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Title **Closing the design cycle: A conclusive set of design principles for formative assessment plans**

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Abstract Designing a plan for formative assessment can support teachers in using formative assessment to inform their decisions about the best next steps in teaching and learning. In an earlier study, design principles were formulated to support teachers in designing a coherent and goal-oriented formative assessment plan. However, those design principles were based only on a theoretical exploration. In this study, teachers from four secondary schools used the principles to design and implement their own formative assessment plans over multiple design cycles. Their experiences became a basis for refining the design principles. The question in the current study is: What is a conclusive set of design principles for formative assessment plans for the purpose

of supporting better-founded formative decision-making based on empirical and theoretical evidence? Through preparatory sessions and interviews with two teachers per school, suggestions were collected for modifying the design principles and essential characteristics of a plan to achieve better-informed formative decision-making. The outcome of this study is a refined set of design principles. It prescribes that a formative assessment plan that contributes to better-informed formative decisions must be constructively aligned, include decision-driven data collection and make room for adjustments and improvement in teaching and learning. Furthermore, it describes the procedures that teachers should follow during the design process to achieve these characteristics and outcomes. While this set of design principles is conclusive for now, further research on their practical efficacy may lead to future refinements.

Keywords Design Principles, Educational design research, Assessment for learning, Teacher's formative decision-making

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Closing the design cycle: A conclusive set of design principles for formative assessment plans

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1.0 Introduction

Formative assessment is a continuous process of gauging students' progress. Black and Wiliam (2009, p. 9) define formative assessment as follows:

"Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited." (Black & Wiliam, 2009, p. 9)

Formative assessment can be seen as an ongoing process of monitoring and regulating learning by coherently implementing multiple strategies that are integrated in classroom practice (Allal, 2020). The strategies that are part of this process are:

- identifying learning objectives and success criteria,
- clarifying expectations to students,
- eliciting and interpreting evidence of student learning,
- providing students with feedback,
- and planning and implementing follow-up actions to adjust teaching and learning based on the information gathered about student learning

(Ruiz-Primo & Furtak, 2007; Antoniou & James, 2014; Veugen et al., 2021).

For the purposes of this study, all these strategies together are referred to as formative assessment and should be perceived and enacted as a coherent and integrated practice (Goertzen et al., 2023).

Formative assessment can occur contingent as well as planned and both sorts of formative assessment can complement each other and support teachers' formative decision-making and students' learning (Shavelson et al., 2008; Gu, 2021). There are many examples of contingent formative assessment in classroom practice, but they rarely include all the aforementioned strategies of a formative assessment process (Gu, 2021; Veugen et al., 2021). Planning formative assessment in

advance can help to ensure that all strategies that are part of formative assessment are present and implemented coherently.

An example of planned formative assessment is working with a formative assessment plan as presented in van der Steen et al. (2022). A formative assessment plan consists of consciously and coherently planned formative assessment strategies for multiple lessons (van der Steen et al., 2022). In a preliminary study that focused on designing such plans, the authors of the current article formulated eight design principles (Fig. 1) based on theory about formative assessment and two rounds of group interviews. The design principles are meant to support teachers in designing a formative assessment plan that informs formative decision-making (van der Steen et al., 2022).

Prototype design principles
1. Use a set of learning objectives and lesson plans as a starting point
2. Choose formative assessment activities that match the learning objectives that you are aiming for and the decisions you want to make
3. Plan formative assessment activities equally divided over time and in a way that they can build on from each other
4. Choose formative assessment activities that provide you with rich information about student learning and the necessary next steps in education and learning
5. Plan time, space and opportunity for students to improve their learning based on the outcome of formative assessment activities
6. Leave room for moments of contingency in formative assessment and lesson plans
7. Align a formative assessment plan with other formative assessment activities that are taking place before, parallel or after this plan
8. The plan must be transparent and feasible to all stakeholders

Figure 1. *Prototype design-principles for designing formative assessment plans.*

Since these design principles were merely the result of a theoretical exploration of formative assessment plans, it is unclear whether their use in practice will indeed lead to better-informed formative decision-making.

Design principles

Design principles are perceived to play a central role in educational design research (Plomp & Nieveen, 2013; Gundersen, 2021; Serwene et al., 2024) that aims to bridge the gap between theory and practice (Dishon, 2023). When theory is embedded in educational design and tested in practice through iterative design cycles, this helps to bring theory into practice and add evidence to theoretical understandings about what does or does not work in educational practice. These new theoretical understandings can then be formulated as design principles for future design (Euler, 2017; Plomp & Nieveen, 2013; van den Akker, 1999). Thus, design principles are a vehicle for generalizing knowledge from educational design research so that it becomes useful and relevant for educational professionals who want to design similar interventions in the future (van den Akker et al., 2006).

According to van den Akker (1999), a design principle should be a heuristic principle that helps designers of a specific design task to select and apply the most appropriate theory. Van den Akker (1999) identifies two main types of design principles:

- Substantive design principles: describe the characteristics of the design itself
- Procedural design principles: describe the characteristics of the design approach

Van den Akker (1999; 2013) suggests combining both substantive and procedural principles and offers a format that can help researchers formulate design principles that incorporate both, along with the context and the purpose the principles were formulated for:

If you want to design intervention X (for the purpose of Y, in context Z) then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis] (van den Akker, 1999, p. 9).

Design principles become more powerful when the knowledge on which they are based is supported by theoretical arguments and empirical evidence, especially if they have proven to be successful in different interventions and contexts (Plomp & Nieveen, 2013). The current study will distinguish between substantive design principles and procedural design principles in line with van den Akker (1999). Substantive design principles describe the characteristics a design requires to achieve its purpose. Here this means the characteristics a formative assessment plan needs to lead to better-informed formative decision-making. Procedural design principles are the steps a designer must follow in the design process to fulfill those substantive design principles and the purpose.

