

Procedural Principles of Design

The Role of Analysis and Evaluation in Educational Design Processes

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Summary

Educational designers conduct a variety of design activities in practice. Building on several reconstructive studies of design practice, 8 procedural design principles, related to analysis and formative evaluation activities were formulated and discussed and elaborated in a one-day workshop with 24 educational designers from various contexts. Purpose was to check the extent to which these designers thought these principles were valid for their own situation, and to increase the robustness of the principles, by further specifying and contextualizing them. The results of the workshop show that the amount of innovation of the product to be designed impacts the way in which analysis and evaluation activities are conducted. Results also show that analysis and evaluation strategies differ in education versus training contexts, or in generic versus specific situations.

Introduction

The work of designers in the field of instructional design and educational technology is aimed at improving learning and performance in a variety of settings (Reiser & Dempsey, 2006). In their design processes, these educational designers are assumed to work systematically while analyzing learning and performance problems, and designing, developing, implementing and evaluating instructional and non-instructional processes and resources. In literature, these types of activities have been visualized in so-called ADDIE-models with a more or less cyclic nature. The last two decades, there has been increased awareness that designers may work differently from what is proposed by traditional ADDIE-design models. This has resulted in a number of reconstructive studies, in which design practice has been studied, resulting in practical design knowledge. Not only were designers found to plan less rigorous and systematic strategies to meet constraints such as limited time, budget, and personnel, they were also forced to adapt their approach along the way, because of unplanned circumstances (c.f. Pieters & Bergman, 1995; Walker, 1990; Wedman & Tessmer, 1993; Winer & Vázquez-Abad, 1995; Visscher-Voerman & Gustafson, 2004). This results in tenable shortcuts and in selective and careful (non)use of design activities contained in the models. Clear differences between practice and literature come to the fore with respect to analysis and formative evaluation activities and their alleged function. One of the areas where the gap between practice and literature is most evident is that of formative evaluation, either or not in relation to analysis.

Most reconstruction studies result in a summary and discussion of the results in contrast with literature, and eventually provide a reflection on the worth of the strategies or activities applied for the studied contexts and for other contexts. As such, it yields articulated state-of-the-art knowledge about design practice. If one wants to help developing design methodology, it is also important to bring the findings to a next level. Firstly, by identifying the activities that are judged relevant and useful in addition to existing methods, and that could have potential for other designers in similar or other contexts as well, formulating them as procedural design principles. Secondly, by exploring to what extent the principles *are* valid for other contexts, situations and designers. And thirdly, by further increasing the robustness of the principles by contextualizing them, i.e. by specifying more precisely in what situations these strategies are valid.

These steps were followed in a study on which this paper reports. Eight procedural design principles, concentrated on educational analysis and evaluation activities, were formulated based on findings in literature and reconstructive studies. In a one-day workshop with 24 designers from various design contexts, these principles were then validated and further contextualized. The general question to be answered is 'What are practical and robust procedural design principles, related to educational analysis and evaluation?' The study was a follow-up study of the DATE-research (Visscher-Voerman, 1999; Visscher-Voerman & Gustafson, 2004) in which 24 design practices were reconstructed. This paper introduces the design principles, describes the design of the workshop and presents and discusses the results. The paper will also reflect briefly on the worth and function of such a workshop as a particular research activity in a process of formulating and increasing design knowledge.

Towards The Formulation of Procedural Design Principles

The first step in the study was to formulate procedural design principles. In order to be able to formulate valuable improvements to existing design methods, the focus was on those aspects that showed a tension or gap between the assumptions and starting points of traditional ADDIE-models as studied in literature, and current practices. Also, those strategies were selected that seemed to be promising and useful ways of dealing with typical design dilemmas. One of the areas where the gap between practice and literature was most evident is that of formative evaluation, either or not in relation to analysis. In this area, 8 procedural design principles were formulated and discussed in the workshop. The subsequent sections will name the 8 principles as used in the workshop. For each principle, a brief rationale will be given for its content and why this principle was chosen. At the end of this section, Table 1 presents an overview of all principles.

Design As A Solution-Driven Process And The Role of Analysis

In traditional ADDIE models, the analysis phase, as the first phase in the process, is meant to explore the problem and its context, usually resulting in a problem definition. It includes the identification of the user or learner group, analysis of the tasks and skills to be mastered or content to be learned, demarcating the user environment (e.g. Kessels, 1993; Romiszowski, 1981; Smith & Ragan, 2004). The analysis should provide the designer with enough information and insights in the situation that (s)he is able to further plan the process.

