2. Curriculum Design Research

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Introduction

The title of this chapter *(Curriculum Design Research)* intentionally combines two fields: 'curriculum design' and 'design research'. It symbolizes the aim of this text to discuss the function and forms of design research from a curricular perspective. In particular, it focuses on how design research can increase the quality of curriculum design and development. Also, it illustrates how the relevance of educational research - a widely debated issue - can benefit from a connection to curriculum policies and practices.
Given this aim it helps to have a number of basic concepts and analytical perspectives available that can structure curricular deliberations and reduce the complexity of curriculum tasks. Thus my initial focus in this chapter (building on van den Akker, 2003) is on summarizing a set of concepts and perspectives that help to increase the transparency and balance of curriculum analysis, development and discourse. Then, the focus will shift towards (curriculum) design research (building on van den Akker, 1999, 2006, and on van den Akker, Gravemeijer, McKenney and Nieveen, 2006). First, I will sketch the potential and characteristics of design research in addressing complex curriculum challenges. Second, I will address a number of methodological issues. Finally, I will pay attention to a classic problem in all educational research: generalization of findings.

Curriculum, what's in a name?

When there is a myriad of definitions of a concept in the literature (as with curriculum), it is often difficult to keep a clear focus on its essence. In those cases it often helps to search for the etymological origin of the concept. The Latin word 'curriculum' (related to the verb 'currere' i.e. running) refers to a 'course' or 'track' to be followed. In the context of education, where learning is the central activity, the most obvious interpretation of the word curriculum is then to view it as a course, trajectory, or '*plan for learning*' (cf. Taba, 1962). This very short definition (reflected in related terms in many languages) limits itself to the core of all other definitions, permitting all sorts of elaborations for specific educational levels, contexts, and representations. Obviously, contextual specification is always needed in curriculum conversations to clarify the perspective.
Given this simple definition, a differentiation between various levels of the curriculum has proven to be very useful when talking about curricular activities (policy-making; design and development; evaluation and implementation). The next distinction appears to be helpful:

- International/comparative (or *supra* level)
- System/society/nation/state (or *macro*) level (e.g. national syllabi or core objectives)

- School/institution (or *meso*) level (e.g. school-specific curriculum)
- Classroom (or *micro*) level (e.g. textbooks, instructional materials)
- Individual/personal (or *nano*) level.

The supra level usually refers to international debates or agreements on aims and quality of education, sometimes fuelled by outcomes of internationally comparative studies (cf. PISA or TIMSS[1]). Curriculum development at the supra level is usually of a 'generic' nature, while 'site-specific' approaches are more applicable for the levels closer to school and classroom practice. Moreover, the process of curriculum development can be seen as narrow (developing a specific curricular product) or broad (a long term, ongoing process of curriculum improvement, often including many related aspects of educational change, e.g teacher education, school development, testing and examinations). In order to understand problems of curriculum decision-making and enactment, a broader description of curriculum development is often most appropriate: usually a long and cyclic process with many stakeholders and participants; in which motives and needs for changing the curriculum are formulated; ideas are specified in programs and materials; and efforts are made to realize the intended changes in practice.

Moreover, curricula can be represented in various forms. Clarification of those forms is especially useful when trying to understand the problematic efforts to change the curriculum. A common broad distinction is between the three levels of the 'intended', 'implemented', and 'attained' curriculum. A more refined typology (van den Akker, 2003) is outlined in box 1.

INTENDED	***Ideal***	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/Written	Intentions as specified in curriculum documents and/or materials
IMPLEMENTED	***Perceived***	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also: curriculum-in-action)
ATTAINED	***Experiential***	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

Box 1: Typology of curriculum representations

Traditionally, the intended domain refers predominantly to the influence of curriculum policy makers and curriculum developers (in various roles), the implemented curriculum

[1] PISA is the OECD Programme for International Student Assessment, a survey every three years of the 15-year-olds. TIMSS is the Trends In Mathematics and Sciences Study, conducted every 4 years by the International Association for the Evaluation of Educational Achievement (IEA) in primary and secondary education.

relates especially to the world of schools and teachers, and the attained curriculum has to do with the students.

Besides this differentiation in representations, curriculum problems can be approached from various analytical angles. For example, Goodlad (1994) distinguishes the following three different perspectives:

- *substantive*, focusing on the classical curriculum question about what knowledge is of most worth for inclusion in teaching and learning;
- *technical-professional*, referring to how to address tasks of curriculum development;
- *socio-political*, referring to curriculum decision-making processes, where values and interests of different individual and agencies are at stake.

