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INSTRUCTIONAL-DESIGN THEORIES AND MODELS, VOLUME IV

The Learner-Centered Paradigm of Education

Edited by Charles M. Reigeluth, Brian J. Beatty, and Rodney D. Myers

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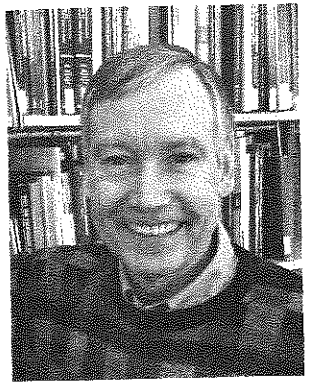
11

DESIGNING TECHNOLOGY FOR THE LEARNER-CENTERED PARADIGM OF EDUCATION

Charles M. Reigeluth

INDIANA UNIVERSITY



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This chapter is largely based on Reigeluth, Aslan, Chen, Dutta, Huh, Jung, Lee, Lin, Lu, Min, Tan, S. Watson, & W. Watson (2015). I am grateful for those authors' contributions to this chapter.

EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All content.*

Learners

- *All students.*

Learning environments

- *Learner-centered and personalized rather than teacher-centered and one-size-fits-all.*

Instructional development constraints

- *Requires substantial integrated technology support for instruction, communication, collaboration and administration.*

Values (opinions about what is important)

About ends (learning goals)

- *All kinds of learning goals are supported.*
- *Development of self-regulation skills and group-process skills is highly valued.*

About means (instructional methods)

- *Immersive, authentic, motivating learning environments and tasks are highly valued.*
- *Supporting the work of the learner foremost and also supporting the work of the teacher are highly valued.*
- *Providing learners with just-in-time coaching and instructional support during performance of authentic tasks is highly valued.*
- *Personalizing instruction to individual learner needs and preferences is highly valued.*
- *Embedding authentic assessment within the learning environment, avoiding the need for separate tests to certify learner attainments, is highly valued.*
- *Freeing teachers from many of their routine, boring tasks is highly valued.*
- *Facilitating communication and collaboration among learners and between learners and teachers, learners and parents, and teachers and parents is highly valued.*
- *Seamless integration of technology-delivered functions into a single system that is modular, interoperable, and customizable is highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness, efficiency, and appeal are all highly valued.*

About power (to make decisions about the previous three)

- *Empowering learners and supporting their self-directed learning is highly valued.*

Universal Principles*

1. Recordkeeping for student learning

- *Standards inventory: PIES should keep a list of all required and optional academic and nonacademic standards, offered by any source—national, state, local, and personal.*
- *Personal attainments inventory: PIES should keep track of each student's progress on all attainments.*
- *Personal characteristics inventory: PIES should keep record of each student's personal characteristics that are useful for promoting student learning, such as learning styles, profile of multiple intelligences, special needs, major life events, career goals and interests, and so forth.*

2. Planning for student learning**

- *Career and long-term learning goals: PIES should help each student's advisory committee collaboratively decide on long-term life goals and interests as well as career goals, which can be a powerful force in motivating the student to learn, even during early childhood.*
- *Prospective attainments: PIES should list current prospective attainments – the full range of required and optional standards (defined broadly as all kinds of learning and development) that are within reach for each individual student – ones that the student can learn without first learning other standards.*
- *Short-term learning goals: PIES should help the student's advisory committee to select, from the list of current prospective attainments, those attainments that the student will work on next, based on the students' long-term learning goals, interests, opportunities, requirements, parents' values, and so forth.*
- *Activity: PIES should help a student to select or design tasks or other activities (e.g., readings with discussions, or tutorials) to attain her or his short-term learning goals.*
- *Team formation: For team tasks, PIES should identify other students who are interested in doing the same task during the same project period, and if different roles are needed, it should identify students interested in each role.*
- *Supporting roles: PIES should help the student's advisory committee to identify people to play supporting roles in helping the student learn, and should help them to define those roles.*

* *Editors' note: In this chapter, there are no identified situational principles.*

** *Editors' note: Of the multiple levels—school, advisory group, and individual student—only individual student is addressed in this chapter.*

- *Learning contracts: PIES should help the advisory committee to develop learning contracts at two different levels: the student (or advisory committee) level and the task/activity level.*

3. Instruction for student learning

- *Tasks: PIES should:*
  1. *introduce tasks to the student,*
  2. *provide an authentic virtual environment within which to conduct the task or alternatively provide task elements that enhance real (community-based) task environments,*
  3. *help students organize and manage their tasks (time and resources),*
  4. *help teachers monitor the tasks,*
  5. *help students collaborate with peers using various documentation and communication tools, and*
  6. *guide students to resolve conflicts that arise during teamwork.*
- *Scaffolding: PIES should provide students with access to just-in-time (JIT) personalized coaching and instruction anytime and anywhere as they work on their tasks.*

4. Assessment for/of student learning

- *Assessing integrated performance: PIES should use tasks to present authentic tasks on which the student(s) can demonstrate integrated sets of knowledge, understanding, skills, and nonacademic attainments, and PIES should assist student reflection on the performance.*
- *Assessing individual learning: PIES should assess individual learning in the individual modules through such functions as formative assessment of knowledge as it is being developed, adjusting difficulty to individual students, and assessing the same knowledge at different times in different ways.*

Secondary Functions

- *PIES must seamlessly and systemically integrate the four primary functions (described above) with at least three additional functions: 1) communication and collaboration, 2) PIES administration, and 3) improvement of PIES.*

System Architecture

- *PIES should be designed as a cloud-based computing system where data are accessed by the users (students, parents, teachers, administrators, and community members) through Web browsers.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING TECHNOLOGY FOR THE LEARNER-CENTERED PARADIGM OF EDUCATION

I. Introduction

For the learner-centered paradigm of education and training to work well and cost-effectively, powerful technological tools are crucial for several reasons (McCombs & Vakili, 2005; Reigeluth & Karnopp, 2013). First, they save huge amounts of teacher time, making it possible and cost-effective for teachers to provide truly personalized, attainment-based instruction and assessment. Second, they afford immersive task environments that enhance student motivation. Third, they provide infinitely patient and soundly designed tutorials at the moment a learner needs them. This article offers suggestions for many of the design features that such tools should have.

In 2006 a research team at Indiana University began to work on identifying the functions that technology should serve to support the learner-centered paradigm of education for primary and secondary schools. This resulted in several research studies (An & Reigeluth, 2011; Aslan, 2012; Aslan, Huh, Lee, & Reigeluth, 2011; Dutta, 2013; Yildirim, Reigeluth, Kwon, Kageto, & Shao, 2013) and a set of design specifications for an integrated technology system (Reigeluth, Watson, Watson, Dutta, Chen, & Powell, 2008). This system was subsequently called the Personalized Integrated Educational System—PIES (Reigeluth, 2014; Watson, Watson, & Reigeluth, 2012), because it is designed specifically for personalized instruction and it requires seamless integration of the full range of functions needed to support student learning. As the team continued this work and learned more from our research, we saw the need for significant enhancements to those initial specifications.