Although design principles play a central role in educational design research, related projects do not always lead to design principles and, when they do, those principles are rarely formulated according to the format which van den Akker (1999; 2013) describes (Bakker, 2019; Hanghøj et al., 2022; Gundersen, 2021). In his literature review of 77 top-cited educational design research articles from the last 15 years, Gundersen (2021) found that only 30 percent of those studies mention design principles. And in the 17 studies that did mention design principles, most used them at the start of the research as guidelines for their studies (i.e. guiding design principles) but did not return to them after evaluation to refine and finalize them into a more conclusive set of design principles. Only one study included in Gundersen's review presented a refined set of design principles at the end of the educational design research.

These findings call to mind the questions Bakker (2019) asked in a commentary on design principles about how they should be perceived and communicated in practice. What is the significance of design principles if they are not the result of multiple design cycles in practice and are

not communicated in a way that gives future designers all the information they need?

Therefore, the current study will be an evaluative study of the design principles formulated for formative assessment plans. It will investigate the prescriptive value of these design principles from the perspective of teachers at four secondary schools.

Overview of previous design cycles

Before presenting the evaluative study, we will give an overview of what has been done so far to refine the prototype set of design principles for formative assessment plans (Figure 1). The generic model McKenney and Reeves (2012) created for conducting educational design research is used to illustrate this overview (Figure 2). The different phases in this model clarify what has been done so far and what still needs to be done.

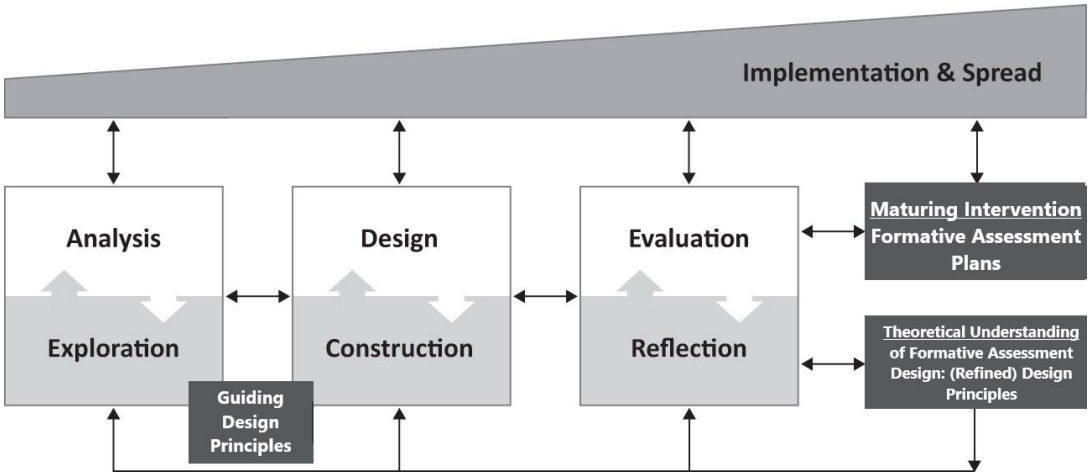

Figure 2. *Generic model for conducting educational design-research (adapted from McKenney & Reeves, 2012, used with permission from authors)*

Analysis and exploration

The set of design principles for formative assessment plans as presented in Figure 1 (van der Steen et al., 2022) is not the result of multiple design cycles. Instead, it was based on theory combined with expert interviews. In three group interviews, 20 experts from research and practice spoke about the ideal characteristics of a formative assessment plan that would support formative decision-making. The outcomes of these interviews were evaluated and refined based on interviews with future users (i.e., 23 teachers; van der Steen et al., 2022). That exploratory study can be perceived as the analysis and exploration phase in the generic model of McKenney and Reeves (2012).

The design principles resulting from this study (van der Steen et al., 2022) had a procedural emphasis for the purpose of giving teachers a starting point for designing formative assessment plans. Thus, they are

procedural design principles (van den Akker, 1999; 2013). However, it was possible to deduce the overarching substantive design principles for formative assessment plans from these procedural design principles as well (van der Steen et al., 2022). The first substantive design principle is constructive alignment, which means that formative assessment should be aligned with the learning objectives and all other learning and assessment activities that are part of the curriculum (Biggs, 1996; Gulikers et al., 2013). The second substantive design principle is decision-driven data collection, which Wiliam (2013) described as an important element for effective formative assessment. Decision-driven data collection means that teachers only collect the targeted evidence of learning that is necessary to make a certain decision, and this is an essential aspect when formative assessment is used to inform formative decisions. The third substantive design principle is ensuring that a formative assessment plan includes the necessary attention, time and space to use the information collected about student learning to improve and adjust teaching and learning (van der Steen et al., 2022). These substantive design principles, together with the procedural design principles, were the outcome of the analysis and exploration phase. Together they are guiding design principles for starting the design process in the current study. But since they are the result of a purely theoretical exploration, they still had to be empirically tested and prove their value in practice (van der Steen et al., 2022).

Design and Construction followed by Evaluation and Reflection

In the design and construction phase, 64 teachers in four secondary schools started to design formative assessment plans based on the guiding design principles in two subsequent cycles. The purpose was to discover whether teachers who used the guiding procedural design principles to design their formative assessment plans achieved constructive alignment, decision-driven data collection and room for adjustment and improvement in these plans. After each cycle, we used the teachers' design experiences, and an analysis of the formative assessment plans they designed to evaluate and reflect on the guiding design principles. This led to a refinement in the form of an extra set of procedural design principles called design steps (van der Steen et al., 2023).

Moving forward: Closing the design cycle

The starting points for the current study were therefore the guiding substantive and procedural design principles from the first study (van der Steen et al., 2022) and a refined set of procedural design principles based on the teachers' design experiences from the second study (van der Steen et al., 2023). However, there was still a lack of information about the implementation of formative assessment plans. Now that the teachers have implemented the formative assessment plans, they designed, we need to refine the design principles again based on these experiences.

Therefore, the current study will focus on the last part of the model developed by McKenney and Reeves (2012) and combine the information from the design phase with the information from the implementation to evaluate and make a conclusive set of design principles for formative assessment plans that support formative decision-making. In this study, the word 'conclusive' will be used in line with Gundersen's definition (2021), but the authors are aware that design principles are never really final since they are meant to be used and changed based on new experiences. Nevertheless, the design principles will be made conclusive for this specific design project according to the format proposed by van den Akker (1999). This should ensure that future designers have all the information they need to put the knowledge of this educational design study and what we know so far into practice and build on this knowledge.