Some might argue that this list is too limited as it refers especially to curriculum issues for 'traditional' planning for learning in schools, and does not include the more 'critical' perspectives that are amply present in curriculum theory literature (e.g. Pinar, Reynolds, Slattery & Taubman, 1995). However, from a primary interest in curriculum improvement, the three perspectives seem useful and appropriate.

The vulnerable curriculum spider web

One of the major challenges for curriculum improvement is creating balance and consistency between the various components of a curriculum (i.e. plan for learning). What are those components? The relatively simple curriculum definition by Walker (2003) includes three major planning elements: content, purpose and organization of learning. However, curriculum design and implementation problems have taught us that it is wise to pay explicit attention to a more elaborated list of components. Elaborating on various typologies, we have come to adhere to a framework (see Box 2) of ten components that address ten specific questions about the planning of student learning.

Rationale or Vision	Why are they learning?
Aims & Objectves	Toward which goals are they learning?
Content	What are they learning?
Learning activities	How are they learning?
Teacher role	How is the teacher facilitating learning?
Materials & Resources	With what are they learning?
Grouping	With whom are they learning?
Location	Where are they learning?
Time	When are they learning?
Assessment	How to measure how far learning has progressed?

Box 2: Curriculum components

The 'rationale' (referring to overall principles or central mission of the plan) serves as major orientation point, and the nine other components are ideally linked to that rationale and preferably also consistent with each other. For each of the components many sub-questions are possible. Not only on substantive issues (see the next section), but, for example, also on 'organizational' aspects as:

- Grouping:
  - How are students allocated to various learning trajectories?
  - Are students learning individually, in small groups, or whole-class?
- Location:
  - Are students learning in class, in the library, at home, or elsewhere?
  - What are the social/physical characteristics of the learning environment?
- Time:
  - How much time is available for various subject matter domains?
  - How much time can be spent on specific learning tasks?

The relevance of these components varies across the previously mentioned curriculum levels (supra, macro, meso, micro, nano) and representations. A few examples may illustrate this.

- Curriculum documents at the macro-level will usually focus on the first three components (rationale, aims & objectives, content; often in rather broad terms), sometimes accompanied by an outline of time allocations for various subject matter domains.
- When one takes the operational curriculum in schools and classrooms in mind, all ten components have to be coherently addressed to expect successful implementation and continuation.
- The components of learning activities, teacher role, and materials & resources are at the core of the micro-curriculum in the classroom.
- The component of assessment deserves separate attention at all levels and representations since careful alignment between assessment and the rest of the curriculum appears to be critical for successful curriculum change.

Our preferential visualization of the ten components is to arrange them as a spider web (Figure 1), not only illustrating its many interconnections, but also underlining its vulnerability. Thus, although the emphasis of curriculum design on specific components may vary over time, eventually some kind of alignment has to occur to maintain coherence. A striking example is the trend toward integration of ICT in the curriculum, with usually initial attention to changes in materials and resources. Many implementation studies have exemplified the need for a more comprehensive approach and systematic attention to the other components before one can expect robust changes.

The spider web also illustrates a familiar expression: every chain is as strong as its weakest link. That seems another very appropriate metaphor for a curriculum, pointing to the complexity of efforts to improve the curriculum in a balanced, consistent and sustainable manner.