One way to think about PIES is in terms of:

- functions to support teachers,
- functions to support administrators,
- functions to support parents, and
- functions to support students.

Clearly, there is overlap among these functions, but in this chapter we focus on functions to support students, who are the most important stakeholders in the learner-centered paradigm of education. It appears that relatively minor modifications are needed to tailor PIES for such other learning contexts as homeschooling, higher education, corporate training, and informal learning.

Our research team still sees four major functions and several secondary functions to support students, all of which should be seamlessly integrated into a single, open-architecture system. The major functions are shown in Figure 11.1. The secondary functions include *communication and collaboration,*

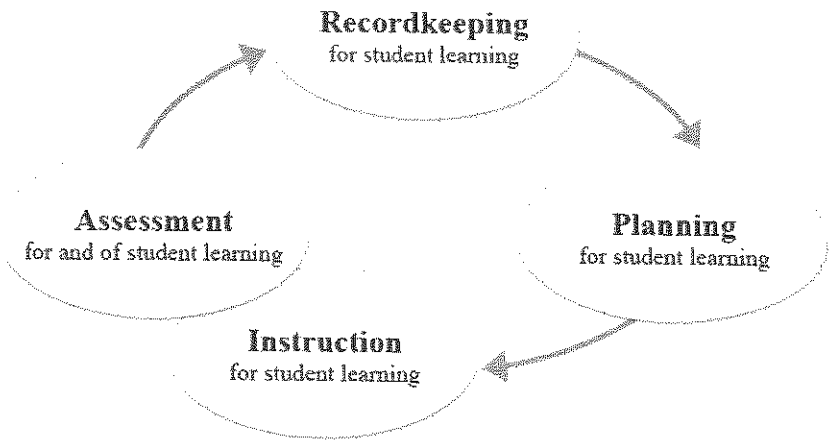

FIGURE 11.1 Proposed Major Functions of PIES. Assessment is Integrated with Instruction

PIES *administration*, and *improvement* of PIES. In this article, each of PIES' major and secondary functions is discussed, followed by a description of the architecture for PIES. Figure 11.2 shows an information schematic of this proposed technology system.

II. Values

The values that underlie the design of PIES include:

- Technology should support the work of the learner foremost, and also support the work of the teacher.
- Technology should be designed to empower learners and support their self-directed learning.
- Technology should be used to create immersive, authentic, motivating learning environments and tasks.
- Technology should be used to provide learners with just-in-time coaching and instructional support during performance of authentic tasks.
- Technology should be used to embed authentic assessment within the learning environment, avoiding the need for separate tests to certify learner attainments.
- Technology should be used to personalize instruction to individual learner needs and preferences.
- Technology should free teachers from many of their routine, boring tasks.
- Technology should facilitate communication and collaboration among learners and between learners and teachers, learners and parents, and teachers and parents.

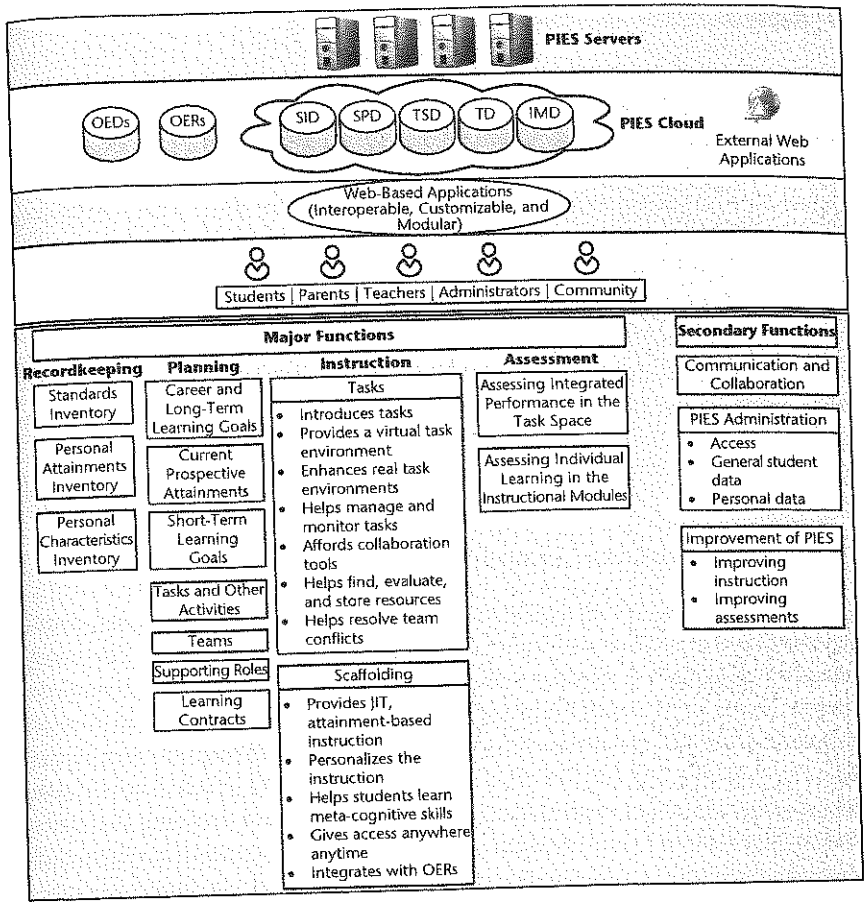

FIGURE 11.2 Proposed Information Schematic for PIES

Key: OED – Open Educational Database; OER – Open Educational Resource; SID – Standards Inventory Database; SPD – Student Profiles Database; TSD – Teammate Selection Database; TD – Task Database; IMD – Instructional Modules Database.

- All the functions that technology serves should be seamlessly integrated into a single system that is modular, interoperable, and customizable with Web APIs (Application Programming Interfaces), which allow developers to develop new modules or add-ons to existing programs.

III. Universal Principles

The universal principles for the design of PIES are grouped under the four major functions of PIES for supporting student learning: recordkeeping, planning, instruction, and assessment.

1. Recordkeeping for Student Learning

Attainment-based student progress is not possible without keeping track of what each student has learned. Report cards or transcripts serve a parallel function in the sorting-focused, industrial-age paradigm of education, except that these do not tell you specifically what each student has learned, only how well the student has done compared to other students in the class. The *recordkeeping* function of PIES replaces report cards and provides detailed information about student learning.[1] PIES' design principles specify three types of records: 1) a *standards inventory* that should include all the attainments that students must or could achieve in their lifetimes, including academic and nonacademic ones,[2] 2) a *personal attainments inventory* that should include all those attainments that each student has already achieved, along with useful learning analytics for each attainment, and 3) a *personal characteristics inventory* that should contain each student's personal characteristics that are demonstrated to be pertinent to student learning.