The research question underlying the current study is:

What is a conclusive set of design principles for formative assessment plans for the purpose of supporting better-founded formative decision-making based on empirical and theoretical evidence?

The following sub-questions were posed:

1. Regarding the procedural design principles: What modifications do teachers suggest based on their experience with designing and implementing formative assessment plans?

2. Regarding the substantive design principles: What are the essential characteristics a formative assessment plan should include so that it contributes to better-informed formative decisions?

Answering these two sub-questions will clarify the modifications teachers suggest based on their experiences working with formative assessment plans and help to discover whether they think the existing set of design principles is complete and beneficial for designing formative assessment plans that inform formative decisions. Once the two sub-questions are answered, it becomes possible to answer the central research question.

2.0 Methods

To answer the research questions, the current study started with interviews per school and ended with a refinement of the design principles in which the findings from the interviews were substantiated with data from the earlier studies (van der Steen et al., 2022; 2023). See Figure 3 for a diagram of the research design and how it leads to the final refinement of the design principles.

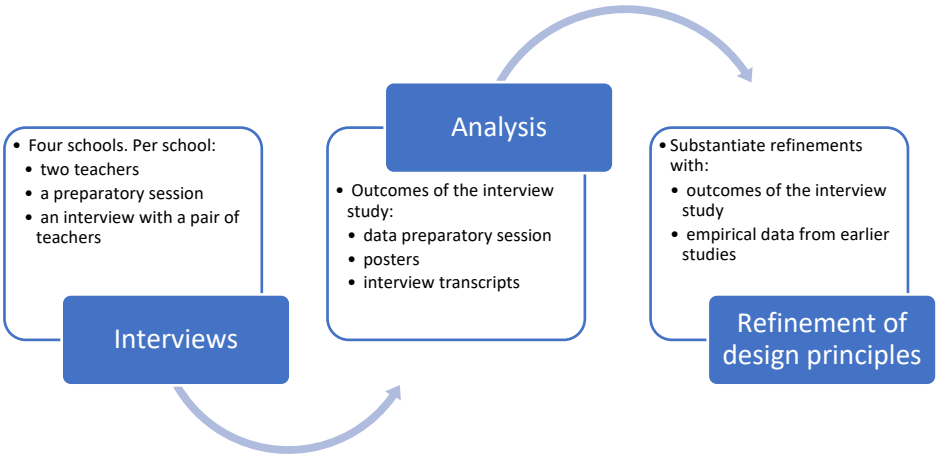

Figure 3. *Visualization of the research design.*

2.1 Respondents

This study is part of an educational design project in which 64 teachers from four secondary schools learned to design and work with formative assessment plans and implemented that knowledge. Each teacher worked in a teacher learning community (TLC) in their own school together with 10 to 23 colleagues. A TLC is a group of teachers that come together for sustained periods of time to engage in inquiry and problem solving with the goal of improving student learning (van Es, 2012). These TLCs met every six weeks over an 18-month period for three-hour sessions in which they learned how to (and did) design formative assessment plans. The TLCs worked in two design cycles, which gave every teacher time to design two formative assessment plans. To answer the research questions in the current study, we then approached two teachers from each of the four schools. The context of the schools is described in Table 1.

Table 1. *Overview of the schools context*

	Type of education	Teachers in the TLC who were experienced with formative assessment prior to the project
School 1	senior general and pre-university secondary education	Some
School 2	pre-vocational and senior general secondary education	About half
School 3	senior general and pre-university secondary education	About half
School 4	pre-vocational secondary education	Few

Two teachers per school were purposively selected; these teachers had designed and implemented a formative assessment plan prior to the interview. These teachers also had shown that they were able to

reflect on working with the design principles and formative assessment plans. For example, they could explain to others the difference between formative assessment with or without a pre-determined plan, or they could share their own learning processes and experiences regarding formative assessment.

2.2 Instruments

To answer the research questions and come to a conclusive set of design principles, the teachers reacted to the design principles in two ways: 1) directly, by giving suggestions for changes, improvements and additions for the procedural design principles and 2) indirectly, by focusing on the positive outcomes they experienced while working with formative assessment plans. These positive experiences made it possible to talk in the interviews about what had led to these positive outcomes, which could subsequently lead to new substantive design principles. In the current study these are the beneficial characteristics of a formative assessment plan that helped teachers achieve positive outcomes.

By having teachers react both directly and indirectly, we could gather information for the procedural as well as the substantive design principles. The teachers first spoke together about these topics in a preparatory session at each school. Subsequently, interviews were conducted to deepen this conversation.

2.2.1 Preparatory session prior to the interview

During the preparatory session, the two teachers from each school prepared for the interview by completing the following assignments together:

- Name as many positive outcomes as you can think of that you experienced while working with a formative assessment plan.
- What features of your formative assessment plan do you believe caused these positive outcomes? In other words, what characteristics must a formative assessment plan have to achieve these results?
- Review the eight design principles (Fig. 1). Would you like to adjust, eliminate or add principles so that working with this set of design principles has the most benefits for teachers and students?

The assignment described at the second bullet focused on retrieving information on the substantive design principles, the assignment at the third bullet focused on retrieving information on the procedural design principles. The teachers sent all their responses to the first author, who prepared and conducted all the interviews.

2.2.2 Interviews

All the positive outcomes and beneficial characteristics that teachers wrote down in the preparatory session and the procedural design principles were put on individual cards per school in preparation for the interviews. Therefore, there were three sets of cards that were used during the interviews. The first set of cards contained the positive outcomes the teachers had experienced, the second set contained the beneficial characteristics they reported, and the third set of cards were the procedural design principles. There was one interview planned at each school with the two selected teachers. Each interview lasted approximately 50 to 90 minutes.