One conclusion, derived from several reconstructive studies (cf. Rowland & Wilson, 1994; Schön, 1983, Visscher-Voerman & Gustafson, 2004, Walker, 1990) is that the nature of design processes is solution-driven, rather than problem-driven. Rather than conducting a full analysis, designers conduct only a restricted analysis, which is also more focused on developing solution specifications than on the problem. To stimulate solution specification, designers conduct several analysis activities that seem to be useful and cost-effective: the making of early prototypes; reviewing existing materials; showing products from former projects. Despite the chance of premature closure of the solution, such activities help to speed up the process. Of course, it seems logical that designers should reflect critically on those solution options. A careful consideration of how those solutions will fit the current situation, and a consideration of potential pitfalls and problems to be expected, will help to create a more realistic view of the design process to be planned. These considerations resulted in the formulation of three design principles (principles 1, 2, 3).

For many designers, the consideration of alternative solutions is likely to be an essential part of the design process. Even if designers have clear ideas for the (potential) solution at the start of the process, the DATE-study (Visscher-Voerman & Gustafson, 2004) showed that a majority of designers considered alternative solutions as an essential part of the design process. Principle 4 has been formulated so as to check participants' opinion on this point.

Because of the large amount of uncertainty, which is a characteristic of the majority of design situations, the following tactic seems to be very useful. It seems reasonable that designers split the design process into phases with formal decision moments and concrete products, and should only plan the upcoming phase in detail (principle 5).

The Role Of Formative Evaluation

The evaluation of a design under construction is a distinct phase in the ADDIE models. Through evaluation activities, the quality of the product under development is being assessed. In accordance with the findings, the product may either be improved or implemented as it is. A typical evaluation activity is the pilot test or try-out of the product late in its development (e.g. Andrews & Goodson, 1991). However, several authors and researchers have stressed the importance of formative evaluation and advice to conduct evaluative activities early in the process, integrated with design activities (e.g. Tessmer, 1994, Nieveen, 1997). The survey research by Winer and Vázquez-Abad (1995) showed that instructional designers increasingly acknowledge the worth of formative evaluation (pilot testing), and increasingly evaluate several prototypes of a product before they deliver the final product. Others, however, found that evaluation activities do not receive the amount of time and attention as suggested in traditional design models (Van den Akker et al., 1990; Pieters & Bergman, 1995, Wedman & Tessmer, 1993, Zemke, 1985; see also Keursten, 1994; Leshin, Polluck & Reigeluth, 1992). The results from the DATE-study (Visscher-Voerman & Gustafson, 2004) do not fully support this conclusion. Here, all designers deliberately conducted one or more evaluation activities, often interwoven with design activities. This shows that designers do not only perceive the value of formative evaluation, but also try to integrate these activities in their processes. Yet, it was also noted that

only in a few cases designers conducted their evaluations systematically, according to previously formulated plans and criteria. Most evaluations were conducted informally, relying on personal judgment of designers and stakeholders involved. Designers also indicated relying on small numbers of evaluation respondents in order to keep their evaluations efficient. Although this seems plausible, given the constraints of many design projects, designers could run the risk of gathering one-sided or biased information. If designers would try to increase triangulation (Miles & Huberman, 1994) over persons or methods, this could increase their effectiveness. This led to the formulation of principle 6.

Another obvious finding was that evaluations were not only used to check the quality of the product under development, but also to sharpen the design specifications. Some designers started designing as early as possible. The use of concrete prototypes was seen as an essential means for identifying the specifications of the product in interaction with client, experts, and, especially, members of the user population. Depending on user satisfaction and available time and finances, the process of design, evaluation, and revision is repeated several times. This is regarded the best way to gather user insights, needs, and wishes regarding the validity, practicality, and effectiveness (Nieveen, 1997) of the products. Evaluations can thus play an important role in clarifying product specifications (principle 7).

Several designers regarded it useful to conduct their evaluations themselves, as an efficient way to integrate evaluations in their processes. Despite the risk of designer bias, this seems a plausible tactic, especially for early evaluations, where the focus may be more on improving the design, rather than on determining its final and overall value. This led to the formulation of the principle 8.

Table 1: Procedural design principles as input for the workshop

1.	Designers should make a prototype in an early stage of the design process.
2.	A useful means to help clients, partners, and other stakeholders to choose a solution and to formulate product specifications is by showing products from former projects.
3.	An essential part of the analysis phase is a consideration of possible pitfalls and problems during the design and implementation phases.
4.	Even if designers have a clear idea for the (potential) solution at the start of the process, consideration of possible alternative solutions is essential.
5.	Designers should split the design process into phases with formal decision moments and concrete products, and should only plan the upcoming phase in detail.
6.	For efficient and effective formative evaluations, several (about three) sources and several (about three) data gathering instruments should be used.
7.	In order to clarify product specifications, designers should spend their time on carefully planned formative evaluations of early versions of a prototype, rather than on an elaborate preliminary analysis.
8.	Designers should conduct formative evaluations themselves.