1.1 Standards inventory principle

PIES should keep a list of all required and optional academic and nonacademic standards, offered by any source—national, state, local, and personal. The standards should be broken down in a hierarchical manner to individual attainments such as skills, understandings, dispositions, and so on. The *standards inventory* should display the attainments in a customizable domain map or chart format based on Domain Theory (Bunderson, Wiley & McBride, 2009). Each domain map should include: a) major attainments with boundaries showing the easiest and hardest version of each attainment, b) categories of attainments, where each category represents a pathway for learning, and c) a difficulty-based sequence of attainments along each pathway. For each attainment in the map, there should be an indication as to whether or not it is a required standard, and if so, what level of difficulty is required. This map will enable the learner to navigate through the attainments within each subject domain such that when the learner masters one attainment, the map indicates the more advanced attainments that are now within reach—Vygotsky's (1978) "zone of proximal development" (see "2. Planning for Student Learning" below).

The *standards inventory* should include such currently optional standards as social, emotional, and character development (Goleman, 1995, 1998; Lewis, Watson, & Schaps, 1999; Lickona, 1991). Examples of a wide range of educational standards are offered by the Partnership for 21st Century Skills (n.d.), the

1 Stanford University and Elon University are experimenting with alternatives to norm-referenced transcripts (see http://www.chroniclecareers.com/article/Making-Transcripts-More-Than/231595/).

2 Standards as currently conceived tend to include many individual attainments.

International Society for Technology in Education (2007), the U.S. Department of Labor (1991), the Common Core (http://www.corestandards.org), and individuals like Daniel Goleman (1995, 1998) and Thomas Lickona (1991). However, most of these standards need to be further broken down into individual attainments. In Chapter 5, Prensky proposes organizing standards around the four key pillars of thinking effectively, acting effectively, relating effectively, and accomplishing effectively, rather than the current four pillars of math, language arts, science, and social studies. We propose that the *standards inventory* be organized around Prensky's standards.

Teachers and other experts who are involved in student learning should be able to customize the standards inventory based on student needs such as learning gaps and cross-disciplinary understanding (Dutta, 2013). In essence, the standards inventory should present a list of things that should or can be learned, along with levels, standards, and/or criteria at which they should or could be learned.

1.2 Personal attainments inventory principle

PIES should support student learning by keeping track of each student's progress on attainments.* Portions of the domain map in the *standards inventory* should be displayed in each student's *personal attainments inventory*, as in the Khan Academy. This way, all the authorized stakeholders (e.g., student, teachers, parents, administrators, employers) can easily see how she is doing and offer support when needed.

Also, a community may want all children to learn certain things within a reasonable age frame, especially for basic skills, in order to make sure that students are not overlooking foundational skills and knowledge. Thus, it may be important to foster some well-rounded development, rather than letting a student exclusively study things she wants when she wants, so the *personal attainments inventory* should also be able to report the student's attainments compared to the community's target age frames (if any) for mastery of required standards (adjusted automatically by the student's average speed of learning, which is continuously tracked by PIES over time, meaning slower learners have a later target within an age frame).

Each attainment, or set of related attainments, should be linked to a repository of evidence of its mastery in the form of summary data and/or original artifacts** that are automatically tagged according to the learning goals (Garrett, Thoms, Alrushiedat, & Ryan, 2009). Tags help students easily organize and find their artifacts and allow the student to easily pull out selected artifacts into

* *Editors' note: This is similar to Principle 7 in Chapter 2, Implement a CBE tracking system.*

** *Editors' note: This is the concept of a portfolio described by many chapters in this volume.*

different e-portfolios for different purposes (exportability). Furthermore, the *personal attainments inventory* should belong to the student, not the school system, so the student can use it throughout his life as a tool for lifelong learning.

In addition, a sharing feature should be provided in the *personal attainments inventory*. An individual student or a team should be able to set a final artifact or a video of their performance for selected others to see—or for public display, in which case it is searchable by the school community. When made public, the artifact should also be able to be linked to the task in the task bank (see "3. Instruction for Student Learning") as a legacy (Schwartz, Lin, Brophy, & Bransford, 1999) for future students to access, either locally or broadly.

Lastly, for all the records of these personal attainments, the student should be able to flexibly control access and levels of security. For example, while a student, his teachers, and his parents have full access to the records, the student could give potential employers or community members limited or no access.

1.3 Personal characteristics inventory principle

PIES should keep records of each student's personal characteristics that are useful for promoting student learning. These characteristics are different from general student data, such as address, birthdate, and information about parents or guardians. Personal characteristics include learning styles, profile of multiple intelligences, special needs, major life events, career goals and interests, and so forth. Personal characteristics should be continuously updated through surveys and automatic collection of data from the *instruction* and *assessment* functions of PIES about which instructional methods work well for each student.

Personal characteristics are useful for a) decisions about learning goals and objectives, b) teacher coaching and advising for the student, and c) customization of PIES' tutorials, simulations, and even tasks.

The student should own and be able to flexibly control access to this inventory for security and privacy reasons. Level of access should typically be granted depending on the relationship with the student. For example, parents or legal guardians, a student's current teachers, and students themselves should usually be granted full access. However, students may give limited or no access to community mentors and other teachers and administrators.

Clearly, a customized paradigm of education requires keeping a lot of records. PIES should greatly alleviate the time, drudgery, and expense of maintaining and accessing those records. It should help ensure that appropriate standards are being met while customized attainments are achieved by each student.

2. Planning for Student Learning

Planning is one of the most important components of the learning process (N.J. Anderson, 2002). While planning was one of the major responsibilities of

teachers in the industrial-age paradigm of education, the learner-centered paradigm requires students and even parents to be actively involved in the planning process, with guidance from the teacher.

Planning for student learning in the new paradigm should take place on three different levels: school, advisory group (traditionally called a classroom or homeroom), and individual student. At the *school level*, many schools want to have an annual school theme that is consistent with the overarching philosophy, mission, and vision of the school. All planning activities can then be informed by overarching school-wide academic and social themes (Dutta, 2013). For example, the Project School in Bloomington, IN, chose "power" as its theme one year, addressing such questions as what power is, how it moves, what it looks like from different perspectives, how it keeps things the same, and so forth. PIES' *planning* function should help all the teachers in a school to select and use an appropriate and powerful theme. It should also help for planning other aspects of school life, such as school plays, science fairs, art exhibits, and much more.

At the *advisory group level*, each mentor teacher[3] (often called a facilitator, guide, or adviser due to the radically different role) should plan ways in which all of that teacher's students can learn together in a collaborative environment. PIES' *planning* function should help each teacher decide on an appropriate culture or climate for the homeroom or workspace and ways to establish and maintain that culture, such as establishing ground rules collaboratively with the students and preparing in advance for the teacher to deal with typical events that may threaten that culture. The *planning* function should also provide advice on how to recognize and take advantage of "teachable moments" that can address emotional, social, and character development issues.* The function should help in diagnosing the causes of academic and social/emotional problems that arise and should recommend alternative actions for dealing effectively with those problems. The function can use both keyword search and menu-driven decision tree to accomplish this.