The interviews were conducted using these sequential steps:

- The interviewer began by asking clarifying questions about the notes from the preparatory session. These were meant to establish that the positive outcomes mentioned were really a result of working with formative assessment plans and that the participants agreed that the information on the cards was correct and complete.
- The next step was to draw lines on a poster to connect the cards describing the positive outcomes they experienced to the cards describing the beneficial characteristics they mentioned. Thus, at the end of the interview, each poster portrayed which (combination of) characteristics of a formative assessment plan had led to which experienced positive outcomes, according to the teachers.
- Subsequently, the teachers were asked to draw lines between the cards with the beneficial characteristics and the cards with the procedural design principles to establish whether all beneficial characteristics were present in the design principles.
- After and during the process of drawing lines between the different cards, teachers were asked to reflect on and discuss what these connections and their experiences could mean for modifications to the existing design principles.
- Once all the positive outcomes they experienced were linked to the corresponding beneficial characteristics and procedural design principles, the interviewer concluded the interview with three final questions:
    - *Can the potential of working with formative programs be further increased? If so, in what way? What does this mean for the design principles?*
    - *Look at the usability/added value in/for practice. Can the design principles be modified/supplemented to improve this?*

- *What are the disadvantages of working with formative assessment plans? Can the design principles be modified/supplemented to improve this?*

2.3 Analysis

The data from the preparatory session, the posters and the interview transcripts were treated as complementary data sources in the analysis.

The notes from the preparatory session and the transcripts of the interviews were used to answer the first sub-question about the modifications teachers suggest for the design principles. The data were analyzed using thematic analysis (Braun & Clarke, 2006; Nowell et al., 2017). After the first author became familiar with the data, all fragments that included suggestions for the design principles were coded and clustered in themes per design principle. When the comments were more general and could not be assigned to a specific design principle, they were clustered in themes that related to all design principles. These themes were reviewed together with the second author, adjusted if necessary, and finalized.

To answer the second sub-question about the characteristics the teachers believed a formative assessment plan should have, the notes from the preparatory session were reviewed together with the poster that was the result of the interview. The experienced positive outcomes and beneficial characteristics teachers had mentioned were analyzed using thematic analysis (Braun & Clarke, 2006; Nowell et al., 2017). After the first author became familiar with the data, all text fragments that described the positive outcomes experienced from working with formative assessment plans or contributing characteristics were gathered, coded and clustered in themes. These themes were reviewed together with the second author and finalized. Then the themes related to the positive outcomes and the themes that summarized the beneficial characteristics were presented as connected themes to create a good overview of which specific characteristics of a formative assessment plan were responsible for which positive outcomes. During an analysis session with the first and second author, the researchers took a closer look at this overview of connected beneficial characteristics and positive outcomes. First, they decided which positive outcomes corresponded with achieving better-founded formative decision-making or the substantive design principles. Then they examined which characteristics teachers had mentioned as beneficial for these specific positive outcomes to answer the second sub-question.

Finally, to answer the central research question, the first and second author used the analysis session to decide which modifications to the design principles were needed to come to a conclusive set, and to discuss which theoretical and empirical data were present to substantiate these choices and design principles.

This analysis session started with deciding for each suggested modification whether there was enough empirical evidence in the current study to make this change (i.e., did other schools agree or disagree with this modification?).

Subsequently, for the sake of robustness of the research the refinements were not based solely on the outcomes of the current study. The suggested modifications were compared with the empirical data from earlier studies that were part of this educational design-based research project and theory about formative assessment to decide whether and how the change would be adopted in the conclusive set of design principles. By doing this, the researchers triangulated the data from the current study with data from prior studies.

As a final step, they looked at the outcomes of sub-question two to determine whether all essential characteristics for coming to better-informed formative decisions were present in the substantive design principles. The refined substantive and procedural design principles that were the result of this analysis session were subsequently formulated according to the format developed by van den Akker (1999; 2013).

3.0 Results

3.1 Suggested modifications to design principles and design steps

The data from the preparatory sessions and the interviews were used to answer sub-question one: Which modifications teachers suggest based on their experience with designing and implementing formative assessment plans? The outcomes are presented in Table 2.

The suggestions presented in Table 2 focus mainly on modifications to the procedural design principles and do not suggest a need for totally different procedural design principles. Neither do they reveal any outcomes for modifications or changes of the substantive design principles.

Table 2. *Themes that Emerged based on the suggested adjustments for the design principles*

	School 1	School 2	School 3	School 4	Sample Quotes
Design principle 1 *Use a set of learning objectives and lesson plans as a starting point*	Success criteria should be included in addition to learning objectives	Success criteria should be included in addition to learning objectives		No additions	*"Those success criteria must also be mentioned, otherwise they are not listed anywhere, (…) The learning objective is a bit more abstract, but ultimately it is precisely those success criteria that the students can tick off." (1)*
	Objectives and success criteria should also become clear for students / Students need to know when they are successful	Objectives and success criteria should also become clear for students / Students need to know when they are successful	Students need to know when they are successful		*"How can the learning objectives and success criteria be clear enough for students to feel ownership of them? Now this is largely determined by the teacher, and it is also portrayed this way in the design principles." (2)*
Design principle 2 *Choose formative assessment activities* for eliciting information on student learning that match the learning objectives you are*	Change the sequence: Focus first on consciously choosing/planning checkpoints (which decision do you need to make here, what information do you	No additions	Change the sequence: Focus first on consciously choosing/planning checkpoints (which decision do you need to make here, what information do you	No additions	*"If we start at the top, you have your learning objectives and you choose the checkpoints. And then you say 'What information do I need?' Then you choose a suitable formative assessment activity that elicits this specific information on student learning." (3)*

