Chapter 10

Formative Research

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Introduction to the Formative Research Method

Formative research is a type of case study research to advance knowledge about means to accomplish a goal by either developing a new, grounded, **design theory** or improving an existing one. It tries to identify better means—such as instructional methods, technologies, practices, or processes—for accomplishing given goals within given situations. Therefore, formative research is useful when researchers want to develop or improve such means using an iterative process of implementing and improving interventions in collaboration with practitioners. It mostly uses qualitative methods as it explores strengths, weaknesses, and possible improvements in means within context, but sometimes it uses mixed methods. Like different routes on an automobile trip, most means such as instructional methods will eventually accomplish their goal, so validity is not the major research objective. Rather, the objective is to find the best of the known methods to accomplish their goal in a variety of situations; that is, do you need to get there fast, or do you prefer to take the scenic route. Thus, formative research addresses usefulness (preferability) more than truthfulness (validity), though construct validity is still of great importance.

Requirements

Formative research is drawn from case study research and formative evaluation methodologies. Hence, the first requirement is one or more real-world cases to study, along with expertise in case study methods. The second requirement is expertise in formative evaluation, which includes observation, interview, and document analysis skills, to answer three main questions: "What worked well?" "What needs to be improved?" "What improvements might be made?"

Therefore, it requires expertise in qualitative methods, including data collection and analysis. Some quantitative methods are also typically useful. A third requirement is the understanding that the best means for accomplishing any given goals are context-specific, and therefore it is important to identify the ways in which the means should differ for different classes of situations, to the extent possible. This is done primarily by investigating cases that are as different as possible from each other.

Why Use It?

Formative research has many advantages. First, it investigates within a real-world environment, complete with all its systemic interdependencies and interactions among methods and situational variables, so it helps build an understanding of them. Second, it goes beyond description—and even summative evaluation—to include formative evaluation, so it finds specific ways to improve the design theory or methods for that case(s), as well as providing rich description of the case(s) to aid use of the design theory in both practice and further research. Researchers and practitioners can all benefit from more detailed guidance for applying the design theory to diverse situations. Last, it can give an absolute sense of levels of performance on outcomes of interest. In sum, formative research is ideal for identifying ways to improve current instructional theories, models, practices, and technologies, and also for developing new ones.

Limitations

A limitation of formative research is lack of generalizability of the findings from a single case. Of course, this limitation applies to all kinds of research studies, including experimental studies. However, this problem can be addressed by replicating the study in different situations and identifying situational variables that call for different methods. Moreover, formative research does not compare the effectiveness of two different methods, as its main concern focuses on *improving* methods rather than proving them.

Description of Formative Research

In this section, we describe formative research as it would be applied in the scenario for this section. However, since formative research is for situations in which the goal is to build or improve a design theory, the scenario needs to be modified a bit for formative research to be appropriate. Hence, we offer the following minor changes:

Jennifer Blevins has noticed a rise in time students spend on digital gaming, and one teacher in the school already had some success last year using an

adaptable adventure game that teaches math and problem solving, so the school has decided to promote its use among the rest of its teachers. In the last week, another classroom teacher working on a Master's degree project approached Blevins and asked her to brainstorm some ideas with her about ways that technology could be used to benefit instructional practices. Blevins sees this as a great opportunity to further explore how they might be able to improve on the way her pioneering teacher used the game last year, so that she could better support her staff in its use, because she believes this is a challenge that could benefit the entire school community by inspiring the students at her school to be more engaged in their learning. But Blevins has very limited knowledge on how her teachers can implement and use this and other educational games in an effective way. Therefore, Blevins' overarching research question is moved from "Are games effective learning tools?" to "What guidance can we offer teachers for the use of educational games in Robertson Elementary School?"

Research Questions

Fortunately, Blevins has one pioneering teacher who already successfully used an adaptable adventure game last year. This case provides a great opportunity to conduct formative research to develop guidance for other teachers. Moreover, she has another teacher working on a master's degree project about ways that technology could be used to benefit instructional practices. This provides another opportunity to conduct formative research to improve the guidance for teachers. The specific research questions for both cases are the following:

- What worked well for the use of this educational game?
- What needs to be improved?
- What possible improvements could be made?

Research Design

Specifics of the research method vary depending on the kind of formative research study. In this scenario, formative research can be used *post facto* by retrospectively studying the first teacher's case to develop a new design theory, and it can be used *in vivo* by the second teacher to study the case as it unfolds. In addition, such studies can be classified as using **designed case** or naturalistic case, depending on whether the situation under investigation is manipulated in any way by the researcher. A *designed case* is one that was created using the existing theory or method under investigation, while a *naturalistic case* is one that was not specifically designed according to the theory or method of interest, but serves the same goals and situations as that theory.