At the *individual student level*, each student needs a personal learning plan that sets out learning goals and ways to meet them. The planning function should help each student's advisory committee (the student, his parents, and mentor teacher) to collaboratively decide on career goals, long-term and short-term learning goals, tasks, teams, supporting roles, and learning contracts. Each of these sub-functions of individual student planning is described in detail in the following sections.

2.1 Career and long-term learning goals principle

Research by Schutz and Lanehart (1994) found that, "when long-term educational goals were accompanied by attempts at day-to-day educational sub-goals

3 A mentor teacher is the student's primary teacher or adviser—someone who gets to know the student well over a period of several years.

* *Editors' note: For more on this, see Chapters 21 and 22 in Volume II.*

and useful learning strategies, high academic performance tended to occur" (p. 407). PIES should help each student's advisory committee collaboratively decide on long-term life goals and interests as well as career goals, which can be a powerful force in motivating the student to learn, even during early childhood.

First, PIES should help each student to explore career options. Questionnaires and existing information about the student's interests and aptitudes should be used to suggest careers that the student might want to explore. The student can then learn more about each of those careers through, for example, interactive video vignettes showing "a day in the life" of a person in that career. Because students typically change their life and career goals and interests often, the sub-function should encourage each student to rethink or reaffirm her career goals on a regular basis. The student should also be able to select more than one life or career goal if she has more than one area of interest.

Second, when the student selects an appropriate career goal, it should be entered into the student's *personal characteristics inventory* (along with all information about the student's interests and aptitudes), as such information can improve instruction. The sub-function should provide the student with information about the kinds of attainments one needs to achieve to succeed in that career, and those attainments should then be listed as long-term learning goals. For older students, the sub-function should provide information about potential community mentors[4] (e.g., a local engineer), grants, and scholarships to help them accomplish their long-term learning goals in pursuit of their career goals.

The *planning* function should provide anytime anywhere access to a report on the progress each student has made towards achieving his long-term goals. Goal setting is an important aspect of self-directed learning and consequently life-long learning (Zimmerman, 2002).

2.2 Prospective attainments principle

Current prospective attainments should be automatically listed by PIES. These attainments are the full range of required and optional standards (defined broadly as all kinds of learning and development) that are, as a set, within reach for each individual student—ones that the student can learn without first learning other sets of standards. PIES' *planning* function can do this by comparing a student's *personal attainments inventory* (the student's current attainments) with the *standards inventory* (all required and optional attainments) to generate a comprehensive list or map of sets of attainments that the student could choose to work on next without

4 Each student has only one "mentor teacher", who typically serves that role for three or more years. However, other people may also be mentors for a single project, including other teachers, community experts, other experts, parents, and guardians. According to Mcpartland and Nettles (1991), "[m]entoring is commonly defined as a one-to-one relationship between a caring adult and a student who needs support to achieve academic, career, social, or personal goals" (p. 568).

overreaching. The student's advisory committee should also have a tool for adding, revising, or deleting attainments on the list. Based on the student's progress as measured by the assessment function (see "4. Assessment for/of Student Learning" below), the list should be updated automatically by the system.

2.3 Short-term learning goals principle

PIES should help the student's advisory committee to select, from the list of *current prospective attainments*, those attainments that the student will work on next, based on the students' long-term learning goals, interests, opportunities, requirements, parents' values, and so forth.* These short-term learning goals should include all dimensions of human development—social, emotional, physical/health, ethical, artistic, and psychological, as well as intellectual. For example, some short-term goals may be established for helping others through volunteer work in the community.

In the move away from time-based student progress, we envision that most school systems will establish project periods, for several reasons. First, it would be difficult for students to form different groups for new tasks without set dates for the beginning of tasks. Second, in the real world people need to meet task deadlines, so it is important to prepare students for that. Third, human nature is to not get things done until they are due, so having a deadline is a motivational issue. With project periods, rate of student learning can be adjusted through selection of the *number* and *scope* of tasks undertaken during a project period. Faster learners can undertake more tasks and larger tasks. Records of how many hours per week a task has taken, on average, should be adjusted automatically by PIES for each student's history of rate of learning, to help select an appropriate learning load for each student. The length of the project period is determined by the school but differs depending on the developmental level of the learners—at lower levels, project periods are shorter.

At the beginning of each project period, short-term goals are chosen by the student's advisory committee (mostly by the student with guidance from the rest of the committee).

2.4 Task/activity planning principle

Task-centered learning is an important part of the learner-centered paradigm of education (McCombs, 2008, 2013; Reigeluth & Karnopp, 2013; United States Department of Education, 2010; Wolf, 2010), primarily because it can

* *Editors' note: Goals are also addressed in Principle 3 of Chapter 1, Principle 1 of Chapter 2, Principle 1 of Chapter 4, Principle 1 in Chapter 6, Principle 1 in Chapter 8, Principle 2 in Chapter 9, and Principle 1 in Chapter 10.*

greatly enhance learner motivation and facilitate transfer of what is learned to the real world.*

PIES' *planning* function should help a student to *select* or *design* tasks or other activities (e.g., readings with discussions, or just tutorials) to attain her short-term learning goals. For selection, it should use those goals to identify tasks or other activities through which she could attain those goals. It should rank-order those tasks/activities on the basis of how many short-term goals each addresses, how well each aligns with the school's mission, vision, core principles, and current theme, and how well it aligns with the student's interests.

The student then selects (with input from her advisory committee) whatever combination of tasks/activities she wants, based on customized weekly time estimates for each task. User ratings and recommendation algorithms similar to those in Amazon and Netflix also help the student to make good choices. After one task/activity is selected, PIES should update the rank-order of tasks/activities for the remaining short-term goals, and the student selects additional tasks/activities until the student's available time is filled.

Alternatively, if the student's advisory committee wants the student to design her own tasks or other activities, the planning function should help her design them based on her short-term learning goals, the school's mission, vision, core principles, and current theme, the student's interests, and current opportunities.

If a task is selected, the *planning* function should allow the student (and her advisory committee) to customize and tailor task attributes, requirements, and assessment criteria to fully address her relevant short-term learning goals and interests. For example, it should allow the committee to select such methods of assessment as products, reports, presentations, contests, single expert review, panel of experts, and public display for each task. The function should help the advisory committee decide whether a task will be done solo, or collaboratively with all teammates sharing the same role, or cooperatively with each teammate performing a different role. If the third, the function should suggest roles that are best aligned with the student's short-term goals and personal characteristics. The function should also estimate the average number of hours per week to complete the task in the selected role given the length of the school's project period, and it should adjust that based on the student's speed of performance on prior tasks.

The task "bank" or database on which the *planning* function draws should be updated as new tasks are posted by all advisory committees worldwide and even by local community members. Improvements to, or variations on, old tasks should also be posted. Since service learning is a key tenet of the learner-centered paradigm (Billig, 2000; Reigeluth & Karnopp, 2013), the *planning* function should allow community organizations and businesses to post upcoming tasks to the local or regional section of the task bank.