Design Of The Workshop

The function of the workshop was to validate the design principles derived from the reconstructive studies and to increase their robustness. The principles were presented to 24 designers from various design contexts, in order to check the extent to which these designers valued these principles valid for their own situation, and to further specify them to different design contexts. In order to make all participants' actions visible and traceable, all materials to be used in the workshop were provided with unique codes (one for each designer). Also, the whole day was videotaped, so that comments made could be replayed. The workshop activities were pilot tested, to test the procedure as well as the clarity of the principles formulated, with eleven researchers from the department of Curriculum at the University of Twente, most of them having experience within one of the six design contexts. Only minor changes were made. These subsequent sections describe and account for the participants selected and the workshop method chosen.

Participants

As participants in the workshop, the choice was made to invite both designers who participated earlier in the DATE-study and 'new' ones. The choice to ask designers who had been interviewed partly relied on the belief they had a right to know and might be interested in the overall findings of the DATE-research (cf. Miles & Huberman, 1994; Stake, 1976). The reason to ask new designers as well, was to check the validity of the principles with new designers and design situations. Since another goal of the workshop was to contextualize the principles, it

was important to select designers from different contexts. To assure sufficient variety, six different contexts were distinguished (see table 2). Ultimately, twenty-four designers participated in the workshop. There were 12 male and 12 female designers. Their design experience ranged from 2 to 21 years. 13 Designers had a formal background in design education, 8 of them at the Faculty of Educational Science and Technology at the University of Twente. 11 Designers had either a background in the subject matter area or in other studies, mostly within the educational domain, such as general educational studies.

Table 2: Designers participating in the workshop (n=24), spread over 6 contexts.

Context		Interviewed	New	Total
TB	Textbook design	2	2	4
CD	Curriculum development	1	2	3
MM	Design of educational multimedia	2	2	4
IT	Design of internal training and HRD programs	2	1	3
ET	Design of training and HRD programs in external bureaus	1	6	7
DE	Design of distance education	3	0	3
Total		11	13	24

Workshop Activity

For the workshop, the design principles were put on flip-over sheets, which were spread over the walls in the room. During the workshop, the design principles were discussed and elaborated in small-groups, using metaplan techniques (Schnelle, 1978). The activity consisted of four steps. The first two steps were aimed at validating the principles, the third at further contextualizing the principles in small groups, the fourth at validating the contextualized principles.

Firstly, review of principles and voting on hand-out (30 minutes). The workshop moderator reviewed each principle briefly, clarifying the meaning of words and explaining the tone. Participants were asked to judge the tenability of each principle in their own specific context. For each principle, they were asked to put their votes on a hand-out, by indicating on a 4-points scale to what extent they agree. They could also circle the question mark if they would not know yet. With the first few principles, designers started to discuss meaning of words. In any of these cases, the workshop moderator suggested the designers to save those remarks and considerations for the discussion in small groups. This first step was a preparation for the next step, and was planned to guarantee that designers scored individually, and were not influenced by scores from their colleagues.

Secondly, voting with stickers. In this 10-minutes step, designers were asked to make their votes visible for others, by putting a sticker on each flip-over sheet, corresponding to their votes on the hand-out. Everyone having voted, the workshop moderator took a few minutes to go over each principle to search for striking patterns (such as much agreement or disagreement on a principle). Since designers from different design contexts received different colored stickers, it was also easily traceable whether there were clear differences between or within different design contexts.

Thirdly, elaboration of principles and defining heuristics in small groups (2 hours). Designers were divided into eight groups of three persons. The groups were formed so as to get a variation over contexts within groups as much as possible. Each group was provided with four design principles to work on. Thus, each principle was being discussed by two groups. Groups were instructed a) to generate arguments in favor of the principle and to state situations or contexts in which they believed the principle is valid; b) to generate arguments against the principle and to state situations or contexts in which they believed the principle is not valid; c) to reformulate the principles into new and valid ones, making use of the generated arguments. After Van den Akker (1999), these new principles should be formulated using the following format: If you want to make ...(product specification)... for context ...(context specification)... then you should do ...(action)... because ...(rationale)... Having finished the group work, designers put these new heuristics on paper and placed these next to the old principles on the flap-over sheets in the room. Then, each designer could walk through the room and read what other groups had come up with.