Table 10.1

Types of Formative Research

	For an existing theory	For a new theory
(*In vivo*) designed case	Designed case for an existing theory (second case) – creating a case using an existing design theory – investigation during the case – manipulation of the case	Designed case for a new theory – creating a case to help you generate the design theory – investigation **during** the case – manipulation of the case
In vivo naturalistic case	*In vivo* naturalistic case for an existing theory – selecting a case within the scope of an existing design theory – investigation **during** the case – **no** manipulation of the case	*In vivo* naturalistic case for a new theory – selecting a case to help you generate the design theory – investigation **during** the case – **no** manipulation of the case
Post facto naturalistic case	*Post facto* naturalistic case for an existing theory – selecting a case within the scope of an existing design theory – investigation **after** the case – **no** manipulation of the case	*Post facto* naturalistic case for a new theory (first case) – selecting a case to help you generate the design theory – investigation after the case – no manipulation of the case

In this scenario, Blevins wants to develop guidance for the use of an educational game through the first teacher's case, and that case was not based on an existing design theory. Therefore, it is a naturalistic case, and it is *post facto* because the case occurred prior to her initiating the study. However, the case with the second teacher will be conducted this year using the guidance or design theory from the first teacher's *post facto* study, so it is a designed case that uses an existing theory and is conducted *in vivo*. Table 10.1 shows the six variations of the formative research method.

Data Collection Methods

This section provides the specifics for conducting formative research using the modified scenario to help the reader understand both naturalistic and designed cases, both *in vivo* and *post facto*, and for both a new theory and an existing theory.

The *post facto* **naturalistic case** was selected based on the goals and situations for which the new theory is intended. The second step is to collect three major kinds of data: (1) descriptive, (2) evaluative, and (3) formative. The descriptive data give detailed information on "what happened" so that researchers and

practitioners can replicate the case in the future. The evaluative data identify the strengths and weaknesses of what was done to identify what should not be changed and what should be improved. The formative data focus on "how it could have been done better" to identify how each weakness might be improved.

These three kinds of data can be collected through three main methods: observations, interviews, and documents. *Observations* can only be done in *in vivo* naturalistic and designed cases, unless video tapes were made of the earlier case as it unfolded. Observations focus on descriptive and evaluative data. For *in vivo* naturalistic cases for an existing theory, they help the researchers to see what elements of the theory were present or missing in the case, and what elements in the case were missing in the theory. To increase the reliability of the data, it is recommended to conduct observations with more than one researcher, as observations are typically subjective.

Interviews allow the researchers to probe the reactions and thinking of the participants, to describe what happened, to identify strengths and weaknesses in what was done, and to explore improvements for the case. They can be done during or after the implementation of the case (*in vivo* or *post facto*). Conducting interviews during the case can help to avoid the memory loss problem, but it might cause intrusiveness. Interviews can be with individuals or focus groups, and they can use open-ended or directed questions.

Documents on methods, outcomes (particularly measures of outcomes), and **situational factors (or situationality)** can help researchers to make judgments about descriptive, evaluative, and even formative data. They are particularly useful for triangulation.

In this scenario for the first case, observations are not possible, because the case has already ended. Interviews of the pioneering teacher will be done to describe (1) what he and his students did with the game last year, (2) his thoughts about the strengths and weaknesses of those actions, and (3) his thoughts about possible improvements in what he and his students did. The document review will look at the game itself, any records produced from students playing the game, measures of student learning, and teacher records or lesson plans about the use of the game.

For the second case, the designed case for an existing theory, the teacher/researcher will observe herself and her students as she uses the design theory from the first teacher's study as guidance. The observations, mostly in the form of field notes, will be used to describe what happened, possibly identify some strengths and weaknesses in what happened, and even record the teacher's own hunches as to how it could have been done better. The teacher/researcher will also interview a purposeful sample of students to get their perspectives on the descriptive (what was actually done), evaluative (strengths and weaknesses of what was done), and formative (how it could have been done better). Finally, the teacher will administer measures of student outcomes, through tests, surveys, and other means, and

review the game itself, to add to or confirm the descriptive, evaluative, and formative data.

For the second case, the teacher/researcher can revise the methods as the data are collected and analyzed, so that the improvements or revised methods can also be studied. A single case can have many iterations of data collection and revision, resulting in more substantive and reliable revisions.