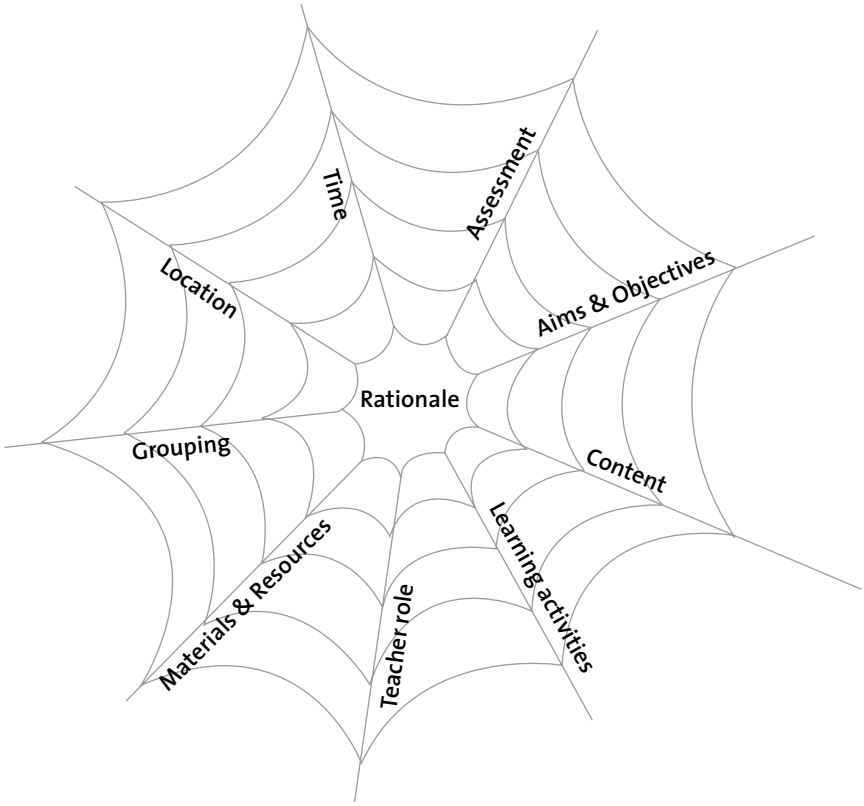

Figure 1: Curricular spider web

Perspectives on substantive choices

A classic approach to the eternal curriculum question of what to include in the curriculum (or even more difficult as well as urgent: what to exclude from it) is to search for a balance between three major sources or orientations for selection and priority setting:

- Knowledge: what is the academic and cultural heritage that seems essential for learning and future development?
- Society: which problems and issues seem relevant for inclusion from the perspective of societal trends and needs?
- Learner: which elements seem of vital importance for learning from the personal and educational needs and interests of the learners themselves?

Answers to these questions usually constitute the rationale of a curriculum. Inevitably, choices have to be made, usually involving compromises between the various orientations (and their respective proponents and pressure groups). Oftentimes, efforts fail to arrive at generally acceptable, clear and practical solutions. The result of adding up all kinds of wishes is that curricula tend to get overloaded and fragmented. Implementation of such incoherent curricula eventually tends to lead to student frustrations, failure, and dropout.
How to create a better curriculum balance? Easy answers are not available, but a few alternatives seem to have some promise. First, in view of the multitude of (academic) knowledge claims, it sometimes helps to reduce the big number of separate subject domains to a more limited number of broader learning areas, combined with sharper priorities in aims for learning (focusing on basic concepts and skills).
Second, referring to the avalanche of societal claims, more interaction between learning inside and outside the school may reduce the burden. However, the most effective response is probably to be more selective in reacting to all sorts of societal problems. As Cuban (1992) phrased it clearly: schools should not feel obliged to scratch the back of society every time society has an itch.
And third, about the learners' perspective: worldwide, many interesting efforts are ongoing to make learning more challenging and intrinsically motivating by moving from traditional, teacher- and textbook-dominated instruction towards more meaningful, activity-based and autonomous learning approaches.

Development strategies

To sketch curriculum development as a problematic domain is actually an understatement. From a socio-political stance, it seems often more appropriate to describe it as a war zone, full of conflicts and battlefields between stakeholders with different values and interests. Problems manifest themselves in the (sometimes spectacular and persistent) gaps between the intended curriculum (as expressed in policy rhetoric), the implemented curriculum (real life in school and classroom practices), and the attained curriculum (as manifested in learner experiences and outcomes). A typical consequence of those tensions is that various frustrated groups of participants blame each other for the failure of reform or improvement activities. Although such blaming games often seem rather unproductive, there are some serious critical remarks to be made on many curriculum development approaches worldwide. First of all, many curriculum reform efforts can be characterized by overly big innovation ambitions (especially of politicians) within unrealistically short timelines and with very limited investment in people, especially teachers. Second, oftentimes there is a lack of coherence between the intended curriculum changes with other system components (especially teacher education and assessment/examination programs). And

last but not least, timely and authentic involvement of all relevant stakeholders is often neglected.

From a strategic point of view, the literature has offered us many (technical-professional) models and strategies for curriculum development. Three prominent approaches are Tyler's rational-linear approach, Walker's deliberative approach, and Eisner's artistic approach. As it does not fit within the purpose of this chapter to explain those models in particular, the reader is referred to educative texts as from Marsh and Willis (2003).