Fourthly, plenary review and discussion of new principles. During this 45-minute review, the workshop moderator asked each group to share their most important point of discussion or most critical aspect.

Results

This section describes the results of the workshop activity. First, the overall scores on the principles will be presented, together with an overview of the general pattern in scores. Then, the scores for each principle will be listed and discussed, according to the following structure: indication of overall score, table with scores differentiated

to the six design contexts, supplemented with the explanation given by the workshop moderator, arguments in favor of and against the principle as generated in the small group discussion, and the new, contextualized design heuristics as the result of the discussion.

General Patterns

- Table 3 provides an overview of the overall scores on the principles. There are several general patterns:
- Overall, designers agreed highly on the different principles, and most principles were scored positively ('+' or '++');
 - 75% or more of the designers scored positively on principles 1, 2, 3, 4, 5;
 - Highest agreement between designers was reached on principle 3;
 - Designers scored most heterogeneously on principles 6, 7, and 8, of which principle 7 was scored most negatively ('-' or '-');
 - Designers scored relatively few question marks;
 - Within all contexts, the DE-designers scored most heterogeneously.

Table 3: Range of votes for each principle

Principle	++	+	-	--	?	Principle	++	+	-	--	?
1	12	10	0	1	1	5	12	6	4	2	0
2	13	10	1	0	0	6	5	6	11	1	1
3	20	4	0	0	0	7	1	6	9	6	2
4	13	8	2	1	0	8	4	8	8	3	1

Principle 1: Designers Should Make A Prototype In An Early Stage Of The Design Process

Table 4 shows the scores for the principle as well as the explanation provided by the workshop moderator. Overall, designers highly agreed on this principle, arguing that early examples help to visualize and discuss the desirable outcome of the project. Only one TB-designer disagreed fully, arguing that prototypes are cost-expensive, and should thus be avoided. In this respect, it is important to use the term 'prototype' in the sense as formulated in the explanation. Evaluations of 'prototypes' being a 90% version of the final product may indeed be cost-expensive, especially when major changes need to be made.

Table 4: Scores on principle 1

	++	+	-	--	?	<i>Explanation</i>
TB	3	0	0	1	0	The concept of 'prototype' refers to any kind of materialization or visualization of an idea for a solution, or part of the solution (e.g. first description of a product, outline of a chapter, a framework, etc.). It should be stressed that designers should make such a prototype early in the process.
CD	2	1	0	0	0	
MM	2	2	0	0	0	
IT	2	1	0	0	0	
ET	2	5	0	0	0	
DE	1	1	0	0	1	
	12	10	0	1	1	
<i>Arguments in favor</i>						<i>Arguments against</i>
+ Early prototype can serve as vehicle to reduce uncertainties and clarify design specifications.						
+ In case of innovative situations (such as multimedia design or innovative learning processes), when clients are not familiar and inexperienced.						
+ Prototype evaluation stimulates discussion between client and users, and might increase commitment						- Not always cost-effective
						- Not in case of clear design specifications, available examples or duplicate of a former product, or in case of 'standard' processes.
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ In case of an innovative or a complex product, designers should make an early prototype (=concretizations of (part of) a possible solution), because: it clarifies the (consequences of the) design specifications; it can be tested quickly; and it increases commitment. ▪ When creating a product for a situation with innovative elements, designers should develop a prototype in an early stage, because expectations could be tuned and uncertainties be reduced. 						

Principle 2: A Useful Means To Help Clients, Partners, And Other Stakeholders To Choose A Solution And To Formulate Product Specifications Is By Showing Products From Former Projects

There was a strong agreement on this principle. Only one ET-designer scored partly negative (Table 5), giving a warning that designers should stay open, and not let the example solution fully define the problem to be solved. This warning is integrated in the first new design heuristic. It also opens the reasoning for principle 4. Overall, participants agreed that, comparable to principle 2, this activity can really clear up matters and help specify the outcomes of the project.

The new heuristics happen to be formulated for the context of curriculum design only. The formulation shows that designers intend to show solution examples from adjacent domains (which may be easier to empathize with) and that they rely on comparable design principles.