Data collection for any case can take place on many levels, from the macro to the micro. For both these cases, the macro level includes such comprehensive or broad issues as criteria for selecting or redesigning the game to add features the game should have, whether the students work in teams or alone on the game, how self-directed the students are in learning from the game, how much guidance and feedback the teacher should provide, and how much reflection and self-evaluation the students should engage in. The macro level also studies the interactions among these broad features of the case. The micro level incudes such narrow issues as the form that the guidance should take each time it is offered, the form the feedback should take each time it is offered, and the nature of prompts to guide each incident of reflection and self-evaluation. The narrower the level, the more iterations of data collection and revision are possible, but data should typically be collected on all levels.

Data Analysis Methods

Data analysis involves data reduction, data display, and conclusion drawing. *Data reduction* is selecting, simplifying, abstracting, and transforming the raw data. The analytical procedure focuses on categorizing the data by the types of observations or the types of answers to questions during interviews.

Qualitative data from each case can be analyzed using the constant comparative method or thematic analysis. For the *constant comparative method*, collected data are broken down into discrete parts and each part is coded into a category, comparing each part with other previously coded parts, open coding. Then, the categories are integrated to make connections among them, axial coding. Finally, the core categories are identified, selected, and systematically related to other categories: selective coding. The comparative method can be used to analyze situational factors for the formative data.

Thematic analysis is a recursive process that begins during initial data collection and continues after data collection is completed. Categories are created in a systematic manner from a combination of *a priori* guiding questions and emergent themes. Data analysis involves regular and reflective review of the database, refining and generating the themes, with interpretation continuing throughout the entire research process, from data collection to the write-up phase. It can be used to analyze descriptive data, evaluative data of strengths and weaknesses, and formative data of potential improvements.

Three types of data to be analyzed include descriptive, evaluative, and formative. *Descriptive data* are typically analyzed as (a) a chronological description of what happened, (b) thematic analysis of principles that appear to underlie what happened, and (c) comparative analysis to identify situational factors that influenced differences in what happened. *Evaluative data* are typically analyzed using thematic analysis of strengths and weaknesses. *Formative data* are usually analyzed with a thematic analysis of potential improvements and a comparative analysis for situational factors.

Data Display

Although the ways of presenting results can vary depending on the number of cases and the number of research questions, results should be presented for descriptive, evaluative, and formative findings, complete with variations in the guidelines based on situational factors.

First, *descriptive findings* about what happened should be described in a detailed manner or rich description. Descriptive findings can be presented either chronologically or thematically, or both. They usually begin with a chronological description of the case, which ranges from the macro perspective about the whole series of events to the micro perspective about shorter series of events often repeated throughout the whole series. Then they describe both descriptive and design principles that appear to underlie or have guided the experience, drawn from thematic analysis. When presenting descriptive findings, it is important to describe situational factors such as the students, content, and contexts that might account for differences in what was done. It is always advisable to summarize with tables or graphics at the end of this section.

Evaluative findings describe strengths and weaknesses from evaluative data. Strengths describe what worked well, and weaknesses indicate what did not work well. *Formative findings* offer suggestions of possible improvements from formative data. It is advisable to use a table to show the alignment of the suggestions for each evaluative factor, as shown in Table 10.2.

Table 10.2
Example of Presenting Formative Findings

Strengths (What worked well)	Weaknesses (What did not work well)	Suggested improvements
• Assessment for learning • Flexible structure • Cognitive scaffolding	• Insufficient instruction	• Provide more practice opportunities • Increase group activities

Drawing Conclusion

Conclusions can vary depending on the kind of study. If the study is to create a new design theory, the conclusions should offer a tentative new theory, whereas if it is to improve an existing design theory, it should offer tentative revisions for the theory.

For *creating a new theory*, the purpose of the first study with the pioneering teacher is to develop a new theory for the use of an educational game through a *post facto* naturalistic case study. Therefore, in the conclusions, you should offer a tentative design theory based on your findings. As it is just one case, it is not possible to generalize your theory to the full range of situations for which the theory is intended, so there will likely be holes and other inadequacies in the theory. You should try to identify and describe any such inadequacies, and those should be tested in additional studies to improve the theory. Also, you should offer a research agenda that identifies the nature of formative studies (e.g., situational factors) you think would help most to further develop the theory.

For offering tentative *revisions for an existing theory*, you should use your findings to revise and elaborate the existing design theory. Your suggestions will not become trustworthy until they have been more thoroughly replicated and qualified based on situational factors. Additional formative research studies will provide the needed replication in diverse situations.

The ultimate conclusion should be a tentative complete set of revised guidelines, design theory for practitioners to use and researchers to further develop, along with limitations and recommendations for future research.