aiming for and the decisions you want to make	need) before choosing formative assessment activities that elicit information on student learning in service of the checkpoint and decision		need) before choosing formative assessment activities that elicit information on student learning in service of the checkpoint and decision		
Design principle 3 *Plan checkpoints* equally divided over time and in a way that they can build on each other*			Checkpoints do not always need to be equally divided, and it is only possible to let them build on each other if they focus on the same learning objectives		*"If I do ten lessons, why can't they be in the last three lessons? That doesn't matter because it works out best one way or another, so I'm now wondering: is it necessary for it to be divided equally?" (3)*
Design principle 4 *Choose formative assessment activities* for eliciting information on student learning that provide you with rich information about student learning and the necessary next steps in education and learning*	No additions	No additions	Focus on the question: 'Which information do I need/is meaningful to inform the formative decisions at this checkpoint?'	Focus on the question: 'Which information do I need/is meaningful to inform the formative decisions at this checkpoint?'	*"…you don't know whether it will provide rich information because what is rich information? How should I ensure that it is rich information?" (4)*
Design principle 5 *Plan time, space and opportunity for students to improve their learning based on the outcome of checkpoints**	No additions	No additions	Needs to include giving feedback/information to students based on/about the outcomes of a checkpoint	No additions	"*After each checkpoint, plan explicit space and opportunities for students to improve. Then they must have had feedback." (3)*
			It is about creating room, not only planning room		*"No, it is really creating room by not giving an instruction, by not doing an assignment, by making an instruction shorter or whatever, because everyone can plan, but not everyone can really create space." (3)*
			Prepare your possible follow-ups in advance		*"But now there is still no guarantee that you have those paths ready in advance. So those three paths that you have in mind, make sure you have worked them out (…) That makes it powerful." (3)*
Design principle 6 *Leave room for moments of contingency in formative assessment and lesson plans*	No additions	No additions	It is about creating room instead of planning room		(See earlier quote)
				Use fewer words to describe the principle	*"I would make it much shorter (…) because we understand that it is based on what you know from a checkpoint." (4)*
Design principle 7 *Align a formative assessment plan with other formative assessment activities that are taking place*	No additions	Not essential	Not essential	Not essential or Use fewer words to describe the principle for example 'Ensure to attune it'	*"…not really one of the basic principles because you first have to have a plan in order to then be able to attune it with the rest." (2)* *"This is true, but you think: 'Huh, what do they mean? Do they mean what I did before and what I will do next? Or do they mean plans from other*

before, parallel to or after this plan					*colleagues?' Yes, so actually, it can be shorter, maybe just 'attune it'." (4)*
Design principle 8 *The plan must be transparent and feasible to all stakeholders*	Not all stakeholders need to know everything				*"I think it would be nice for teachers if it was at least transparent and feasible. For students, I think it should be transparent in the sense that they know what they are working towards (…) I think they become very overloaded if they know every little step." (1)*
		Transparency and feasibility are important in every step		Transparency and feasibility are important in every step	*"…an element that must be present in everything, otherwise you simply cannot implement this, you lose people." (2)*
			Not essential		*"This is not an end in itself." (3)*
General comments of teachers	The first set of guiding procedural design principles are clear to us, but the design steps are easier to understand	The first set of guiding procedural design principles are clear to us, but the design steps are easier to understand	The first set of guiding procedural design principles are clear to us, but the design steps are easier to understand	The design steps are easier to understand	*"I think those are much clearer." (1)*
	Examples can make the design principles clearer to others	More accessible language and examples can make the design principles clearer to others		More accessible language and examples can make the design principles clearer to others	*"Examples often provide some additional support."*

*Design principle three and five are formulated slightly differently from the design principles in Figure 1; in line with the procedural design principles that emerged in van der Steen et al. (2023), the phrase 'formative assessment activities' was changed to the word 'checkpoints'. A checkpoint is the moment when teachers have planned to collect data on student learning for specific intended learning objectives (ILOs) or consciously bring together different sources of information to get a good overview of all the students' progress on these ILOs. When the phrase 'formative assessment activities' is used in one of the other design principles in Table 2, a short explanation is added to specify which specific formative assessment activity was meant.

Apart from these suggestions for the initial set of design principles, teachers also made suggestions for the future. For example, they suggested that, when teachers get better at designing formative assessment plans, design principles 7 and 8 become more important than they are at the start. Additionally, they say that in the future it would be interesting to know which design principles should be added or changed to foster more self-regulated learning among their students. As one teacher stated in an interview: "How to realize even more independence with your students, because that is what we have not necessarily included now (…) An elaboration could be 'And how does that contribute to their self-regulation or independence?'"

3.2 The advantages of working with formative assessment plans for classroom practice

To answer sub-question two and discover which characteristics a formative assessment plan should have to lead to better-informed formative decisions, teachers were asked to describe the positive outcomes they experienced while working with formative assessment plans and which features of the plan they thought had caused these positive outcomes.

The teachers reported that working with formative assessment plans led to several positive outcomes for both students and teachers. For students, the themes that emerged were:

1. Students have a better understanding of where they stand in their learning process,
2. Students have a better understanding of what is expected,
3. Students have a better understanding of formative assessment,
4. Students feel they have more room to learn from their mistakes, and
5. Students seem to retain learned information better.

For teachers, four themes emerged from the reported positive outcomes:

6. Teachers have a better understanding of where students stand in their learning and what the next steps in teaching and learning should be,
7. Teachers make decisions with regard to formative assessment more consciously,
8. Teachers experience more structure in a series of lessons, and
9. Teachers experience more shared responsibility for learning with their students.

The last outcome can be an advantage for both teachers and students, but it is in the teachers' list because they were the ones to report this as an advantage in this study.

Eight beneficial characteristics emerged from the teachers' answers that are essential to achieving the positive outcomes they experienced:

A. Paying attention to learning objectives and success criteria in advance
B. Clarifying expectations with students about learning objectives
C. Consciously planning checkpoints and formative assessment activities that elicit information about student learning
D. Giving students feedback based on the outcomes of a checkpoint
E. Planning and creating room for improvement and modifications in teaching and learning
F. Having multiple checkpoints
G. Having a timeline

H. Preparing multiple follow-ups

Although sub-question two originally focused on retrieving information that could result in modifications and/or additions to the substantive design principles, the answers provide information about the characteristics of the design itself as well as characteristics of the design approach. Therefore, in the tables below they are listed as beneficial characteristics of (designing) a formative assessment plan.