* *Editors' note: For more about tasks, see especially Chapters 1 (Principle 2), 3 (throughout), 4 (Principle 2), 6 (Principle 4), 8 (Principle 1), 9 (Principle 1), and 15 (Principles 3–4).*

The task bank should also store a variety of metadata for each task, such as the short-term learning goals (or attainments) that each task addresses, assessment criteria and standards of performance, recommended methods of assessment (e.g., contests, single expert, panel of experts, public display), whether the task requires multiple roles, average number of hours required for each role, previous students' evaluations of the task, and previous students' products if they choose to make them public (through each school's repository, where the student and advisory committee should be able to evaluate the products using a system similar to that used by Amazon customers to rate their purchases, and PIES should automatically generate a list of exemplary products). This also allows teachers to select exemplary artifacts to showcase student learning in their school.

For some short-term goals, such as learning about philosophy, a task may not be the most appropriate vehicle for meeting the goals. In such cases, PIES' *planning* function should help the advisory committee to plan other kinds of activities for meeting the goals.

2.5 Team formation principle

Students may occasionally choose to do solo tasks, though advisory committees should ensure that their students engage in sufficient team tasks to develop high levels of collaboration and conflict-resolution skills. Literature suggests that when students are collaborating with peers on academic tasks, they show higher intellectual performance than when working alone (Bandura, 1986; Vygotsky, 1978). Bruner (1985) also stated that students enhance their problem-solving skills through cooperation, as they have more opportunities for observing problem-solving skills.

For team tasks, the *planning* function should identify other students who are interested in doing the same task during the same project period, and if different roles are needed, it should identify students interested in each role. Then the function should help the students select teammates who are in the same or even different schools. Teachers, schools, and even districts should be able to add criteria to this selection process that ensure students don't only collaborate with their best friends—that they also team up with students of different gender, ability, compatibility, ethnicity, and socio-economic status. PIES should also use personality inventories (e.g., Myers-Briggs) to help students understand why their teammates may behave quite differently and how to deal with that.

2.6 Supporting roles principle

PIES should help the student's advisory committee to identify people—including themselves as well as other teachers, community or academic experts, senior students, parents, and guardians—to play supporting roles in helping the

student learn from each task or other activity, and should help them to define those roles.

2.7 Learning contracts principle

"Learning contracts are practical devices helping one to bridge the gap between curricular requirements and self-initiated and self-directed learning" (Motschnig-Pitrik, Derntl & Mangler, 2003, n.p.). Each school or district can establish a project period appropriate for the developmental stage(s) of its students. Having the same start time makes it possible to form new teams for new tasks. However, some tasks can span two or more project periods, and individual tasks may span a fraction of a period. All local schools at the higher developmental levels typically coordinate the length and timing of project periods so that their students can collaborate with students from other schools.

As an essential part of the planning process, PIES should help the advisory committee to develop learning contracts at two different levels: the student (or advisory committee) level and the task/activity level. At the student level, the contract should specify the short-term learning goals and all the tasks/activities for a given project period. At the task/activity level it should be prepared and signed by all teammates and external collaborators (if any) and should specify the following for each task/activity: short-term learning goals, teammates (if any), student roles and responsibilities, mentor roles, roles of any external collaborators, deadlines, milestones, resources, assessment criteria, methods of assessment, and criteria for modifying the contract. Any modifications must be submitted through this function and be approved by the advisory committee. This *learning contracts* sub-function should be linked with a sub-function that helps students and their advisory committees manage each task/activity in the contract (see section 3.1.2 below).

3. Instruction for Student Learning

PIES' *instruction* function should contain sub-functions for *tasks* and for *scaffolding*. It should have a task database, a coaching database, and an instructional module database whose instructional modules are linked to specific points in tasks when instruction is needed just-in-time.

3.1 Task performance principle

PIES should a) introduce tasks to the student, b) provide an authentic virtual environment within which to conduct the task or alternatively provide task elements that enhance real (community-based) task environments, c) help students organize and manage their tasks (time and resources), and d) help teachers monitor the tasks. It should also e) help students collaborate with peers

using various documentation and communication tools and f) guide students to resolve conflicts that arise during teamwork.

Introduce tasks. PIES should introduce the task to students, and also help teachers do so. Alternatively, it should help students initiate a task of their own design by helping them choose and use a checklist of considerations for initiating their task. Considerations should include getting more information about the task, identifying subtasks to perform with milestones for each, deciding who will do what and how they will work together, and identifying resources they will need. For pre-designed tasks, introducing the task should often be done through a simulation or virtual world, such as Bransford's STAR LEGACY (Schwartz et al., 1999).*

Provide a virtual task environment. In many cases,** PIES should provide a virtual world or simulation game in which the task is conducted. In such cases, it should provide natural consequences for student actions within the virtual environment. A virtual environment is "a computer-generated display that allows or compels the user (or users) to have a sense of being present in an environment other than the one they are actually in, and to interact with that environment" (Schroeder, 1996, p. 25). Many researchers have argued that virtual environments and simulations can be used to facilitate learning tasks that lead to increased understanding, motivation, engagement, collaboration, and knowledge transfer (Barab, Thomas, Dodge, Carteaux & Tuzun, 2005; Chittaro & Ranon, 2007; Dickey, 2005; Mennecke, Hassall & Triplett, 2008; Rieber, 1992). When appropriate, this function should also provide virtual coaching as students proceed, with a virtual coach appearing just-in-time to offer advice (but not instruction—that is described in the next section, though the same virtual agent could provide both advice and instruction seamlessly).

Enhance real task environments. Real-world tasks require students to solve authentic, hands-on, and interdisciplinary problems. In cases where a real-world environment is used for conducting the task,*** PIES should enhance that environment by introducing task elements related to the real environment, such as key knowledge, quality standards, planning, self-management, and other related resources on mobile devices using augmented reality. It can also provide tools for students to use while conducting the task, such as data collection, data analysis, communication, and collaboration tools. When appropriate, virtual coaching should also be provided as students proceed. This helps connect their knowledge to the real world.

Help manage and monitor tasks. The *task performance* sub-function should help students organize and manage their task work, including identifying,

* *Editors' Note: This reference is Chapter 9 in Volume II.*

** *Editors' Note: This is a situational principle. The major situationality is cost-effectiveness of developing a virtual world or simulation game.*

*** *Editors' note: This is the situationality for this situational principle.*

assigning, and monitoring subtasks, managing time and resources, and documenting progress daily. Students should be able to log time they devote to each task each day to help their advisory committees keep track of their progress. This sub-function can also be used to organize and manage any non-task activities. The *task performance* sub-function should help teachers, parents, and other supporters monitor the tasks/activities, by flagging ones that require guidance, facilitation, and scaffolding. Artificial intelligence should be utilized, to provide expert guidance automatically, under the watchful eye and additional insights of the teacher. The artificial intelligence can be deployed partly through pedagogical agent software. Hawryszkiewycz (2004) and Hawryszkiewycz and Lin (2003) detail the infrastructure for such agents to take on much of the role of teacher and expert (coach), and interact with learners by perceiving the progress of students in their learning activities, and offering just-in-time assistance. The agents should also be able to facilitate the learning process by helping students set up and manage their workspaces.

