21 The Design Principles Database
as a Means for Promoting
Design-Based Research

Yael Kali
Technion-Israel Institute of Technology

Introduction
From its early stages, design-based research (DBR) has had the vision of developing into a design science of education (Collins, 1992), in which critical elements in learning environments are explored systematically in terms of their effect on learning. Herbert Simon (1969) identified various professions, such as architecture, engineering, computer science, medicine, and education, with the sciences of the artificial, which Collins et al., (2004) refer to as design sciences. One of the approaches adopted by these fields is to gather and abstract designers’ experiences and research by creating collections of design principles or design patterns that synthesize each of these fields and can guide new designs. Some examples are from the areas of architecture (Alexander et al., 1977), information science (Tufte, 1983), and computer science (Gamma et al., 1995).

The Design Principles Database, described below (and accessible at http://design-principles.org), was developed in this spirit to coalesce and synthesize emerging design knowledge about the use of technologies for education. Kali (2006) illustrates how the Design Principles Database can serve as a collaborative, knowledge-building endeavor for the community of the learning sciences. This chapter focuses on the utility of the database to fill a missing niche in DBR. The chapter commences with a short review of the literature about the methodological challenges in DBR. Then, an approach for conducting DBR is introduced, which uses the Design Principles Database as a means for warranting and generalizing DBR outcomes. A three-phase analysis of the ways in which researchers used the database, an example of a DBR study about peer evaluation, is provided to demonstrate this approach. Finally, the potential of the Design Principles Database to promote DBR is discussed.

Methodological Challenges in Design-Based Research
In order to explore how curricular innovations affect learning in naturalistic settings, more and more researchers are adopting the emerging paradigm of DBR. The notion of DBR is very much in vogue in the learning sciences community, but it faces obstacles in the broader research community (Collins et al., 2004). Recently, three major journals have dedicated special issues to illuminating the added value of this methodological niche and to discussing still unsolved challenges (Barab & Squire, 2004b; Dede, 2005b; Kelly, 2003).

Collins et al. (2004: 21) describe “design experiments” (one of the labels referring to the early stages of DBR) in the following manner:

Design experiments bring together two critical pieces in order to guide us to better
educational refinement: a design focus and assessment of critical design elements. Ethnography provides qualitative methods for looking carefully at how a design plays out in practice, and how social and contextual variables interact with cognitive variables. Large-scale studies provide quantitative methods for evaluating the effects of independent variables on the dependent variables. Design experiments are contextualized in educational settings, but with a focus on generalizing from those settings to guide the design process. They fill a niche in the array of experimental methods that is needed to improve educational practices.

However, DBR is still in its infancy (Barab & Squire, 2004a; Dede, 2005a; Design-Based Research Collective, 2003), and its methodologies are still being challenged (e.g., Kelly, 2004; Shavelson et al., 2003). Questions that doubt DBR methodologies focus on issues of generalization in a field that is contextual in its nature. For instance, Kelly (2004: 120), in his remarks in the special issue of the *Journal of the Learning Sciences* about DBR, asks: “When one foregoes experimental controls, how can one generalize to other settings regardless of how rich are the local descriptions?” Similarly, Shavelson et al. (2003: 27) ask: “To what extent would the tool developed in one intensively engineered setting generalize to another setting?”

In order to answer such questions, it is clear that more positivist-reductionist methodologies are required. To be able to generalize that learning, or any other behavior, is caused by the interaction of students with a technology, and not by any of the vast number of other potential factors involved in naturalistic settings, one is required to reduce all of these factors and design a more controlled study. One approach to bridge between these two methodological polarities, and to earn both the insights gained in naturalistic methods and the generalizability acquired with more quantitative methods, is to sequence them. As Collins et al. (2004) suggest, DBR can include both formative and summative strategies. The formative strategies are used to describe lessons learned in successive implementations of an innovation in particular settings; the summative strategies seek to derive more general conclusions. For example, they state that...

... if we wanted to compare how effective the Waterford and Peabody reading programs are, we would need to carry out comparative analyses in a variety of different settings, such as urban, suburban, and rural schools, and perhaps even homes, workplaces, and military settings. In such studies there must be a fixed experimental procedure, unlike the flexible design revision we recommend for formative evaluation.

