamblyn, 1980; Duffy & Raymer, 2010; Savery, 2009). They include guidance for selection of a good problem or project, formation of groups, facilitation of higher learning by a tutor, use of authentic assessment, and use of thorough debriefing activities. Computer-based simulations are often highly effective for creating and supporting the project environment, but the project space could be comprised entirely of places, objects, and people in the real world (in which case the instructional space could be accessed on a mobile device), or it could be a combination of virtual and real-world environments. STAR LEGACY (Schwartz, Lin, Brophy, & Bransford, 1999) is a good example of a computer-based simulation for the project space.

Instructional Theory for the Instructional Space

Selection of instructional strategies in the instructional space is primarily based on the type of learning (the ends of instruction) involved (see Unit 3 in Reigeluth & Carr-Chellman, 2009). For *memorization,* drill and practice is most effective (Salisbury, 1990), including chunking, repetition, prompting, and mnemonics. For *application* (skills), tutorials with generality, examples, practice, and immediate feedback are most effective (Merrill, 1983; Romiszowski, 2009). For *conceptual understanding,* connecting new concepts to existing concepts in a student's cognitive structures requires the use of such methods as analogies, context (advance organizers), comparison and contrast, analysis of parts and kinds, and various other techniques based on the dimensions of understanding required (Reigeluth, 1983). For *theoretical understanding,* causal relationships are best learned through exploring causes (explanation), effects (prediction), and solutions (problem solving); and natural processes are best learned through description of the sequence of events in the natural process (Reigeluth & Schwartz, 1989). These sorts of instructional strategies have been well researched for their effectiveness, efficiency, and appeal. And they are often best implemented through computer-based tutorials, simulations, and games.

This is one vision of instructional theory for the post-industrial paradigm of instruction. I encourage the reader to try to think of additional visions that meet the needs of the post-industrial era: principally intrinsic motivation, customization, attainment-based student progress, collaborative learning, and self-directed learning. To do so, it may be helpful to consider the ways that roles are likely to change in the new paradigm of instruction.

Key Roles in the Post-Industrial Paradigm of Instruction

This information-age paradigm of instruction requires new roles for teachers, students, and technology. Each of these roles is briefly described next.

New Roles for Teachers

The teacher's role has changed dramatically in the new paradigm of instruction from the "sage on the stage" to the "guide on the side." I currently see three major roles involved in being a guide on the side. First, the teacher is a *designer of student work* (Schlechty, 2002). The student work includes that which is done in both the project space and the instructional space. Second, the teacher is a *facilitator of the learning process.* This includes helping to develop a personal learning plan, coaching or scaffolding the student's learning when appropriate, facilitating discussion and reflection, and arranging availability of various human and material resources. Third, and perhaps most important in the public education sector, the teacher is a *caring mentor,* a person who is concerned with the full, well-rounded development of the student.

Teacher as designer, facilitator, and mentor are only three of the most important new roles that teachers serve, but not all teachers need to perform all the roles. Different kinds of teachers with different kinds and levels of training and expertise may focus on one or two of these roles (including students as teachers—see next section).

New Roles for Students

First, learning is an active process. The student must exert effort to learn. The teacher cannot do it for the student. This is why Schlechty (2002) characterizes the new paradigm as one in which *the student is the worker,* and that the teacher is the designer of the student's work.

Second, to prepare the student for lifelong learning, the teacher helps each student to become a *self-directed and self-motivated learner.* Students are self-motivated to learn from when they are born to when they first go to school. The industrial-age paradigm systematically destroys that self-motivation by removing all self-direction and giving students boring work that is not relevant to their lives. In contrast, the post-industrial system is designed to nurture self-motivation through self-direction and active learning in the context of relevant, interesting projects. Student motivation is key to educational productivity and helping students to realize their potential. It also greatly reduces discipline problems, drug use, and much more.

Third, it is often said that the best way to learn something is to teach it. Students are perhaps the most under-utilized resource in our school systems. Furthermore, someone who has just learned something is often better at helping someone else learn it, than is someone who learned it long ago. In addition to older students teaching slightly younger ones, peers can learn from each other in collaborative projects, and they can also serve as peer tutors.

Therefore, new student roles include student as worker, self-directed learner, and teacher.

New Roles for Technology

I currently see four main roles for technology to make the new paradigm of instruction feasible and cost-effective. These roles were first described by Reigeluth and colleagues (Reigeluth & Carr-Chellman, 2009; Reigeluth *et al.,* 2008). They include record keeping for student learning, planning for student learning, instruction for student learning, and assessment for/of student learning. These four roles are seamlessly integrated in a special kind of learning management system called a Personalized Integrated Educational System. These four roles are equally relevant in K–12 education, higher education, corporate training, military training, and education and training in other contexts.

It should be apparent that technology will play a crucial role in the success of the post-industrial paradigm of education. It will enable a quantum improvement in student learning, and likely at a lower cost per student per year than in the current industrial-age paradigm. Just as the electronic spreadsheet made the accountant's job quicker, easier, less expensive, and more enjoyable, so the kind of technology system described here will make the teacher's job quicker, easier, less expensive, and more enjoyable. But the new paradigm of instructional theory plays an essential role for technology to realize its potential contribution.

Conclusion

While much instructional theory has been generated to guide the design of the new paradigm of instruction, much remains to be learned. We need to learn how to better address the strong emotional basis of learning (Greenspan, 1997), foster emotional and social development, and promote the development of positive attitudes, values, morals, and ethics, among other things. It is my hope that you, the reader, will rise to the challenge and help further advance the knowledge we need to greatly improve our ability to help every student reach his or her potential. □

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ePortfolio Pedagogy, Technology, and Scholarship: Now and in the Future

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A number of indicators, including new professional organizations, the proliferation of software tools, and the launch of a new international journal, are signaling a critical mass of interest in ePortfolios in educational settings (Batson & Watson, 2011). This article describes the current ePortfolio landscape by examining the key promises offered by such tools in teaching and learning, assessment, and professional development settings. Appraisals of existing technologies along with likely directions for technological development are discussed. The article concludes by identifying key areas of current and future scholarship associated with ePortfolios.

Introduction

Over the past decade, there has been increasing international interest in ePortfolios (electronic portfolios) in educational settings. The EPAC (Electronic Portfolio Action and Communication) community of practice, launched in 2002, was among the first to herald concerted interest in ePortfolio. Since then, professional organizations, such as EIfEL in Europe, the Australian Flexible Learning Framework, and the Association of American Colleges and Universities, have embraced ePortfolios, as evidenced by their launching of related conferences and various associated development activities. Two years ago, a new plateau was reached when the Association for Authentic, Experiential, and Evidenced-Based Learning (AAEEBL, pronounced

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