Obviously, the context and nature of the curriculum development task at hand will determine to a large extent what kind of strategy is indicated. It is noteworthy that we are beginning to see more blended approaches that integrate various trends and characteristics of recent design and development approaches in the field of education and training (for an overview and a series of examples: see van den Akker, Branch, Gustafson, Nieveen & Plomp, 1999). Some key characteristics:

- *Pragmatism:* Recognition that there is not a single perspective, overarching rationale or higher authority that can resolve all dilemmas for curriculum choices to be made. The practical context and its users are in the forefront of curriculum design and enactment.
- *Prototyping:* Evolutionary prototyping of curricular products and their subsequent representations in practice is viewed as more productive than quasi-rational and linear development approaches. Gradual, iterative approximation of curricular dreams into realities may prevent paralysis and frustrations. Formative evaluation of tentative, subsequent curriculum versions is essential to such curriculum improvement approaches.
- *Communication:* A communicative-relational style is desirable in order to arrive at the inevitable compromises between stakeholders with various roles and interests and to create external consistency between all parties involved.
- *Professional development:* In order to improve chances on successful implementation, there is a trend towards more integration of curriculum change and professional learning and development of all individuals and organizations involved.

Design or development(al) research is a research approach that incorporates some of these characteristics, and it becomes even more promising by adding the element of knowledge growth to it (van den Akker, 1999). Such research can strengthen the knowledge base in the form of design principles that offer heuristic advice to curriculum development teams, when (more than in common development practices) deliberate attention is paid to theoretical embedding of design issues and empirical evidence is offered about the practicality and effectiveness of the curricular interventions in real user settings.

However, there are several persistent dilemmas for curriculum development that can not easily be resolved, let alone through generic strategies. For example: how to combine aspirations for large-scale curriculum change and system accountability with the need for

local variations and ownership? The tension between these conflicting wishes can be somewhat reduced when one avoids the all too common 'one size fits all' approach. More adaptive and flexible strategies will avoid detailed elaboration and over-specification of central curriculum frameworks. In-stead, they offer substantial options and flexibility to schools, teachers, and learners. Although struggles about priorities in aims and content will remain inevitable, the principle of 'less is more' should be pursued. However, what is incorporated in a core curriculum should be clearly reflected in examination and assessment approaches.

The 'enactment' perspective (teachers and learners together create their own curriculum realities) is increasingly replacing the 'fidelity' perspective on implementation (teachers faithfully follow curricular prescriptions from external sources). This trend puts even more emphasis on teachers as key people in curriculum change. Both individual as well as team learning is essential (Fullan, 2001). Teachers need to get out of their customary isolation. Collaborative design and piloting of curricular alternatives can be very productive, especially when experiences are exchanged and reflected upon in a structured curriculum discourse. Interaction with external facilitators can contribute to careful explorations of the 'zone of proximal development' of teachers and their schools. Cross-fertilization between curriculum, teacher, and school development is a conditio sine qua non for effective and sustainable curriculum improvement. The increasingly popular mission statements of schools to become attractive and inspiring environments for students and teachers can only be realized when such integrated scenarios are practised.

The potential of curriculum design research

Various motives for initiating and conducting curriculum design research can be mentioned. A basic motive stems from the experience that many research approaches (e.g. experiments, surveys, correlational analyses), with their focus on descriptive knowledge, hardly provide prescriptions with useful solutions for a variety of design and development problems in education. Probably the greatest challenge for professional designers is how to cope with the manifold uncertainties in their complex tasks in very dynamic contexts. If they do seek support from research to reduce those uncertainties, several frustrations often arise: answers are too narrow to be meaningful, too superficial to be instrumental, too artificial to be relevant, and, on top of that, they usually come too late to be of any use. Curriculum designers do appreciate more adequate information to create a solid ground for their choices and more timely feedback to improve their products. Moreover, the professional community of developers as a whole would be helped by a growing body of knowledge of theoretically underpinned and empirically tested design principles and methods.

Another reason for curriculum design research stems from the highly ambitious and complex nature of many curriculum reform policies in education worldwide. These reform endeavors usually affect many system components, are often multi-layered, including both large-scale policies and small-scale realization, and are very comprehensive in terms of factors included and people involved. Those radical 'revolutions', if promising at all, cannot be realized on the drawing table. The scope of diverse needs is often very wide, the problems to be addressed are usually ill-specified, the effectiveness of proposed interventions is mostly unknown beforehand, and the eventual success is highly dependent on implementation processes in a broad variety of contexts. Therefore, such curriculum reform efforts would profit from more evolutionary (interactive, cyclic, spiral) approaches, with integrated research activities to feed the process (both forward and backward). Such an approach would provide more opportunities for 'successive approximation' of the ideals and for more strategic learning in general. In conclusion: curriculum design research seems a wise and productive approach for curriculum development.