Table 3 presents all the positive outcomes reported for students, along with the beneficial characteristics of (designing) a formative assessment plan that according to the teachers led to these outcomes (as presented above).

Table 3. *Teachers's perceived positive outcomes for students as a result of working with formative assessment plans*

Positive outcomes for students	**School**	**Illustrating quotes**	**Beneficial characteristics of (designing) a formative assessment plan that led to these positive outcomes (the letters represent the characteristics teachers mentioned)**
1. *Students have a better understanding of where they stand in their learning process*	1, 2, 4	*"Students can self-assess where they stand in relation to the learning objectives and success criteria."*	A, B, C, D
2. *Students have a better understanding of what is expected*	1, 4	*"Students have more control over assignments and their content."*	A, B, C, E
3. *Students have a better understanding of formative assessment*	2	*"You notice also with students that if you let them experience that multiple times, certain things become logical for them. First when I would start with a learning objective they said: 'Nice, what do I have to do with it?' and now they do not even notice it so much."*	F
4. *Students feel they have more room to learn from their mistakes*	3	*"And that it is actually also very nice for students that you have thought about this (possible misconceptions) in advance, so it is not surprising that they do not get it right or that they make a mistake."*	D, E
5. *Learning outcomes*	4	*"Students seem to retain learned information better."*	A, B, C, D

Table 4 presents all the positive outcomes that were reported for teachers, along with the characteristics of (designing) a formative assessment plan that according to the teachers led to these outcomes.

Table 4. *Teachers' perceived positive outcomes for teachers as a result of working with formative assessment plans*

Positive outcomes for teachers	School	Illustrating quotes	Beneficial characteristics of (designing) a formative assessment plan that led to these positive outcomes (the letters represent the characteristics teachers mentioned)
1. *Teachers have a better understanding of where students stand in their learning and what the next steps should be*	1, 2, 3, 4	*"Makes the progress of the whole class visible."*	A, B, D
2. *Teachers make decisions regarding formative assessment more consciously* *a. Thinking in advance about what you are going to do with collected information* *b. Thinking in advance about which information you need for your decision* c. *Coherency*	1, 2, 3	*"Because you think in advance about the plan, you have more possibilities to search for time and space for rehearsal or remediation."*	A, B, C, E
3. *Teachers experience more structure in a series of lessons*	1, 3, 4	*"Clarity for myself about the timeline."*	A, B, C, E, G, H
4. *Teachers experience more shared responsibility for learning*	1, 2, 4	*"It feels like you, as a teacher, are no longer solely responsible but you share this with the students."*	A, B, C, D, E

3.3 Formulating a conclusive set of design principles

The refinement of the existing design principles happened through answering the central research question in an analysis session. This refinement occurred in two steps. The first step was deciding to adopt or reject each suggestion based on empirical and, if possible, theoretical evidence. In the second step this was complemented by determining which modifications were needed to increase the chance that the design principles would contribute to better-informed formative decision-making.

Because all the teachers thought the design steps as presented in van der Steen et al. (2023) were clearer than the procedural design principles from van der Steen et al. (2022), the researchers decided to use the design steps as a starting point for changes. Table 5 shows the decision for each suggestion.

Table 5. *Decisions regarding the suggested modifications for the conclusive set of design principles*

Suggestions	Evidence	Decisions
Success criteria should be included as an addition to learning objectives	Current study: Teachers from two schools mentioned that this was a valuable addition Former studies: Zooming in on learning objectives to the level of success criteria was also mentioned as an important design strategy used by experienced teachers (van der Steen et al., 2023)	Adopt this suggestion and include success criteria as an addition to learning objectives in the procedural design principles
Objectives and success criteria should also become clear for students / Students need to know when they are successful	Current study: Teachers from three of the four schools agreed on this suggestion. The outcomes in Table 3 and formative assessment theory also present 'clarifying expectations' as an important prerequisite for formative assessment that has positive outcomes for students and teachers.	Adopt this suggestion and keep 'clarifying expectations' in the conclusive set of procedural design principles. 'Clarifying expectations' should be placed after the need for teachers to thoroughly understand the learning objectives
Change the sequence: Focus first on consciously choosing / planning checkpoints (which decision do you need to make here, what information do you need) before choosing formative assessment activities that elicit information on student learning in service of the checkpoint and decision. The focus is on the decisions	Current study: Teachers from two schools suggested this sequence. Furthermore, the outcomes in Table 3 identify consciously planning / choosing checkpoints as an important element of designing formative assessment plans. Former studies: Decision-driven data collection is a key criterion for formative assessment plans that inform formative decision-making (van det Steen et al., 2022; 2023). Consciously choosing and planning checkpoints plays a central role in decision-driven data collection. (van der Steen et al., 2022; 2023)	Adopt this suggestion, include the checkpoints and verify that the sequence of the design steps corresponds to the suggested sequence. Give the decisions a more central role in planning data collection.
Checkpoints do not always need to be equally divided or to build on each other. The latter is only possible if they focus on the same learning objectives	Current study: Teachers from two schools argued that equally dividing checkpoints is not always suitable. Former studies: Analysis of the formative assessment plans and design strategies of teachers also revealed this (van der Steen et al., 2023).	Adopt this suggestion and abandon the idea of equally dividing checkpoints. Limit the advice to let checkpoints build on each other to only those instances where they concern the same learning objectives
Teachers should focus on the question 'Which information do I need/is meaningful to inform the formative decisions at this checkpoint?'	Current study: Teachers from two of the four schools preferred the word 'meaningful' to 'rich'. Former studies: 'Meaningful data' is also more appropriate within the context of decision-driven data collection and constructive alignment because it emphasizes the alignment between the data collection and the decision for which the data must be meaningful.	Adopt this suggestion and change this word to 'meaningful' for the specific learning objectives, decision and checkpoint you want to use the data for
Needs to include giving feedback/information to students based on/about the outcomes of a checkpoint	Current study: Teachers from one school mentioned this. Theory about formative assessment substantiates that feedback is a key element in the process of effective formative assessment.	Adopt this suggestion and include feedback as part of room for improvement