(Collins et al., 2004: 39)

The current study, by using the Design Principles Database, suggests an alternative to the sequencing approach described above for providing warrants for lessons learned by DBR.

**The Design Principles Approach**

Successful curricular materials depend on a process of iterative refinement to respond to the complex system that impacts classroom learning. DBR methods suggest ways to capture this process and describe how research teams gather evidence to make decisions about refinements (e.g., Bell et al., 2004; Linn et al., 2004). However, it is difficult to use the design knowledge residing in traditional forms of publication for creating new designs. To make this knowledge more useful, new approaches for its organization and
synthesis are needed. Linn et al. (2004) suggested using design principles as an organizational unit. According to this approach, design principles that cut across a variety of designs are synthesized and abstracted based on various DBR projects. Bell et al. (2004: 83) refer to such design principles as:

... an intermediate step between scientific findings, which must be generalized and replicable, and local experiences or examples that come up in practice. Because of the need to interpret design principles, they are not as readily falsifiable as scientific laws. The principles are generated inductively from prior examples of success and are subject to refinement over time as others try to adapt them to their own experiences. In this sense, they are falsifiable; if they do not yield purchase in the design process, they will be debated, altered, and eventually dropped.

Thus, the warrants for design principles are provided in this approach by the empirical studies that explore their application in new designs and contexts and are based on the cumulative design knowledge of the community.

This chapter focuses on the potential of the Design Principles Database to provide an alternative type of warranting for DBR outcomes, based on the design principles approach described above. The type of corroboration supported by the database is based on a community endeavor, in which researchers build on each others’ knowledge of design, articulated as principles for design, to create new designs. They explore the application of these principles in new contexts and bring their findings back to the database. In this manner, knowledge about design grows in the community, and the principles are debated, refined, or warranted with additional, field-based evidence.

The Design Principles Database

Evolution of the Project

The Design Principles Database has emerged from meetings, conversations, and collaborative activities that occurred between 2001 and 2004. The design principles project started as a grassroots movement and grew gradually to involve a substantial number of educational software designers who contributed to the development of the current form of the database. The project was initiated at a conference of the Center for Innovative Learning Technologies (CILT) in 2000. Participants in a visualization and modeling workshop requested a set of guidelines that would synthesize the knowledge in the field and enable designers to create innovative, technology-based, learning environments that are founded on principled design knowledge (Kali, 2002). This call resulted in a CILT, seed-grant project, in which a series of invited, face-to-face, and online workshops were organized subsequently that led to the development of the Design Principles Database. The database was intended to guide conversations in the workshops and interactive poster sessions; to capture the library of features of technology-enhanced, learning environments; to link features, empirical evidence, and theoretical underpinnings of this work; and to synthesize design knowledge at multiple levels of analysis. Today, through the NSF-funded Technology Enhanced Learning in Science (TELS) Center, we continue to develop the Design Principles Database and use it as a core framework to capture, synthesize, discuss, and disseminate the research-based design ideas of TELS technology software innovations.
The design principles project has stimulated the development of an emergent vocabulary to communicate design ideas. Terms used in this chapter follow:

- **Feature** is used to refer to any design effort to use technology to advance learning. In particular, we use feature to describe designed artifacts, or parts of artifacts, such as modeling tools (e.g., Buckley et al., 2004; Wu et al., 2001), visualizations (e.g., Dori & Belcher, 2005; Kali & Orion, 1997), collaboration tools (e.g., Guzdial et al., 2001; Ronen et al., 2006), games (e.g., Barab et al., 2005; Shaffer, 2005), and assessment tools (e.g., Birenbaum et al., 2006). The term also is used for activities designed to support the use of any of these tools.

- **Learning environment** is defined as a system that incorporates a set of features along with a navigation system and curricular materials.

- **Design principle** is used to refer to an abstraction that connects a feature to a form of rationale. Design principles are described at several levels of specificity, which are articulated below.