Afford collaboration tools. Various collaboration tools (such as documentation and communication tools) and social apps should be used by students as collaborative and resource-sharing platforms. Social software and other cloud-based tools should be integrated into the system, offering students personal tools for production, presentation, reflection, and collaboration. Networks are created among students, teachers, and experts working within the field to maximize learning. For example, social software tools like blogs and wikis can make student work visible to other students, allow students to follow each other's work, and give students access to each other's networks of people and references. These networks also allow teachers to follow and potentially participate in the work of students. This should be supported through connections between students' and teachers' weblogs using RSS feeds and social bookmarking (Richardson, 2005).

Help find, evaluate, and store resources. The *task performance* sub-function should help students to find, evaluate, and store resources and links related to their task work, and cultivate information literacy (American Library Association, 2000) to locate, evaluate, and use the needed information. It should provide some guidance, demonstrations, and practice with feedback to develop good strategies for these activities. It should teach the concepts of personal knowledge management and how to retrieve, organize, and evaluate information from the Web. One way this can be done* is to integrate open-source tools (such as social bookmarking tools, knowledge logs, and task managers) into the system as a mashup,[5] with demonstrations on how these can be used for personal knowledge management (Weber, Thomas & Ras, 2008).

* *Editors' note: This is a cue for a situational principle. The situationality is not identified here.*

5 Mashup is defined by Wikipedia as "a web page, or web application, that uses content from more than one source to create a single new service displayed in a single graphical interface."

Help resolve team conflicts. PIES should help students and teachers address conflict resolution issues, since conflicts are inevitable in teamwork, not just in school, but also in family life and work life. Students thereby learn conflict resolution strategies, which include "constructive self-management (emotional, cognitive, and behavioral self-control), communication, social perspective-taking, cooperative interpersonal problem solving, and promoting respect for individual and group differences" (Garrard & Lipsey, 2007). These strategies are learned as students who encounter problems should have the option to either use a decision tree or keyword entry within the PIES system, which then suggests particular strategies for dealing with the problem. This sub-function should be available to both students and teachers as a resource. When needed, students may contact their teachers for help so that teachers can direct students to specific strategies or offer personal suggestions for resolving conflicts.

3.2 Scaffolding principle

The *scaffolding* sub-function should provide students with access to just-in-time (JIT) personalized coaching and instruction anytime and anywhere as they work on their tasks.* According to Hmelo-Silver, Duncan, and Chinn (2007), besides offering direct instruction when students experience the need to learn something, scaffolding may also make parts of the task harder, in order to force students to engage with key disciplinary frameworks and strategies. These redirect students to examine counterclaims, articulate explanations, and reflect on progress. Coaching should be provided by PIES just-in-time as needed,** typically*** upon student request, but occasionally on a predetermined schedule or on student choice upon suggestion by the student's virtual pedagogical agent. For the instruction, PIES should use validated instructional theory to help students develop specific skills, understandings, facts, and dispositions through learning by doing, tutorials, mini-simulations, and so forth. Instruction should be tailored to each learner's learning style, kind of intelligence (Gardner, 1983), interests, preferences, knowledge, and background based on the student's *personal characteristics inventory*. Students should have great freedom to navigate through such instructional resources, including open educational resources, and should be taught to use metacognition and self-direction.

Provide JIT, attainment-based instruction. PIES' *scaffolding* sub-function should provide a just-in-time, personalized "instructional overlay" (such as simulations, tutorials, drill & practice, research tools, and student-expert academic

* *Editors' note: Scaffolding for tasks is addressed by many theories in this volume, especially Chapters 1 (Principle 2), 3 (Principle 1), 4 (Principle 3), 6 (Principle 6), 8 (Principle 1), and 13 (Principle 3).*

** *Editors' note: "As needed" is a situationality.*

*** *Editors' note: This is a cue for another situationality, but the situational variables that lead to deciding among the following three options are not specified here.*

communication tools) to support learning throughout each task. The emphasis of this sub-function should be on learning by doing multiple, authentic, divergent performances (to promote transfer) for individual skills, understandings, and other kinds of attainments until mastery, with the help of tutorials and demonstrations when appropriate, similar to the Khan Academy (https://www.khanacademy.org/). This instructional support should sometimes* be provided automatically to a student when he reaches a certain point in the task, sometimes suggested by his virtual pedagogical agent or teacher when he reaches that point, and sometimes left to the student to request the support whenever he wants it. This instruction promotes efficiency of learning, student motivation, and transfer of learning to diverse contexts, and develops automaticity of skills when appropriate (J.R. Anderson, 1996). Furthermore, PIES should automatically collect data on student performance on each attainment and make it available to the student and his advisory committee, to promote self-directed learning.

Personalize the instruction. In contrast to many learning management systems that focus on content management and administrative support, PIES should provide personalized instruction that is tailored to each learner's profile in terms of learning styles, multiple intelligences, goals, preferences, knowledge, and background. Using artificial intelligence techniques, such as intelligent tutoring systems, semantic webs, and adaptive systems, PIES should infer, update, and store information about the learner from each instructional module in order to adapt the instructional format, content, resources, feedback, and exercises to the individual learner in subsequent instructional modules. This is a customized, localized alternative to "big data." PIES should allow the learner to navigate the instruction by providing learning-path options tailored to each learner. In addition, PIES' instructional sub-functions should make extensive use of aural, visual, and dynamic as well as verbal modes of instruction, thus accommodating a greater variety of learning styles and enhancing motivation. As supported by research, PIES can be seen to function as an intelligent learning management system (Yacef, 2002)—a personalized environment for learning with a greater focus on student learning styles, difficulties, and progress that allows the system to diagnose and remediate and to adapt to changes in a student's personal characteristics. PIES should encourage personal knowledge management (Agnihotri & Troutt, 2009), with an emphasis on the learner's effort to discover, share, learn, and explore through different combinations of skills and technology. The learner should be able to customize screen appearance on PIES, rearrange learning content, and include/exclude learning services. Sub-learning spaces should also be able to be created to enable different types of collaboration (Ong & Hawryszkiewycz, 2003).

* *Editors' note: This is another cue for a situationality. Again, the situational variables are not specified for selecting among the three method variables.*

Help students learn meta-cognitive skills.* Researchers have found that meta-cognitive skills or cognitive self-regulation skills can be taught to students (Bandura, 1991; Zimmerman, 2002), and that there is a need to provide instructional strategies that inspire, motivate, and guide students to develop self-directed learning skills (Vovides, Sanchez-Alonso, Mitropoulou & Nickmans, 2007), such as determination of learning goals, learning and management strategies, instructional resources, and external resources. PIES' virtual pedagogical agent should address this need by providing rich resources in its instructional support for students to learn metacognitive skills, such as how to learn, monitor, evaluate, and reflect, and how to become self-directed learners (see Chapter 9 for details). Direct support should also be provided to nurture students' curiosity, creativity, everyday living skills, social skills, collaboration skills, character development, critical thinking, and problem-solving skills. Of course, such support is also provided by the student's teachers and mentor.