Features of curriculum design research

Curriculum design research is often initiated for complex, innovative tasks for which only very few validated principles are available to structure and support the design and development activities. Since in those situations the image and impact of the intervention to be developed is often still unclear, the research focuses on realizing limited but promising examples of those interventions. The aim is not to elaborate and implement complete interventions, but to come to (successive) prototypes that increasingly meet the innovative aspirations and requirements. The process is often cyclic or spiral: analysis, design, evaluation and revision activities are iterated until a satisfying balance between ideals and realization has been achieved.

To what extent do these design research activities differ from what is typical for design and development approaches in professional practices? What are the implications of the accountability of researchers to the 'scientific forum'? At the risk of exaggerating the differences, let us outline some of them, based on what is known about routinized standard-patterns in curriculum development practices. Of course, a lot of activities are more or less common for both approaches, so the focus will be on those additional elements that are more prominent in design research than in common design and development practices.

(1) Preliminary investigation

A more intensive and systematic preliminary investigation of curriculum tasks, problems, and context is made, including searching for more accurate and explicit connections of that

analysis with state-of-the-art knowledge from literature. Some typical activities include: literature review; consultation of experts; analysis of available promising examples for related purposes; case studies of current practices to specify and better understand needs and problems in intended user contexts.

(2) Theoretical embedding
More systematic efforts are made to apply state-of-the-art knowledge in articulating the theoretical rationale for curriculum design choices. Moreover, explicit feedback to assertions in the design rationale about essential characteristics of the intervention (substantive design principles) is made after empirical testing of its quality. This theoretical articulation can increase the 'transparency' and 'plausibility' of the rationale. Because of their specific focus, these theoretical notions are usually referred to as 'mini'- or 'local' theories, although sometimes connections can also be made to 'middle-range' theories with a somewhat broader scope.

(3) Empirical testing
Clear empirical evidence is delivered about the practicality and effectiveness of the curriculum for the intended target group in real user settings. In view of the wide variation of possible interventions and contexts, a broad range of (direct/indirect; intermediate/ ultimate) indicators for 'success' should be considered.

(4) Documentation, analysis and reflection on process and outcomes
Much attention is paid to systematic documentation, analysis and reflection on the entire design, development, evaluation and implementation process and on its outcomes in order to contribute to the expansion and specification of the methodology of curriculum design and development.

More than most other research approaches, design research aims at making both practical and scientific contributions. In the search for innovative 'solutions' for curriculum problems, interaction with practitioners (in various professional roles: teachers, policy makers, developers, and the like) is essential. The ultimate aim is not to test whether theory, when applied to practice, is a good predictor of events. The interrelation between theory and practice is more complex and dynamic: is it possible to create a practical and effective curriculum for an existing problem or intended change in the real world? The innovative challenge is usually quite substantial, otherwise the research would not be initiated at all. Interaction with practitioners is needed to gradually clarify both the problem at stake and the characteristics of its potential solution. An iterative process of 'successive approximation' or 'evolutionary prototyping' of the 'ideal' intervention is desirable. Direct application of theory is not sufficient to solve those complicated problems. One might state

that a more 'constructivist' development approach is preferable: researchers and practitioners cooperatively construct workable interventions and articulate principles that underpin the effects of those interventions.
Another reason for cooperation is that without involvement of practitioners it is impossible to gain clear insight in potential curriculum implementation problems and to generate measures to reduce those problems. New interventions, however imaginative their design, require continuous anticipation at implementation issues. Not only for 'social' reasons (to build commitment and ownership of users) but also for 'technical' benefits: to improve their fitness for survival in real life contexts. Therefore, rigorous testing of practicality is a conditio sine qua non in design research.