### Structure of the Design Principles Database

The Design Principles Database is a set of interconnected features and principles. Each feature is linked with a principle and principles are linked between themselves in a hierarchical manner. Principles in the database are described in three levels of generalization:

- **Specific principles** describe the rationale behind the design of a single feature or a single research investigation. Because of their direct relation to one feature, specific principles in the database are embedded in the features.

- **Pragmatic principles** connect several specific principles (or several features).

- **Meta-principles** capture abstract ideas represented in a cluster of pragmatic principles.

Figure 21.1 illustrates these multiple connections schematically and provides examples of software features and principles in the three hierarchical levels.

![Figure 21.1 Schematic Representation of the Structure of the Design Principles Database.](image)
The database includes two main modes of interaction: a **Contribute** mode and a **Search/Browse** mode. The **Contribute** mode enables designers to submit new features and principles to the database. To publish features in the database, authors are required to provide the following pieces of information: (a) a detailed description of the functionality of the feature, (b) the rationale behind the design (i.e., the specific principle), (c) the context in which the feature was used, and (d) the category, or several categories, that describe the feature (e.g., visualization tools, inquiry tools, communication tools, ubiquitous computing, etc.). Finally, it is required that every feature be connected to a pragmatic principle. Once a feature is connected to a pragmatic principle, the author of the feature can edit any part of the pragmatic principle, which usually is authored by another contributor, using Wiki technology (e.g., Nicol et al., 2005). The Wiki tools enable multiple authoring while keeping track of the principle’s history to ensure the retrieval of old documentation, if needed. In order to contribute a pragmatic principle, authors are required to provide a detailed description of the principle, its theoretical background, and tips for designers, including the limitations, trade-offs, and pitfalls for designing with the principle. Authors also are required to connect pragmatic principles to meta-principles. There are four meta-principles, which are built into the database and which originate from the Scaffolded Knowledge Integration framework (Linn et al., 2004). The **Contribute** mode thus enables the database to grow while maintaining connectedness between features and principles and between principles in the different levels. It also enables the community to refine pragmatic principles continually. About 120 features, with their specific principles, have been contributed already to the Design Principles Database from several disciplines (mainly the physical, life, and earth sciences, but also mathematics, humanities, and others). About 80 of these features are in the public area; the others are in areas designated for groups, such as workshops and graduate courses, or are at draft stages.

The **Search/Browse** mode enables users (researchers, teachers, and students in the learning sciences) to search for features and principles using filters, which include any of the pieces of information described above. The database is navigated through the connections between the features and the three levels of principles. For instance, one might start a browsing path by using filters, to find all the features in chemistry that are based on inquiry learning for the tenth grade. After choosing one of these features to review the details, the user might want to link to a pragmatic principle connected to the feature in order to understand the overarching rationale better and to read the theoretical background. Finally, the user can review other features connected to this pragmatic principle and see how it is applied in other learning environments in various contexts.

**Promoting Design-Based Research Through the Design Principles Database: A Three-Phase Study Example**

The potential of the Design Principles Database for advancing the field of design is illustrated here by the analysis of a particular DBR project about a peer evaluation activity in an undergraduate-level course on the philosophy of education (Kali & Ronen, 2005). The analysis of this particular study demonstrates how the researchers used the database in three stages to build on the existing body of knowledge for designing a new peer evaluation activity and how this use led eventually to the generation of new design knowledge that was shared with the community, which strengthened the original claims. The description of the study below is followed by an analysis of the three phases in which the researchers used the Design Principles Database.

The peer evaluation study, which is analyzed here to demonstrate the researchers’ use
of the database, took place in a philosophy of education course for undergraduates at the Technion-Israel Institute of Technology, taught by the author of this chapter. The main goal of the course was to help students develop their own perceptions about fundamental issues in education and schooling (e.g., What is the goal of schooling? What contents should be taught in school? What should be the role of the teacher?). A main theme in the course was the “ideal school” project, in which groups of three-to-four students constructed a conceptual model of a school that met their evolving educational perceptions. Toward the end of the semester, each group gave a short presentation describing one day in their ideal school. For this purpose, most of the students used PowerPoint, but other, less conventional means such as drama performances, were used also. The presentations took place in three class meetings, with three or four presentations in each session. One challenge the instructor faced during these presentations was how to ensure that students made the most out of these meetings. Prior teaching experience in similar contexts had revealed that students tended to focus on accomplishing the course’s requirements (their own presentations in this case) and are less interested in their peers’ projects.