Give access anywhere anytime. As a Web-based educational system, PIES should connect students and guides across geographic, temporal, and cultural boundaries with a variety of portable and wearable devices.**

Integrate with open educational resources. PIES should serve as a portal to various OERs, such as those of the Khan Academy, OER Commons (https://www.oercommons.org/), and EngageNY (https://www.engageny.org). OERs should be easily integrated into PIES, similar to the way apps are integrated into a smart phone, except that the OERs should be seamlessly interoperable with the other apps (other parts of PIES)—they should be designed to share information with them—so the appropriate OER is called up automatically when the student encounters a learning need while working on a task, and the student's performance results are automatically fed from the OER to the student's *personal attainments inventory*. In essence, PIES' instructional modules should be seamlessly connected with educational resources that are available free or for a fee, hence enhancing students' learning options within a social constructive learning approach, while keeping the cost low for schools.

4. Assessment for/of Student Learning

PIES' fourth major function is *assessment for/of* student learning. Its sub-functions are: 1) *assessing performance outcomes* in the task, and 2) *assessing learning outcomes* in the instructional modules. When a group successfully completes a task or an activity, it may not necessarily indicate that each member of the group has

* *Editors' note: Metacognitive skills, or higher-order thinking skills, are a matter of curriculum theory, not instructional theory. However, as described in Chapter 1, the two are so highly interrelated that we have chosen to address both in this volume. Chapter 5 is dedicated to what-to-teach, and many other theories in this volume also address the importance of these skills.*

** *Editors' note: See Chapter 14, Design Considerations for Mobile Learning, for more about this.*

attained all the associated learning outcomes to the desired degree of proficiency. But it is important to determine the individual learning attainments, in order to have learning-based student progress. Therefore, the *assessment* function should assess both *team performance* on the task and *individual student learning* through the instructional modules.

Also, PIES should assess attainments in all four pillars of the new curriculum: thinking effectively, acting effectively, relating effectively, and accomplishing effectively (see Chapter 5). Thus, it should assess not only academic outcomes, but also nonacademic ones, such as meta-cognitive thinking skills, collaboration and communication skills, work ethic, and other kinds of emotional, social, and character development. In doing so, PIES should enable assessment by non-teachers, including peers, community members, and parents. Student assessment data collected through the assessment function should automatically feed into the recordkeeping function of PIES.

Although *instruction* and *assessment* are discussed as two separate functions in PIES, they should be seamlessly integrated and take place simultaneously. This is an important difference between the Industrial-Age and Information-Age paradigms of education. In the Industrial-Age paradigm, instruction and assessment take place separately. However, in the Information-Age paradigm, assessment is embedded in instruction. In a task, the outcomes of the task should be evaluated to assess student or team performance. In the instructional modules, assessments should take place within the practice exercises. A student should continue with the exercises until she meets established criteria of competency or attainment. When she meets the criteria, she moves on to the next topic of instruction needed just-in-time for the task work. PIES should also note attainments that benefit from periodic review and should provide periodic opportunities for each student to use those attainments in tasks, as a form of review.

4.1 Assessing integrated performance principle

PIES' *assessment* sub-function should use authentic tasks on which the student(s) can demonstrate integrated sets of knowledge, understanding, skills, and other attainments. Simulations or virtual worlds make it easier, less expensive, and/or safer to do this, but some real-world performances may also be needed or desired, such as learning to back up a truck with a trailer or do a pirouette in ballet.

After a student or team has performed an authentic subtask in the task, the assessment sub-function should assist student or team reflection* on the performance as a part of developing self-direction in learners. It should help students reflect on several aspects, such as the strategies they used in the task, strengths and weaknesses of student performances, and apparent misconceptions. Then it

* *Editors' note: Reflection is an important part of the learner-centered paradigm and is crucial to self-regulated learning (see Chapter 9). It is advocated by many of the theories in this volume.*

should offer feedback on the student reflections by providing formative evaluation of performances on the authentic task, when appropriate and when the performance is done in a simulation. For real-world performances, it should provide criteria or a rubric for a teacher or other observer to use while observing the performance, preferably with a handheld device that uploads the evaluation results to PIES.

At the end of the task, the assessment sub-function should assist reflection on, and summative evaluation of, the final product or performance in any of several ways, using the specifications in the task contract: the assessment criteria, standards of performance, and methods of assessment. Some examples of methods of assessment include hosting a contest (i.e., competition), arranging a public display (i.e., invite students, teachers, parents and community members to attend; a rating system may or may not be used by them), and being evaluated by a single expert or a panel of experts.

The assessment sub-function should promote and assess nonacademic outcomes developed while performing tasks, such as metacognitive thinking, collaboration skills, and work ethic, by using self-, peer-, and expert-evaluations. For self-evaluation, the system should assist student reflection during and after each task. During reflection, students self-assess their own performance by reflecting on several aspects, including the strategies they used during tasks, the process through which they performed, the strengths and weaknesses of student performances, and their misconceptions. The system should provide different kinds of templates for different tasks to help students reflect on what they have learned and the process through which they performed. For peer-evaluation, their group members offer feedback on various aspects of their performance on the group task, such as collaboration and communication skills. The system should provide different templates and rubrics to aid the peer assessment. And for expert-evaluation, experts are invited to provide feedback on the final outcome as well as the process of the student's performance. The system should also provide customizable templates and rubrics for this assessment.

Lastly, the final task, artifacts, evaluations, and reflections of students should be stored in the system and linked to each student's inventory of attainments. Therefore, students and teachers have easy access to them for future use (e.g., creating portfolios or planning future learning activities).

4.2 Assessing individual learning principle

Students' individual learning outcomes should be assessed in the instructional modules. PIES should provide functionalities, including assessing knowledge as it is being developed, adjusting difficulty to individual students, and assessing the same knowledge at different times in different ways.

Each standard should be broken down into individual attainments in the *standards inventory* (otherwise some important attainments may not be assessed

and mastered), and each attainment should be accompanied by criteria or a rubric for evaluating mastery. PIES' instructional modules should all require students to *do* things, both to promote learning-by-doing and to assess mastery of the attainment. When a student does not meet the criteria for a given performance, feedback (formative evaluation) should be provided through hints or explanations or demonstrating the correct performance. The criteria for mastery should include: a) criteria for a correct performance, b) a criterion for number of unaided correct performances in a row, and sometimes c) a criterion for speed of performance (or performing multiple tasks simultaneously, to ensure automatization of the skill). When the student has met all these criteria, then the summative evaluation is complete.* In this manner, formative and summative assessment are embedded in the instruction—there is no test. The student has reached mastery, upon which PIES should update the student's *personal attainments inventory*, including links to summary data and products, as appropriate.