It is about creating room instead of planning room	Current study: Mentioned by teachers from one school. Former studies: This also was revealed as an important strategy that distinguished the experienced teachers from others since they consciously created space in advance to make room for adjustment and improvement in teaching and learning (van der Steen et al., 2023).	Adopt this suggestion and speak of planning and creating room instead of just planning room for adjustment and improvement in teaching and learning
Prepare your possible follow-ups in advance	Current study: Mentioned by teachers from one school. Former studies: This also was revealed as an important strategy that the experienced teachers used and benefited greatly from (van der Steen et al., 2023).	Adopt this suggestion. This was already part of the design steps so that it will be preserved in the conclusive set
Use accessible language and fewer words	Current study: Teachers from two schools mentioned a preference for more accessible language. Former studies: Accessible language has been a point of discussion and attention since the first design principles (van der Steen et al., 2022).	Adopt this suggestion and use text from design steps that is already shorter
Reduce the text or discard 'Alignment with other formative assessment plans' because it is not essential	Current study: Teachers from three schools agreed that 'alignment with other formative assessment plans' is not essential to designing a formative assessment plan.	Discard this design principle about aligning with other formative assessment plans since the first focus is on constructive alignment within the formative assessment plan
Discard 'transparency and feasibility as a design principle' or 'make it part of every step'	Current study: Teachers from two schools considered feasibility to be a prerequisite for everything. Transparency was less important because teachers focus first on making their own plans before making them accessible to others.	Choose to make teachers aware that they need to check for feasibility in every step. Transparency is important but not specific to formative assessment plans, so it is not included in this conclusive set
More accessible language and examples can make the design principles clearer to others	Current study: Teachers from three schools mentioned a need for more accessible language and examples. Former studies: Accessible language has been a point of discussion and attention since the first design principles (van der Steen et al., 2022).	Choose to use the texts from the design steps since these teachers already found them clearer than the prototype design principles. Include examples of formative decisions and the moments at which you may need a checkpoint

Subsequently, the two researchers looked at the positive outcomes teachers had reported in the interviews and decided which outcomes were related to the main purpose (better-informed formative decisions) or the substantive design principles. They did this by coding the outcomes in four categories:

1. Better-informed formative decisions (central aim)
2. Constructive alignment
3. Decision-driven data collection
4. Room for adjustment and improvement in teaching and learning.

The outcomes that were related to one of these four categories were selected, leading to two themes that remained: 6) Teachers have a better understanding of where students stand in their learning and what the next step should be (which is the basis for better-informed

decision-making), and 7) Teachers make decisions regarding formative assessment more consciously (relates to the substantive design principles).

The beneficial characteristics of (designing) a formative assessment plan that led to these two themes were:

1. Paying attention to learning objectives and success criteria in advance
2. Clarifying expectations regarding learning objectives to students
3. Consciously planning checkpoints and formative assessment activities that elicit information on student learning
4. Providing students with feedback based on the outcomes of a checkpoint
5. Planning and creating room for improvement and modifications in teaching and learning

This outcome did not lead to additional alterations since all these characteristics were already present in the conclusive set of design principles.

4.0 Theoretical context of the design process

Design principles in educational design research are often not made conclusive based on experiences in practice and therefore remain a guiding set of design principles (Gundersen, 2021). The focus of the current study was to come to an empirically and theoretically substantiated and conclusive set of design principles for formative assessment plans that support formative decision-making. This set is presented in Figure 4 and is the answer to the central research question in this study.

The formative design principles are presented according to the format devised by van den Akker (1999; 2013) with one exception. The second part is formulated differently: “You are best advised to give it the following characteristics” has changed to “You must give this plan the following characteristics”. Since these design principles have now been substantiated theoretically and tested in practice, they can be formulated more directly and prescriptively (Gundersen, 2021).

If you want to design a formative assessment plan for the purpose of better-founded formative decisions in the context of secondary education…	
You must give that formative assessment plan the following three characteristics:	**A. All elements are constructively aligned**
	B. Include decision-driven data collection
	C. Leave room for adjustment and improvement in teaching and learning
And do that via procedures 1 - 5:	**1. Start designing a plan based on a set of learning objectives and corresponding success criteria and the lessons that are central in the chosen period.**

	• Sketch a timeline of the lessons you will teach in the chosen period. Preferably this is an existing series of lessons already designed, checked, implemented and evaluated with constructive alignment in mind.
	
	• Take time to thoroughly understand learning objectives by zooming in and formulating success criteria and zooming out to search for overarching learning objectives. At the end of the timeline, describe the learning objectives and success criteria you are working towards and how this series of lessons will be finalized (e.g., with a test, assignment or observation).
	
	• Consider how and in which lessons you want to clarify expectations regarding the learning objectives and success criteria to your students. Add this to the timeline.
	
	2. Plan checkpoints: Consciously chosen moments when you want to know where all students are
	
	• Choose the moments at which you need to know where all students stand in their learning so that you can choose the best next step. These moments can be chosen consciously based on where or when misconceptions and difficulties are likely to arise, when you want to repeat or differentiate or when you want to decide if and how you can go on to a next topic, chapter or learning objective. These moments are checkpoints that you add to your timeline. When different checkpoints concern the same learning objectives, let them build on each other.
	
	• For each chosen checkpoint, describe the specific decision at this point. These decisions should include a 'yes or no' decision (e.g., 'Can I go on to the next chapter?' or 'Is it necessary to differentiate?') as well as a decision that informs the follow-up and focuses on the question 'What is the best way to move forward?'
	
	3. Design meaningful data collection: Meaningful for the formative decision you are planning to make and the learning objectives that are central
	
	• Decide which information is necessary to inform the pre-determined formative decision at each checkpoint. What do you need to know to come to a 'yes or no' decision regarding the learning objectives and what information do you need to decide on the best way forward?
	
	• Choose which formative assessment activities that elicit information on student learning are most suitable to elicit the information you need. Combine multiple data collection methods at each checkpoint to inform the decisions about your next steps. Preferably, use and repurpose existing learning activities that are already part of your existing lesson plan for data collection. For each checkpoint, describe in the timeline which formative assessment activities that elicit information on student learning you have chosen to gather meaningful information.
	