This challenge was addressed by designing a peer evaluation activity, in which students were involved in the assessment of their peers’ ideal school presentations. The rationale for engaging students in this activity was to: (a) ensure their involvement in their peers’ projects, (b) create a framework for them to learn from each other’s projects, (c) help them develop evaluation skills that they would need as future educators, and (d) reinforce criteria for designing their projects. The analysis of this peer evaluation activity by the instructor involved the integration of hundreds of assessments (35 students times ten groups times about four criteria). To help facilitate the analysis, a computerized system was used, which enabled gathering, presenting, and analyzing these assessments in a productive manner. The activity was performed online with Collaborative e-Learning Structures (CeLS) (accessible at http://www.mycels.net), a novel system that allows the instructor to create and conduct a variety of online, structured, collaborative activities (Ronen et al., 2006).

Methodological Approach

The current study is designed as a metastudy; it analyzes the process by which the peer evaluation DBR study described above shaped the design knowledge represented in the Design Principles Database. To do this, three main phases in the researchers’ use of the database in the peer evaluation study were defined: Phase One: Articulating design principles; Phase Two: Design–enactment–refinement iterations; and Phase Three: Revising pragmatic principles. The metastudy used descriptive analysis to characterize the researchers’ use of the database in these three phases. The peer evaluation study used DBR methodologies, which are described below.

It is important to note that the current metastudy is carried out by one of the researchers who conducted the DBR analyzed in the metastudy. In this sense, the metastudy is a reflective description of using the Design Principles Database to support the DBR studied. However, it is assumed that the involvement of the researcher in the DBR does not constrain the analysis. Rather, it helps in describing the details required to illustrate the potential of the database for supporting other DBR studies and for synthesizing the cumulative knowledge in the field.
Phase One: Articulating Design Principles

Because the Design Principles Database is still in its beginning stages, no design principles were articulated for peer evaluation when the study was conducted. Therefore, it was necessary to abstract design principles from existing empirical studies in this field and to design the first version of the peer evaluation activity based on these principles. The literature reviewed for articulating the pragmatic and specific principles included: Cuddy and Oki (2001); Davies (2000); Dominick et al. (1997); Falchikov (2003); Falchikov and Goldfinch (2000); Mann (1999); McConnell (2002); Miller (2003); Ronen and Langley (2004); Suthers et al. (1997); Topping (1998); and Zariski (1996).

At the end of this phase, one pragmatic principle (Figure 21.2) and three specific principles (embedded in features) were added to the database as follows (more details for each principle and feature are available in the database):

- **Pragmatic Principle:** Enable students to give feedback to their peers.
- **Specific Principle One:** Involve students in developing the evaluation criteria for the peer evaluation.
- **Specific Principle Two:** Ensure anonymity to avoid bias in evaluating peers.
- **Specific Principle Three:** Make the synthesis of the peer evaluation results visible for learners.

It is important to note that the rich body of knowledge concerning peer evaluation can be translated into many more design principles. For the purpose of this study, only ideas that seemed useful for designing the peer evaluation activity were articulated as design principles and contributed to the database.

---

**Figure 21.2** Pragmatic Principle in the Design Principles Database.
Phase Two: Design–Enactment–Refinement Iterations

Methods in the Peer Evaluation Study

In order to explore the challenges of peer evaluation in the specific context, the study was organized around three design–enactment–refinement iterations. These took place in three successive semesters, with a total of 144 students participating (Iteration One: Fall 2003, with 80 students in two groups; Iteration Two: spring 2004, with 29 students; Iteration Three: fall 2004, with 35 students). Each iteration was followed by an analysis of the data and refinements to the design of the online, peer evaluation activity. Data sources included:

- Peer evaluation data (numeric grades and textual justifications) gathered in the CeLS environment.
- Artifacts created by each group (PowerPoint slides of the ideal school project and online discussions used by each of the groups for developing the conceptions for their project).
- Students’ responses to an attitude questionnaire administered at the end of the course.
- Students’ spontaneous online discussions in a virtual “coffee corner” at the course’s site.
- Instructor’s reflective journal, including remarks about the events that took place during class.