Table 5: Scores on principle 2

	++	+	-	--	?	
TB	2	2	0	0	0	<i>Explanation</i> By showing one or more products, or by explaining what you have done in former projects, you help the client shape his ideas and needs.
CD	2	1	0	0	0	
MM	2	2	0	0	0	
IT	0	3	0	0	0	
ET	5	1	1	0	0	
DE	2	1	0	0	0	
	13	10	1	0	0	
<i>Arguments in favor</i>						<i>Arguments against</i>
+ Cheap and inspiring activity						- Risk of premature closure, of having the example solution define the problem to be solved.
+ Clears up matters and questions (leading from abstract to concrete specifications)						- Can create negative opinions about solution chosen
+ Do not only show solutions but also design approach and its potential results						
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ When designing for clients who are unfamiliar with the type of solution, designers should show them a wide range of possible solutions, because that will be inspiring and illuminating. But, it should not lead to copying a solution unthinkingly or to insufficient problem analysis. ▪ If you want to design course materials for the subject French to be taught in schools, you should show course materials for the subject English that are based on the same principles, because that provides the client with a concrete picture of the course materials and the results gathered with it thus far. ▪ In case of curriculum design for a general context, designers should show a concrete example of a teaching method in a comparable domain, because that gives the client a concrete idea of the teaching method used and results obtained. ▪ In case of curriculum design for a general context, designers should be careful with showing products from former projects, because the example could come to lead its own life and push the actual problem into the background. 						

Principle 3: An Essential Part Of The Analysis Phase Is A Consideration Of Possible Pitfalls And Problems During The Design And Implementation Phases

There was a very strong agreement on this principle (Table 6). Only four designers, from different sectors, only agreed partly. The other designers all agreed completely with the principle. The remarks made seemed to focus just on the importance of analysis, per se as resulting in a baseline against which decisions can be made regarding the product to be designed. An analysis focusing on needs may in itself prevent later problems from occurring.

Both new design heuristics show that the amount in which designers have physical access to stakeholders and target group determines whether the analysis is focused on ‘now’ (analysis of current needs) or is oriented on the future (consider possible problems in future phases). Formulated in this way, the difference between corporate programs and educational programs is also a difference between specific and generic situations.

Principle 4: Even If Designers Have A Clear Idea For The (Potential) Solution At The Start Of The Process, Consideration Of Possible Alternative Solutions Is Essential

Twenty-one designers (88%) scored positively on this principle (see Table 7). Designers from the sectors IT, ET, and DE were most consistent in their scores. In the TB, CD, and MM sector, a small minority scored negatively on the principle. CD-designers showed the largest spread in scores. Comparison of the arguments shows

that the arguments in favor seem to stress the importance of the principle in general, whereas the arguments against show specific situations in which the principle should not be applied. Such as when designers need or want to design a specific type of product (because it is being subsidized or because they want to make exemplary materials). Or put

Table 6: Scores on principle 3

	++	+	-	--	?	<i>Explanation</i>
TB	3	1	0	0	0	This principle refers to a consideration of certain possible consequences of a specific design. This could lead to anticipation of this problem during the process, or to the choice not to go that direction.
CD	3	0	0	0	0	
MM	4	0	0	0	0	
IT	2	1	0	0	0	
ET	6	1	0	0	0	
DE	2	1	0	0	0	
	20	4	0	0	0	
<i>Arguments in favor</i>						<i>Arguments against</i>
<ul style="list-style-type: none"> + In analysis phase, designers determine what clients want, which is the basis for the formulation of learning goals, and accordingly, the design. + Important to check whether client's initial solution ideas fit real needs. Will prevent problems in implementation phase. 						<ul style="list-style-type: none"> - Not in case of innovative situations, in which certain vision or ideology is being developed. They should not be constrained before they even started.
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ When designing a corporate development program, designers should conduct an analysis amongst all stakeholders involved (client, future users, or designers), because this increases the chance that the program will be geared to everyone's needs. ▪ When designing 'normal' (non-ideological) educational products, designers should consider possible design and implementation pitfalls and problems during the analysis phase, because it helps to be prepared and adjustments can be made if possible. 						

Table 7: Scores on principle 4

	++	+	-	--	?	<i>Explanation</i>
TB	1	2	1	0	0	Design processes need to be split up into phases that stakeholders can recognize. Each phase needs to end formally, so that the process can be stopped or adjusted. Only the next phase should be planned, because that is the one that is most easy to foresee.
CD	1	1	0	1	0	
MM	1	2	1	0	0	
IT	2	1	0	0	0	
ET	6	1	0	0	0	
DE	2	1	0	0	0	
	13	8	2	1	0	
<i>Arguments in favor</i>						<i>Arguments against</i>
<p>Helps client to make soundly based choices; and satisfied clients will return</p> <ul style="list-style-type: none"> + Alternative solutions could work better. + If effectiveness is more important than efficiency. + Transfer, implementation aspects and implementation can be studied. + Another option is to investigate applicability of solutions that worked in other situations 						<ul style="list-style-type: none"> - Not, when initial choices have already been made. - Not in case of constraining conditions, such as market factors or technical hindrances. - Not if specific solution type is subsidized. - Not, when designers need to take specific educational or learning psychology as starting point. - Not if designers wish to create a recognizable product to compete in the market.
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ When the solution has not been prescribed imperatively, designers should carefully consider possible alternative solutions and choose one based on relevant arguments, because they should always strive for the best solution and should not entrust that that is the one that came first to their minds. ▪ When designing learning systems for companies, designers should pay a lot of attention to the analysis, because it highlights the relation between problem definition, solution direction, and constraints, which facilitates decision-making. ▪ When designing a method for schools, designers should choose a certain profile or concept, because that makes them recognizable and identifiable. This provides clarity (but is a producer's risk). 						