Emphasis on formative evaluation

As has become clear in the previous sections, formative evaluation holds a prominent place in curriculum design research. The main reason for this central role is that formative evaluation provides the information that feeds the cyclic learning process of curriculum developers during the subsequent loops of a design and development trajectory. It is most useful when fully integrated in a cycle of analysis, design, evaluation, revision, et cetera, and when contributing to improvement of the curriculum.
The basic contribution of formative evaluation is to quality improvement of the curriculum under development. Quality, however, is an abstract concept that requires specification. During development processes, the emphasis in criteria for quality usually shifts from relevance, to consistency, to practicality, to effectiveness[2]. Relevance refers to the extent that the intended curriculum is perceived to be a relevant improvement to practice, as seen from the varied perspectives of policy makers, practitioners and researchers. Consistency refers to the extent that the design of the curriculum is based on state-of-the-art knowledge and that the various components of the intervention are consistently linked to each other (cf. the curricular spider web). Practicality refers to the extent that users (and other experts) consider the intervention as clear, usable and cost-effective in 'normal' conditions. Effectiveness refers to the extent that the experiences and outcomes with the intervention are consistent with the intended aims.

The methods and techniques for evaluation will usually be attuned to that shift in criteria. For example, validity can adequately be evaluated through expert appraisal, practicality via micro-evaluations and try-outs, and effectiveness in field tests. In later stages of formative evaluation, methods of data collection will usually be less intensive but with an increasing number of respondents (e.g. achievement test for many students compared to in-depth interview with a few experts).

2) See for these criteria also chapters 1 and 5.

Formative evaluation within development research should not only concentrate on locating shortcomings of the intervention in its current (draft) version, but especially generate suggestions on how to improve those weak points. Richness of information, notably salience and meaningfulness of suggestions in how to make an intervention stronger, is therefore more productive than standardization of methods to collect and analyze data. Also, efficiency of procedures is crucial. The lower the costs in time and energy for data collection, processing, analysis and communication will be, the bigger the chances on actual use and impact on the development process. For example, samples of respondents and situations for data collection will usually be relatively small and purposive compared to sampling procedures for other research purposes. The added value of getting 'productive' information from more sources tends to decrease, because the opportunities for 'rich' data collection methods (such as interviews and observations) are limited with big numbers. To avoid an overdose of uncertainty in data interpretation, often triangulation (of methods, instruments, sources, and sites) is applied. These arguments especially hold true for early stages of formative evaluation, when the intervention is still poorly crystallized.

Generalization of curriculum design research findings

The practically most relevant outcome of curriculum design research is its contribution towards optimization of the curricular product and its actual use, leading to better instructional processes and learning results. However, a major contribution to knowledge to be gained from design research is in the form of (both substantive and methodological) 'design principles' to support developers in their task. Those principles are usually heuristic statements of a format such as: "If you want to design curriculum X [for the purpose/function Y in context Z], then you are best advised to give that curriculum the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of theoretical and empirical arguments P, Q, and R." Obviously those principles cannot guarantee success, but they are intended to select and apply the most appropriate (substantive and procedural) knowledge for specific design and development tasks.

It is not uncommon in design research that such knowledge, especially the substantive knowledge about essential curriculum characteristics, can partly be extracted from a resulting prototype itself. That is one of the reasons that make it so profitable to search for and carefully analyze already available curricula to generate ideas for new design tasks. However, the value of that knowledge will strongly increase when justified by theoretical arguments, well-articulated in providing directions, and convincingly backed-up with empirical evidence about the impact of those principles. Moreover, those heuristic principles will be additionally powerful if they have been validated in successful design of more interventions in more contexts. Chances for such knowledge growth will increase

when design research is conducted in the framework of research programs, because projects can then build upon one another.

Since data collection in design research is often limited to small (and purposive) samples, efforts to generalize findings cannot be based on statistical techniques, focusing on generalizations from sample to population. Instead one has to invest in 'analytical' forms of generalization (cf. Yin, 2003): readers/users need to be supported to make their own attempts to explore the potential transfer of the research findings to theoretical propositions in relation to their own context. Reports on design research can facilitate that task of analogy reasoning by a clear theoretical articulation of the design principles applied and by a careful description of both the evaluation procedures as well as the implementation context. Especially a 'thick' description of the process-in-context may increase the 'ecological' validity of the findings, so that others can estimate in what respects and to what extent transfer from the reported situation to their own is possible. Another option that may stimulate exploration of possibilities for (virtual) generalization is to organize interactive meetings with experts from related contexts to discuss the plausibility of the research findings and recommendations for related tasks and contexts.

Last but not least, design research may offer drafts of various relevant curriculum versions (with proven consistency and practicality) that can be compared in more quantitative, large-scale studies.

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