First Iteration: Initial Design

Following Specific Principle One, the initial design of the peer evaluation activity included criteria that were derived from students’ suggestions in a classroom discussion that occurred before the presentations and included the following: (a) Is the uniqueness of the school apparent? (b) Is the rationale for the activities clear? (c) Are the activities that take place in the school demonstrated clearly? The activity included an online form in which students were required to grade each of the group presentations between 1 (poor) and 7 (excellent). The form also included text fields for students to justify their grading according to the three criteria. Students used printout of these forms to take notes during the presentations and entered their grades and justifications at the online environment in the next few days. Following Specific Principles Two and Three, at the end of the activity, all of the students were able to view: (a) a histogram of the scores for each group, (b) statistical data (sample size, mean, median, and standard deviation), and (c) the individual scores and the justifications for them (presented anonymously) (Figure 21.3). All of this information was generated automatically by the CeLS environment without requiring any extra work from the instructor.

In order to assess the validity of the students’ scoring, the set of mean scores that were given by the students for each of the ten presentations was compared with the set of scores given by the instructor for these presentations. The analysis indicated that, although there was a moderate positive correlation between the students’ scores and the instructor’s scores ($r = 0.43$), it was not significant ($p = 0.10$). A detailed examination of the qualitative data enabled the cases in which large discrepancies were found between the students’ and the instructor’s scoring to be identified. Such discrepancies were especially apparent in presentations that introduced educational perceptions that were
relatively “extreme,” according to views held by many students. Although the students were instructed specifically to try to ignore personal viewpoints in their grading, it seems that they found it difficult to do so. The issue of differentiating between objective criteria and personal stands was taken as a focus for the second iteration. It is important to note that this study assumed that purely objective criteria do not exist because we are all somewhat subject to our personal viewpoints. However, an essential aspect of peer evaluation is to find those criteria that will provide equitable measures that will minimize biases.

**Second Iteration: Differentiating Between Objective Criteria and Personal Stands**

Based on the outcomes of the first iteration and in order to foster objectivity, it was decided to refine the design of the online, peer evaluation activity so that it would provide students with a way to differentiate between objective aspects of the presentation and their personal nonobjective viewpoints. The rationale was that if students were given a chance to express these views in a neutral area, which does not affect the score, they would be more aware of their personal values and emotional stands and, thus, provide a more objective score. Therefore, the following specific principle, to explore in this iteration, was defined:
Specific Principle Four: Enable students to state their personal nonobjective viewpoints about their peers’ work.

As in the first iteration, a class discussion about evaluation criteria preceded the activity. To engage students with the issue of personal viewpoints in peer evaluation, the class discussion was seeded with ideas for criteria, including a criterion about the degree to which a student is in agreement with views introduced during the presentation. After the class discussion, four text fields for justifying scores were defined. The first three were similar to those defined in the first iteration (referring to the uniqueness of the school, the rationale for it, and a demonstration of its activities), but a fourth text field was added, named “My personal opinion about this school.” As suggested by the students, the ideas expressed in this field did not affect the scoring. Rather, this component of the peer review was intended to provide general feedback for the presenters about the degree of acceptance of their ideas by the other students. Another specific principle was defined for further exploration, namely:

Specific Principle Five: Design features to foster discussion about nonobjective evaluation criteria.

Outcomes indicated that the refined design, which enabled the students to express their personal viewpoints, assisted them in differentiating better between objective criteria and personal stands. This was evident from a higher correlation between the set of scores provided by the instructor for each of the groups and those provided by the students ($r = 0.62$, $p = 0.03$), compared to the first iteration. Furthermore, the learning gains from the peer evaluation activity, as indicated by the attitude questionnaire, seemed to be higher in the second iteration (see Figure 21.4). However, it was found that because the contents that are being evaluated involved cultural and political values, tensions in class discussions between students were aroused, and they infiltrated as biased scoring and inappropriate language, even affecting justifications in the peer evaluation activity (Kali & Ronen, 2005). Therefore, the issue of respecting classroom norms was decided as a main focus for exploration and design in the third iteration.
Third Iteration: Evaluating Students as Evaluators

Based on the findings of the second iteration and in order to foster further objectivity, classroom norms, and tolerance, a third iteration of the activity was designed according to the following principle:

- **Specific Principle Six:** When the contents being evaluated are socially or culturally sensitive, avoid grading students according to peer evaluation results. Rather, evaluate students as evaluators.