- When designing a program for an external client, designers should offer many educational concepts, because the client should be committed to final products.
- Educational solutions for a company should be offered as flexibly as possible, because attunement to the working context is a determining factor for transfer and effectiveness.

differently, when developing a specific type of product or conceiving a certain theory is a goal, rather than a means. In such cases, consideration of alternative solutions may only be distractive.

Principle 5: Designers Should Split The Design Process Into Phases With Formal Decision Moments And Concrete Products, And Should Only Plan The Upcoming Phase In Detail

75% Of the designers scored positively on this principle (see Table 8). Two out of three IT-designers partly disagreed with the principle. Designers from the TB, CD, and DE-sector were most positive. Designers from the others sectors were most divided. While the workshop moderator read the principle, several remarks were made by designers. MM10 indicated that her company works with fixed-time, fixed-money proposals towards clients. This means that an advanced planning is made for the client, which should also be kept, but that designers may constantly change and adapt their individual and internal plans during the project. Designer ET17 argued as the most important that the planning makes sense to stakeholders and that they recognize themselves in the planning.

The newly formulated heuristics seem to refer to the function and use of planning in general, rather than to the specific assertion of the principle (split the overall process into phases and plan only the first phase in detail). Both heuristics seem to focus on different functions of planning. The first heuristic refers to the function of a planning document as a communication tool, and as such supports a detailed planning (in all phases). The second acknowledges the complexity of many design processes, thus indicating that a planning can never fully structure the process.

Table 8: Scores on principle 5

	++	+	-	--	?	<i>Explanation</i>
TB	4	0	0	0	0	Design processes need to be split up into phases that stakeholders can recognize. Each phase needs to end formally, so that the process can be stopped or adjusted. Only the next phase should be planned, because that is the one that is most easy to foresee.
CD	2	1	0	0	0	
MM	2	0	1	1	0	
IT	1	0	2	0	0	
ET	1	4	1	1	0	
DE	2	1	0	0	0	
	12	6	4	2	0	
<i>Arguments in favor</i>						<i>Arguments against</i>
+ planning useful for structuring and monitoring process						- Can be a hindrance when acceptance of the design is more important than timely delivery.
+ only next phase can be ‘known’						
+ Establishes clarity towards client						
+ Note, phases can still be conducted partly concurrently						
<i>New design heuristics</i>						
▪ When designing educational products for specific clients, the principle should be put to work: designers should present concrete work plans to clients because these plans support communication and establish clarity.						
▪ When designing innovative products for large companies, the work plan should be kept global, because the change process cannot be estimated in advance, and a detailed work plan could raise resistance.						

Principle 6: For Efficient And Effective Formative Evaluations, Several (About Three) Sources And Several (About Three) Data Gathering Instruments Should Be Used

Designers were divided in their scores on this principle (see Table 9). Although only one designer totally disagreed, half of the group partly disagreed with the principle. The other half was fairly or fully positive. This division is also evident in the way the groups elaborated the arguments for the principle. Also within sectors, except the IT-sector, scores were heterogeneous. From the arguments given in favor and against the principle, it can be concluded that the factor time plays a decisive role in conducting or omitting on or more formative evaluation activities. The fact that the application of several evaluation methods may increase the reliability of the conclusions is perceived as less relevant.

The first new heuristic repeats the overall worth of evaluation. In the second heuristic designers did not so much add a specific design context but provide a constraint that exists in every design situation, namely time.