Methodological Issues

Qualitative research has been criticized for lacking rigor, validity, and reliability by proponents of the quantitative approach. The criticism for case studies is often related to lack of rigor in the methods. However, these concerns can be addressed by paying close attention to three methodological issues: (1) construct validity, (2) trustworthiness of data collection and analysis procedures, and (3) transferability/generalizability to the theory.

Construct validity focuses on establishing correct operational measures for the concepts being studied. In this scenario, the main constructs are the methods for the use of the educational game, the situations that influence the use of methods, and the indicators of strengths and weaknesses that are the criteria for outcomes. To assure construct validity, an expert should be involved in developing a list of criteria based on the operational definition, and the criteria should be reviewed by another expert.

The *trustworthiness* of data collection and analysis procedures is influenced by two major factors: thoroughness and credibility. *Thoroughness* of the data can be enhanced through several techniques, including advance preparation of

participants, gradually decreasing obtrusiveness, and iteration until saturation. Students are often hesitant to criticize their instruction. Therefore, it is important to prepare the participants to be critical. Establishing rapport with the participants will tend to make them more open to sharing their reactions. It is natural to start with fairly obtrusive probes in the early rounds of data collection. However, they should gradually become less obtrusive to confirm the earlier findings and improve external validity. Also, to be thorough, it is advisable to continue the iterations of probes until you have reached saturation.

Credibility of the data can also be enhanced through a variety of techniques, including triangulation and member checking. First, triangulation entails gathering data from multiple sources such as observation, individual or group interviews, and document review. Furthermore, triangulation of investigators can also be utilized, which occurs when several researchers work together to evaluate the case(s), to reduce personal bias and get some sense of the credibility of the findings. Because of the uniqueness of each individual, researchers have a diversity of approaches and perspectives. Second, member checking entails requesting participants to review the interpretations and asking them to correct inaccurate interpretations. Member checking should be done with each participant as soon as possible after the information is recorded.

Transferability/generalizability to the theory refers to the degree to which the results of the research can be transferred or applied to other situations. To enhance transferability, the researcher must provide a thick description of phenomena to help readers make a judgment about applicability to their situation. Also, situational factors should be recognized by looking for different results in different iterations, and purposely varying elements of the situation in the iterations of data collection to see if the results differ.

Benefits of Formative Research

This research method is for researchers who want to improve the quality of teaching and training by improving instructional design theory and the learning sciences. To build and improve knowledge about instruction and learning, researchers have to understand both "what is" (descriptive knowledge/theory) and "how to do" (design theory/guidance). To improve the means for accomplishing goals, the primary research concern is usefulness (preferability) rather than truthfulness (validity) and requires research to improve rather than research to prove. Few research methods have been developed to serve this purpose. Design-based research (DBR) is a notable exception, and formative research is a specific kind of DBR that offers more detailed guidance about how to do it than is available for DBR in general.

Strengths of formative research include its ability to provide a description of case(s) that helps you to understand the methods in a given situation and thereby

Table 10.3
Summary Chart: Formative Research

Overall purpose	To advance knowledge about means to accomplish a goal by either developing a new, grounded, design theory or improving an existing one
Advantages	• Investigates in a real-world environment • Helps build an understanding of systemic interdependencies among methods and situational variables • Finds specific ways to improve the design theory • Provides rich description of the case(s) • Can give an absolute sense of levels of performance on outcomes of interest
Disadvantages	• Lack of generalizability without replication • Does not compare the effectiveness of two different methods
Steps in process	For an existing theory 1. Select a design theory. 2. Design an instance of the theory. 3. Collect and analyze descriptive and formative data on the case. 4. Revise the instance. 5. Repeat the data collection and revision cycle. 6. Offer tentative revisions for the theory. For a new theory 1. Create a case to help you generate the design theory. 2. Collect and analyze descriptive and formative data on the case. 3. Fully develop a tentative theory.
Data collection methods	• Observation • Interview • Document review
Data analysis methods	• Constant comparative method • Thematic analysis

to replicate in similar situations (Table 10.3). Also, it gives you formative information on specific ways to improve the methods (design theory) for that case(s). Furthermore, concerns about rigor can easily be addressed through attention to the three methodological issues mentioned earlier. And formative research enables continued improvement of educational design theories over many iterations across diverse situations.

Glossary of Key Terms

Design theory: A design theory offers means to accomplish a goal or set of goals in different situations.

Designed case: It refers to a case that was created or managed using a design theory.

In vivo **naturalistic case:** It refers to a case that was not designed or managed using a design theory, and that is being studied while it happens.

Post facto **naturalistic case:** It refers to a case that was not designed or managed using a design theory, and that is being studied only after it happened.

Situational factors (or situationality): Situational factors influence the outcomes of one or more methods and therefore the preferability of the method(s).

Further Reading

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