According to this principle, 15 percent of the students’ scores in the fall semester of 2004 were derived from the peer evaluation activity and indicated how well they had served as evaluators. The score was comprised of: (a) the number of evaluations provided, (b) the respect shown for predefined classroom norms, (c) the quality of the justifications, and (d) the degree of correlation with the instructor’s score. The outcomes indicated that implementation of the redesigned activity enabled students to exploit better the vast advantages of peer evaluation, tensions were decreased (Kali & Ronen, 2005), and a higher correlation with the instructor’s score ($r = 0.7$, $p = 0.02$) was found. Furthermore, learning gains and students’ satisfaction, as indicated from the attitude questionnaire, stayed high.

Phase Three: Revising Pragmatic Principles

After the new specific principles were added to the database, together with the example features that were explored in Phase Two, the researchers of the peer evaluation study were able to enrich the original pragmatic principle (“Enable students to give feedback to their peers”), which connects these features, with lessons learned through the cycles of the DBR. An important way to enrich a pragmatic principle in the database is to add emerging design knowledge to the section entitled “Tips (Challenges, Limitations, Trade-offs, Pitfalls).” Because the knowledge gained through the particular DBR related to a very specific context, it was decided to articulate this knowledge as limitations of the pragmatic design principle. These limitations were stated in the database as follows:

- Note that when the contents being evaluated in a peer evaluation activity relate to beliefs and morals, there is a higher probability for biased scoring. In such cases, it is recommended that students be enabled to state their personal nonobjective viewpoints about their peers’ work in a neutral space, which does not affect scoring. As in other peer evaluation contexts, this feature works best when students are involved in developing the criteria. To do that, it is recommended that the discussion be seeded (or other means be used for criteria building) with ideas for non-objective criteria.
- Note also that biased scoring and inappropriate language in peer evaluation can occur when the contents being evaluated are socioculturally sensitive. In such cases, it is advised to avoid grading students according to peer evaluation results. Rather, to reduce tensions, it is recommended that students be evaluated as evaluators, based on their respect for classroom norms and on the quality of their justifications.

Another revision to the original pragmatic principle was done automatically by the system. The new features (and specific principles) that were explored in this study...
became parts of the pragmatic principle in the form of links that exemplify the use of the principle and provide additional evidence and further warranting for the principle.

Discussion
The three-phase study described above illustrates a process in which design knowledge, abstracted from the existing body of knowledge about peer evaluation and contributed to the Design Principles Database, was explored in a new context. The design knowledge was strengthened by this exploration; the pragmatic principle “Enable students to give feedback to their peers” was applied successfully in the philosophy of education course and thus was connected with additional empirical outcomes. Furthermore, new theoretical knowledge about issues of bias and objectivity in peer evaluation was created, brought back to the database, and synthesized with the existing knowledge. The development of this theoretical knowledge was articulated as practical design knowledge; namely as tips for designing peer evaluation activities in which the contents being evaluated relate to morals, values, or sensitive issues.

Ideally, researchers who refine pragmatic principles based on their outcomes are not those who are the original contributors of the principles, as in the case of this research. A design study that uses the Design Principles Database could start when a researcher or a research group articulates a pragmatic design principle that summarizes outcomes from a DBR study in a certain area. The researchers provide the theoretical background and connect the pragmatic principle with one or more features, which provide field-based evidence and illustrate how the principle was applied in their specific context (this corresponds to Phase One in the current study, with the exception that the pragmatic principle was abstracted from the literature). Then, another research group uses the information provided in the pragmatic principle to design new features and explore them in new contexts (this corresponds to Phase Two in the current research). Up to this stage, this is quite similar to the common process in which researchers build on knowledge published by the traditional means of publication.