Table 9: Scores on principle 6

	++	+	-	--	?	<i>Explanation</i>
TB	2	1	1	0	0	Formative evaluations are often skipped because people think they are time-consuming, expensive, and need a lot of respondents. The idea behind this principle is that evaluations could be conducted on a small scale, although 'triangulation' is needed to draw justifiable conclusions.
CD	1	0	2	0	0	
MM	0	2	1	1	0	
IT	0	0	3	0	0	
ET	2	1	4	0	0	
DE	0	2	0	0	1	
	5	6	11	1	1	
<i>Arguments in favor</i>						<i>Arguments against</i>
<ul style="list-style-type: none"> + Evaluation can be valuable and valid, and is important for all contexts. + Formative evaluation: <ul style="list-style-type: none"> - can help prevent problems during process; - can partly contribute to creating commitment; - can increase product quality. + Triangulation over respondents and data (sources) leads to empirically reliable conclusions 						<ul style="list-style-type: none"> - Formative evaluation may be excluded from process if it hinders the time range of the project. - Relying on many resources may blur the results (different opinions) and may take too much time. - Usually one (client) or two (client and content expert) sources are enough.
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ In case of educational design for one-off clients, designers should conduct formative evaluations during the design and implementation phase, because formative evaluation improves the quality of the product, may prevent problems further in the design process, and helps to create commitment. ▪ If they want to design efficient and effective formative evaluations of a product, designers should not use too many sources, because it hinders the time range of the process, and because designers run the risk that not all gathered relevant information can be processed. 						

Principle 7: In Order to Clarify Product Specifications, Designers Should Spend Their Time on Carefully Planned Formative Evaluations of Early Versions of a Prototype, Rather Than on an Elaborate Preliminary Analysis

Designers disagreed highly on this principle, either within or between contexts. Overall, this principle was supposed to be different between corporate training and education sectors, which again seem to relate to generic and site-specific situations. Negative scores were dominant (see Table 10).

Table 10: Scores on principle 7

	++	+	-	--	?	<i>Explanation</i>
TB	1	0	1	1	1	The concept of formative evaluation activities means in this case: show intermediate versions to stakeholders with a specific goal and question. The term preliminary analysis refers to several analysis activities prior to the design phase.
CD	0	1	2	0	0	
MM	0	2	2	0	0	
IT	0	1	1	1	0	
ET	0	2	3	2	0	
DE	0	0	0	2	1	
	1	6	9	6	2	
<i>Arguments in favor</i>						<i>Arguments against</i>
<ul style="list-style-type: none"> + In the education sector, extensive analysis (content-related) is often not possible. Thus, formative evaluation is absolutely necessary. + Teachers prefer seeing a first product and react to it, above having a thorough analysis and wait for the product. 						<ul style="list-style-type: none"> - Training needs and preferences can only be detected in analysis phase. Formative evaluation could help improve the product.
<i>New design heuristics</i>						
<ul style="list-style-type: none"> ▪ In case of design for the context of schools (generic design!), designers should attribute major time to formative evaluation, because they cannot rely on other sources than market research for changing the product. 						

- When designing specific corporate training programs, designers should conduct a thorough analysis because that will clarify the relationship between problem definition and direction for solution, and constraints. This facilitates decision-making.

Principle 8: Designers Should Conduct Formative Evaluations Themselves

Similar to the previous principle on formative evaluation, designers disagreed on this principle. Scores within sectors were also heterogeneous (see Table 11). Although some of the arguments refer to a specific type of context (such as politically sensitive situations) the arguments mostly seem to refer to basic ideas about evaluation (the drive to be objective versus the convenience of being subjective) or to specific evaluation qualities of the individual designer or team.

The first design heuristic tries to balance between objectivity and subjectivity. The second heuristic adds a context to the original principle.

Table 11: Scores on principle 8

	++	+	-	--	?	<i>Explanation</i>
TB	2	0	1	1	0	Formative evaluation is showing a prototype or intermediate product to clients, experts, users, and other stakeholders, to get their judgments on the product and to generate suggestions for revision. If designers conduct formative evaluation themselves, it will save time (efficiency). Also, designers will get to know where problems occur, so that they can prevent/overcome these problems in next versions adequately (effectiveness).
CD	1	1	0	1	0	
MM	0	2	2	0	0	
IT	0	2	1	0	0	
ET	1	2	3	1	0	
DE	0	1	1	0	1	
	4	8	8	3	1	
<i>Arguments in favor</i>						<i>Arguments against</i>
+ Designers can evaluate more purposively than someone who does not know the design process.						- Designers could be biased, thus hindering objectivity
+ Designers can be more subtle because they know what to probe;						- Not in case of politically-sensitive situations or when fundamental choices need to be made with respect to the content.
+ Is efficient, designers can do it quickly themselves and can immediately apply the results;						- Not when the evaluation gets too specific for designers' evaluation expertise.
+ Diminishes ballast.						
<i>New design heuristics</i>						
▪ If designs are made in a team, the team should evaluate themselves, since they know what to probe. The evaluator is preferably not the designer, as this will benefit the objectivity.						
▪ If formative evaluations need to be conducted on projects that are politically insensitive, or content-insensitive, then designers should conduct these themselves, because they are quick, have no ballast, can directly apply results, and have a chance to probe.						