	4. Plan and create room for adjustment and improvement in teaching and learning
	
	• Add the possibilities and time for follow-up activities to your timeline after each checkpoint.
	
	  ○ Decide what you as a teacher will do with the information you gather.
	
	  ○ Choose how and when you will communicate with students about the outcomes of checkpoints and the necessary follow-up.

	○ Decide what students will do with the gathered information and/or the feedback/feedforward they will receive. • Prepare multiple follow-ups for different possible outcomes and students at each checkpoint. Consider that although you are prepared for multiple outcomes, the actual output of a checkpoint can still be contingent; it is possible that check-points may present you with unexpected outcomes that call for different follow-ups than you prepared in advance. Keep an open mind and be prepared to act on this contingency. • Define possible risks for your room for adjustment and improvement in teaching and learning and decide how you could tackle them. **5. Continuously check the alignment and feasibility for all elements of the plan**

Figure 4. *Conclusive set of design principles for formative assessment plans that support formative decision making.*

To provide the empirical evidence to validate this set of design principles, this study answered two sub-questions through interviews, preparatory notes and posters. Looking at the outcomes on the first sub-question, it is interesting to see that 1) teachers from different schools and contexts offered similar suggestions and 2) the suggestions are focused only on the procedural design principles and do not lead to new substantive design principles. These results emphasize that teachers need design principles to be actionable and ready to use, as other studies have found (Bakker, 2019; Gundersen, 2021; Hanghøj et al., 2022; Kustusch et al., 2020). Furthermore, these results show that the design principles are suitable for use in different secondary education contexts.

The second sub-question focused on what important characteristics a formative assessment plan should have, according to teachers based on their experience with implementing formative assessment and the positive outcomes they noticed. The purpose of this sub-question was to discover whether working with formative assessment plans indeed leads to better-informed decision-making and what characteristics of a plan make this possible. This could have consequences for the substantive design principles that resulted from earlier studies (van der Steen et al., 2022; 2023).

The teachers in the current study described many positive outcomes that go beyond having more information about student learning they can use to inform their decisions. This aligns with other studies about formative assessment that describe effects on self-regulated learning, learning results or students' growth mindset (Lee et al., 2020; Beekman et al., 2021; Yan et al., 2021). However, to answer the second sub-question, it was crucial to establish whether the teachers found that they had more information about student learning that they could use

to inform their decisions (which was the purpose of the formative assessment plans). It was also important to determine whether all the procedural design principles were present to accomplish the substantive design principles. Looking at the outcomes on this question, one can conclude that the conclusive set of design principles presented in Figure 4 does indeed include the right substantive and procedural design principles to create formative assessment plans that lead to better-informed decision-making.

Teachers' experiences with designing and implementing their formative assessment plans were the main stimulus to make changes to the guiding set of design principles that resulted from the theoretical exploration of the topic in the first study. This also illustrates some of the limitations of the current study. First, since the researchers were only able to speak with a small group of teachers, and their perspectives played an important role in the refinement of the design principles. In future research it would be important to substantiate these design principles with experiences from a greater number of teachers who used the design principles and formative assessment plans. Another limitation is that the data in this study only represent the teachers' perspectives. That was suitable for the purpose of this study, but it would be interesting for future research to include other perspectives so that they could be used to verify the claims teachers made (e.g., about the positive outcomes they experienced or the characteristics of a formative assessment plan they found to be beneficial). Observations and interviews with students would make this possible. The current findings have led to design principles that according to the teachers lead to formative assessment plans that contribute to formative decision-making; future research could expand on this by including other perspectives as well.

Although this set is now called conclusive in line with the terminology used in Gundersen (2021), one may wonder whether a design principle can ever be truly conclusive. The design principles presented in Figure 4 are formulated in such a way that future designers know when, how and why to apply them in an actionable and prescriptive way so that they are ready to use in practice. Nevertheless, when the design principles are applied in practice, and the context and teachers' agency come into play, this could lead to new and context-specific knowledge that might arise the need to modify the design principles again (Hanghøj et al., 2022; Serwene et al., 2024). This way of working with design principles matches the character of educational design research: It is a participative and continuous, cyclical process in which a combination of implementation in practice and validation are the foundations for the progression of knowledge and educational practice (Serwene et al., 2024).

Furthermore, it is necessary to continuously check and modify design principles based on experience in practice because design principles do not always take into account the complexity of classroom practice (Kidron & Kali, 2017). Therefore, future research should focus on how other teachers and schools adopt and modify the design principles and what new knowledge this generates about designing formative assessment plans. This creates an opportunity to validate the design principles in educational contexts beyond secondary education, the context in which this study and the other studies that substantiated these design principles were carried out.

Alongside the literature that presents educational design research as a linear process of refinement in the direction of pre-determined goals, design-based research is also called messy or complex, ambitious even (Bakker, 2019; Hanghøj et al., 2022, Akkerman et al., 2013). This is also something the authors of this study experienced. The conclusive set of design principles is the result of iterative cycles of design research over a four-year period. During such a period, the design and research steps are numerous and not always linear. That made it difficult to write this study in a linear, coherent, complete and concise way. This might explain why there are so few studies that present both a guiding set of design principles and a conclusive set of design principles. Gundersen (2021) notes that the only study they found that did so was 30 pages long. But it can also be complex to present the guiding and conclusive sets of design principles in two different articles, as done in the current project. This complexity results from the necessary repetition and fragmented publication of the research. Publishers' guidelines can make a researcher hesitant to consider either one of these options, and this illustrates one of the main difficulties of presenting educational design research. It would be interesting to keep investigating how best to present knowledge derived from educational design research.

This study is unique since it describes how the authors moved from a guiding set of design principles to a conclusive set of design principles with the input of the teachers who were the designers. As a result, it is now possible to present a conclusive set of design principles for formative assessment plans for the purpose of better-founded formative decision-making in secondary education based on empirical and theoretical evidence. At least this set of design principles is conclusive for now; further research on their practical efficacy may result in future refinements.

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