When variability of a task is an issue (for near and far transfer), PIES should present the student with a representative variety of cases for the performances. The greater the variability, the larger the item pool, and the more performances the student needs to do correctly to reach mastery. Mere memorization is insufficient to perform well because the variety of cases is drawn from a large item pool. Students should be required to do even more performances when automatization of a skill is important. Authentic contextual information is provided for each of the cases, when appropriate.

When a set of related attainments (skills, understandings, memorizations, personal attributes, etc.) is mastered, a digital badge or a certificate should be awarded for that set of attainments. This motivates students and provides more valuable information for potential employers and other interested individuals. For instance, when a student masters a set of collaborative skills (e.g., helping teammates, coordinating tasks), he can be awarded a collaboration badge. Different badges can be awarded for different levels of attainment in collaboration.

In summary, PIES serves four major functions to support student learning in the information-age paradigm of education: *recordkeeping*, *planning*, *instruction*, and *assessment*. These must be seamlessly and systemically integrated with each other. In brief, the *recordkeeping* function should automatically provide necessary information to the *planning* function. The *planning* function should identify *instruction* functions (mainly tasks) for the student to use. The *assessment* function should be fully integrated with the *instruction* function. And the *assessment* function should feed information into the *recordkeeping* function.

* *Editors' note: Summative evaluation is essential for attainment-based student progress, one of the most fundamental characteristics of the learner-centered paradigm. However, it must be criterion-referenced rather than norm-referenced for reasons described in Chapter 1 (Principle 1).*

5. Secondary Functions

In order for PIES to be most useful for the information-age paradigm of education, these four major functions to support student learning must be seamlessly and systemically integrated with at least three additional functions: 1) communication and collaboration, 2) PIES administration, and 3) improvement of PIES. These secondary functions support users in ways less directly related to the learning process. To see the design features for these functions, see Reigeluth et al. (in press).

6. System Architecture

PIES should be designed as a cloud-based computing system where data are accessed by the users (students, parents, teachers, administrators, and community members) through Web browsers. As the schematic diagram for PIES illustrates (see Figure 11.1), the PIES cloud is to be housed within PIES servers. This might be supported by the U.S. Department of Education or by private foundations. Each of the major functions of PIES (recordkeeping, planning, instruction, and assessment) and the secondary functions (communication and collaboration, administration, and improvement of PIES) are to be housed in individual modules within the PIES cloud. The major and secondary functions should be connected to five major databases in the PIES cloud:

1. The Standards Inventory Database (SID), which includes federal, state, and local standards
2. Student Profiles Database (SPD), which includes personal attainments, personal characteristics, and task contracts
3. The Teammate Selection Database (TSD), which shows other students interested in the same tasks at the beginning of each project period
4. The Tasks Database (TD), which contains fully developed tasks, as well as ideas for tasks to be developed by students
5. The Instructional Modules Database (IMD), which contains all the instructional modules, including mastery assessments in the form of practice.

In the Student Profiles Database, the personal attainments inventory should belong to the student, not the "school," and can be accessed by the student at any time throughout her life, to promote lifelong learning and sharing of accomplishments.

In addition, the PIES cloud should be interoperable and seamlessly integrated with data systems that house OERs, external Web-based apps, and other open educational databases (OEDs). Features of the PIES cloud should include *interoperability*, *modularity*, and *customizability*. For descriptions of these design features, see Reigeluth et al. (in press).

VI. Closing Remarks

In summary, PIES is a set of design specifications for a technology system to support the learner-centered paradigm of education. It has four major functions, three secondary functions, and three architectural design features, as shown in Table 11.1.

TABLE 11.1 A Summary of PIES' Design Features

Major Functions	1. Recordkeeping for student learning	1.1 Standards Inventory
		1.2 Personal Attainments Inventory
		1.3 Personal Characteristics Inventory
	2. Planning for student learning	2.1 Career and long-term learning goals
		2.2 Current prospective attainments
		2.3 Short-term learning goals
		2.4 Tasks and other activities
		2.5 Teams
		2.6 Supporting roles
		2.7 Learning contracts
	3. Instruction for student learning	3.1 Tasks: introduces, provides virtual environment, enhances real task environments, helps manage and monitor tasks, affords collaboration tools, helps find, evaluate, and store resources, and helps resolve team conflicts
		3.2 Scaffolding: provides JIT attainment-based instruction, personalizes the instruction, helps students learn metacognitive skills, gives access anywhere anytime, and integrates with OERs
	4. Assessment for/of student learning	4.1 Assessing integrated performances in the task space
		4.2 Assessing individual learning in the instructional modules
Secondary Functions		1. Communications and collaboration
		2. PIES administration: general student data, personnel data
		3. Improvement of PIES: improving instruction, improving assessments
Architectural Features	Databases	1. Standards Inventory Database
		2. Student Profiles Database
		3. Teammate Selection Database
		4. Tasks Database
		5. Instructional Modules Database
	Other features	1. Interoperability
		2. Modularity
		3. Customizability

Fifty years of piecemeal educational reforms have left our public education systems increasingly inadequate to the educational needs of a post-industrial society, but there are over 140 school systems (mostly charter schools) that are pioneering the learner-centered paradigm (Reigeluth & Karnopp, 2013). The largest positive effect on increasing the current rate and success of paradigm change would likely be the development of technological tools appropriate for the learner-centered paradigm. Without such tools, it is difficult for teachers to truly personalize learning and base student progress on learning rather than on time. This chapter has presented a design of a system that could provide such tools, PIES. It is our hope that this chapter will inspire researchers to advance these design specifications and develop such a system.

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UNIT 3

Steps Toward the Learner-Centered Paradigm

Unit Foreword

As described in the chapters in Unit 1, student progress in the learner-centered paradigm should be based on learning rather than on time spent learning, should require the performance of authentic tasks, and should be personalized based on the learner's goals, interests, preferences, and prior learning. This paradigm shift requires changed roles for instructors, learners, and technology; and it requires a changed curriculum that is expanded to encompass emotional and social development and is restructured around effective thinking, acting, relating, and accomplishing.

The four chapters in Unit 3 present some emerging instructional-design theories that reimagine where and how instruction and learning take place, focusing in particular on learning that happens outside the classroom and how it can be tied to in-class instruction. Because these approaches are all working in (or perhaps more precisely, trying to work around) the current paradigm of content-focused and time-bound instruction, we see these as steps toward the new paradigm, attempts to employ some of the learner-centered principles to disrupt the current system from within.

In **Chapter 12**, *Designing Instruction for Flipped Classrooms*, Strayer prescribes the use of out-of-class tasks in which learners examine reified information to initiate construction of knowledge and provide responses that the instructor then uses to guide in-class activities. Class time is spent on shared reflection and on tasks that address learners' questions and misunderstandings and require learners to grapple with non-routine problems, communicate their thinking, and critique the reasoning of others. Flipped classroom instruction seeks to optimize the time that instructors and students spend with each other by making