Conclusions

The study started with the overall question ‘What are practical and robust procedural design principles, related to educational analysis and evaluation?’. To answer this question, 8 design principles, primarily related to analysis and evaluation, were formulated based on a number of reconstructive studies. As such, these design principles had a basis in practice. In order to check how robust these practical principles are, a workshop was planned with 24 designers from different design contexts, in which these principles were discussed and contextualized.

Overall, designers showed a remarkable agreement on the majority of the principles. Although this may be due to the rather general nature of the principles, it also indicates that the principles have potential for different contexts. In the new heuristics that were formulated by designers, some of the old formulations were sharpened. Some of them were specified more towards different contexts and thus increased insights into the specific situations in which the principles are valid. The discussion of the principles shows that to some extent, the specific design situation influences the way in which analysis and evaluation activities are conducted. But the discussion also shows that the choice to conduct or omit specific activities, and the perceived relevance of the activities rely on more basic and personal perceptions. For example, some designers argue that designers should never conduct formative evaluations themselves because they cannot be objective, while others view this subjectivity as very positive for conducting evaluation themselves, since they are much subtle because they exactly know what they want to evaluate

and they are more sensitive to the findings. Overall, the factor *time* shows to be a very important and decisive factor in the choice of conducting or omitting evaluation activities. Although this finding fully supports findings from other reconstructive studies, it partly contradicts the finding for principles 1 and 2, where designers indicated to support the principle of showing and discussing early prototypes or examples from other projects, which are in fact kinds of (informal and low-profile) evaluations. One possible explanation is that designers may have different perceptions of the term evaluation, this being rather formal and more towards the end of the process.

With respect to the context, the amount of innovation of a situation or a product seems to highly influence the flow of the design process. Designers proposed an iterative approach in these cases, as a means to tackle and reduce uncertainty. The creation of prototypes early in the design process was regarded as useful because it helps to clarify the design specifications and their consequences. In this way, expectations can be tuned and uncertainties reduced. Because results are visible early in the process, they can be tested quickly. For these reasons, the use of early prototypes was also supposed to create commitment. Because of the amount of uncertainty that exists in innovative situations or for innovative products, designers need not to be too pretentious with their plans. In these contexts, it seems to be more efficient to keep the planning global and to let the process flow evolve.

Several newly formulated heuristics distinguish between the education and the training or corporate education sector as a specific design context influencing the process. The supposed difference between these sectors came out especially in relation to principles 4 and 7. It would be interesting to further explore whether this difference stems from differences in for example target groups (kids versus adults) or function of the design (aimed at increasing general knowledge versus specific skills or work related knowledge) or whether they really refer to a difference in site-specific situations in which they can and do know the target group (which is more often the case in organizations) and generic situations in which they can not possibly know the whole target group. Designers attached different weight to analysis activities for both education or training contexts. Overall, the role of analysis as activity to steer the project was regarded more important in the context of corporate training than in education, because in the former, a clear link can be established between a problem and the solution. In education, analysis was only regarded useful in case of redesign of an existing product. In case of 'new' design, formative evaluation was supposed to have more impact. Also, the consideration of different solutions was regarded to be more important in the corporate context, to help clients deliberately select a solution and get them committed to ideas. Only in cases where a certain program is prescribed, considering alternative solutions was not regarded necessary. For educational publishers, it is important that their products can be recognized. Therefore, they tend to develop a specific rationale of their materials and do not consider alternatives.

For the validation of design principles, either stemming from specific design research as identified by Van den Akker, Gravemeijer, McKenney and Nieveen (2006) or from reconstructive design research, such as the DATE-study, such a workshop can be a valuable activity in later stages of the research process. By bringing several designers together, the researcher has quick and efficient access to a huge amount of experience and contexts, as long as careful selection of respondents has been taken care of. The workshop seems to be primarily relevant for the validation of procedural design principles compared to substantive principles. Whereas substantive design principles could certainly be validated by evaluating a product that has been designed according to the principles, the validation of procedural principles by applying them on a design process seems to be less evident, given the time that is needed to finish the process. In those situations, it can be a good alternative to discuss the principles with designers whose daily work is to design.

While the discussion of design principles in a workshop may help the researcher to develop design theory, it may also directly impact design practice, since it provides designers with an opportunity to discuss and network with congeners, also across disciplines, which they may miss at their busy jobs. It helps them sharpen their own ideas about what design is or should be and thus, directly impacts their work. As such, the learning experiences of such a workshop feed both practitioners and researchers.

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