The added value of the Design Principles Database is particularly evident in the next stage (which corresponds to Phase Three), in which new contributions to theory are brought back to the database and synthesized with the existing knowledge. This can be performed in several ways: (a) empirical outcomes from the design iterations are translated explicitly into new features and specific principles and connected to the original pragmatic principle, (b) additional, practical, design knowledge based on the research, such as limits, trade-offs, and pitfalls, is added to a pragmatic principle, and (c) the pragmatic principle is refined, using the Wiki capabilities of the database, to capture the new design knowledge gained in the research.

Conclusions
The analysis above indicates that the Design Principles Database can contribute to the development of theory, on the one hand, and to design practice, on the other. Theory is developed through the continuous empirical re-examination, negotiation, and refinement of pragmatic design principles by the community. At the same time, these principles become more useful for designers (and thus deserve their name better) when they are connected with a variety of features and specific principles, which exemplify how they can be applied to different contexts.

At the beginning of this chapter, methodological challenges in design-based research, expressed by several researchers such as Kelly (2004) and Shavelson et al. (2003), were
stated. These authors were concerned that because of the contextual nature of DBR, methodologies usually refrain from experimental controls. Therefore, they questioned the ability of DBR methodologies to generalize findings and to warrant claims. The current study suggests that the process of synthesizing design knowledge through the use of the Design Principles Database can move DBR toward meeting these challenges. This process maintains the naturalistic methodologies required in order to gain a deep understanding about the effect of technology on various aspects of learning. Yet, it also enables re-examination of the outcomes, articulated as design principles, by different researchers in other settings. It is argued here that this process, supported by the Design Principles Database, can serve as a productive approach for advancing DBR.

Nonetheless, the Design Principles Database is still in its initial stages, and its framework is open for public negotiation and refinement. Other research teams have suggested frameworks for connecting elements of design and generalized design guidelines. One important endeavor in this direction is the Scaffolding Design Framework for designing educational software suggested by a group from the University of Michigan and Northwestern University (Quintana et al., 2004). Another important venture in this direction is the Design Patterns trajectory (Linn & Eylon, 2006), which seeks to identify common factors in promising sequences of activities and define them as patterns that can guide designers of learning environments. Advances to merge efforts between these projects are taking place.

Additionally, in order to attain the full potential of the Design Principles Database, a critical mass of contents needs to be contributed and negotiated by the community. As Collins et al. (2004: 33) state:

Our approach to design research requires much more effort than any one human can carry out. We put forward these ideas not because we expect each and every design experiment to embody them, but to give an overview of all the things the design research community is responsible for. In our ideal world, design research will move in the direction of embodying many of the practices we outline here. But it will take teams of researchers and accessible archives documenting design experiments . . . to make these dreams at all possible.

We envision this dream coming true when the Design Principles Database is populated with hundreds of features and specific principles, connected to pragmatic principles, which evolve continuously through the negotiation of a dynamic, knowledge-building community. To meet this challenge, the TELS (Technology Enhanced Learning in Science) Center continues to organize workshops and graduate courses that support researchers in contributing features and principles to the database. Additionally, we encourage readers who are involved in DBR to take part in this endeavor and share their design knowledge with the community associated with the Design Principles Database.

Acknowledgments

The Design Principles Database is supported by the National Science Foundation as a part of the Technology Enhanced Learning in Science (TELS) Center (Grant No: ESI/CLT 0334199). I would like to thank Marcia Linn, the TELS Principal Investigator, for her enormous inspiration, support, and contribution to the Design Principles Database project. I also would like to thank the postdoctoral scholars and principal investigators at the Center for Innovative Learning Technologies who supported and encouraged the design principles project in its early stages.
Many thanks to Miky Ronen, at the Holon Academic Institute of Technology, for providing the Collaborative e-Learning Structures environment and helping with the peer evaluation analysis; to Orit Parnafes, at the University of California, Berkeley; and to the design group graduate students at the Technion-Israel Institute of Technology, for their very thoughtful comments on drafts of this chapter.

Finally, thanks to all of the people who helped shape the framework of, and contributed features and principles to, the Design Principles Database.

References


