Blended Phenomenography: An alternative to investigate learning

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Research Methodology. Blended phenomenography:
An alternative approach to investigate learning

This paper is presenting the research method used by the authors in [31], still, most of it was written for this publication.

Background

Phenomenography is a qualitative research methodology [1], within the interpretivist paradigm, that investigates the qualitatively different ways in which people experience a phenomenon (i.e. the different ways people experience a "thing"). It is an approach to educational research that initially emerged from an empirical rather than a theoretical or philosophical basis in the early 1970s, and the term phenomenography was "coined in 1979 and it appeared first in the work of Marton" [2], [3, p. 145]. As it is implemented in the present day, researchers continue to emphasize analysis approaches that allow finding to emerge from the empirical data rather than using existing or a priori frameworks to analyze the qualitative data. The primary data collected using a phenomenographic approach is interview data, with research participants interviewed individually in a single session. The structure of the interview and what the participant is asked to do while in the interview varies depending on the specific approach to phenomenography that is taken. In this paper, we discuss three approaches to phenomenography: Marton's first approach[2], [4], Bowden's "Developmental phenomenography" [5], and Marton's second approach [3], [6]–[8]. We then present a hybrid approach, which combines aspects of these three approaches.

Phenomenography has experienced an evolution that the literature reports principally in two moments or "faces of variation" [3]. The first 'face of variation', that we will call in this paper Marton's first phenomenography, "aims at description, analysis, and understanding of human experience" [2], or variation in human meaning, understanding, or conceptions [2], [6], or in other words, variation "in ways of seeing something as experienced and described by the researcher" [3, p. 154]. The second 'face of variation', that we will call Marton's second phenomenography, aims to awareness or ways of experiencing a particular phenomenon" [6]–[8], and these are described in terms of "critical aspects" [7] or "dimensions of variation" and "critical features" [8] or variation within the dimension of variation, as "experienced by the learners but described by the researchers" [3]. In this paper, we will use the terms critical aspects and dimensions of variation (DoV) as equivalent and interchangeable.

Both Marton phenomegraphic approaches shared similar data analysis methods. The following description is based on Marton's publication [4, pp. 42–43]: The researcher reads each transcript, identify utterances (quotes) that are "found to be of interest for the question being investigated", and put them together creating a "pool of quotes" in which it can be said that the phenomenon was "narrowed down to and interpreted in terms of these quotes." Once the researcher has the pool of quotes, her/his attention shifts from the participants to the meaning embedded in the quotes. Therefore, there is no individual participants anymore, but a "pool of meanings" that is established or "discovered" by the researcher from the quotes. The different meanings, based on their similarities, are grouped into categories, and the categories are differentiated from one another in terms of their differences. In more recent publications the "Categories" are also called

"Categories of Description," "Dimensions of Variation," or "Critical Aspects," while the internal variation within each Critical Aspect (DoV) are called "Critical Features"[8]

Later, in 2000, an Australian researcher, John Bowden, developed another phenomenographic approach known as "Developmental phenomenography" [5] in which he proposed a data analysis method that was different than the one proposed by Marton [2], [4], [7], [8]. In the developmental approach, the researcher brackets himself from the data (or at least try to do so), and it can be said that the variation is experienced and described by the learner. It is expected that the researcher does not make interpretations of the meaning of what the participant says (as in Marton's approaches) but relies only on what they say to obtain such a meaning.

Educational researchers have used these methodological approaches extensively to investigate how a learner approaches various educational phenomena, and in many cases have combined them without stating which one they are using, but such combination can be identified by the way authors design and complete their study following the premises of either Marton's first or second phenomenography and performing the data analysis following Bowden's approach. Accordingly, since Marton's first phenomenography investigates "human experience," seeking to find 'what are the different ways of experiencing the phenomenon' and 'how are these related to each other?" [3, p. 147], research questions that are similarly written are framed by this theoretical framework, and the researchers do the data collection through open-ended interviews in which the participants are asked to describe their experience with the phenomenon. Regarding the data analysis method, when combining, researchers have used the premises of the developmental phenomenographic approach [9]. Therefore, their unit of analysis is the whole transcript [6], [9], [10] instead of quotes (as proposed by Marton [2], [4], [6]–[8]), and have taken the first-order stance trying to bracket themselves and make only conclusions extracted from the data among other research design premises proposed by the developmental approach.

Engineering Education researchers have used this combination extensively. Table 1 shows some of these studies and the participants:

Table 1 - Phenomenographic studies using Marton's first phenomenography for data collection and Bowden's developmental phenomenography for data analysis and the kind of participants who participated.

Phenomenon to investigate	Participants
The concept of Design [11]	Designers in different disciplines
Dealing with uncertainty when making design decisions [12]	Aerospace engineers
The transition from pre-college engineering programs [13]	First-year engineering students
Interdisciplinary learning [14]	Undergraduate students from different years
Human-centered design [15]	Undergraduate students from different years
Use of computational simulations to support teaching and learning [16]	Instructors, undergraduate, and graduate students
Dealing with problems with multiple solutions [17]	First-year engineering students

An example of using Marton's second and Bowden's approach for data analysis [8] can be identified in the study to identify the experiences of participants with conditional and repetition structures in computing programming [18]. In this study, the participants were asked to address

the same task, but the data analysis was performed using the whole transcript technique instead of quotes as proposed in both of Marton's methods.

On the other hand, there are several studies in which Marton's second phenomenography or an approach based on those premises was used in different educational settings to study for example learning in computer education with questions such as "what it means and what it takes to learn to program," "How novice programmers learn to program?," "How novice students understand the computer science concepts of object and class" [19], and learning the concept of Information Systems [20], [21]. There are also examples in Science education to identify students' conceptions of energy in first-year chemical engineering students [22] and to find levels of explanations, models, and misconceptions in basic quantum chemistry [23]. Similarly, it has also been used in economics education [24], [25], and health sciences [26], [27], among other fields. In these studies, Marton's analysis approach was used, with analysis focusing on quotes rather than whole transcripts.

Each approach has created useful outcome spaces; however, it is relevant to identify the crucial implications of using one or the other approach when creating a research design. Some of the implications for either approach can be seen in Table 2:

Table 2 - Comparison of Research Design Considerations in Phenomenography. "X" is used to represent the phenomenon that is the focus of the study.

	Marton's first phenomenography combined with Bowden's Developmental Phenomenography (Australia) [3], [6], [9]	Marton's second phenomenography (Sweden) [3], [6]–[8]
Research question	What is a way of experiencing something (X)?	What is the actual difference between two ways of experiencing "the same thing" (X)?
Data Collection	Ask for experience with X. Ensure that all participants	Ask to experience the same instance of X through a task
Data	People talking about their past experiences with what they identify as X (Since there is no common experience, participants will talk about "different things")	Participant talking about what they can "see" of X while addressing the task. Participant reflections on their way of addressing the task (Since they shared the same experience, they will be talking about the "same thing" but with different levels of awareness of that "thing"). Deliverables the participant create when doing the task
Unit of analysis	Whole transcript	A pool of quotes that are talking about experiences during the interview, or meaning that can be seen in the deliverables by the researcher. Such quotes are not linked to the specific participant.
Researcher's job	Seek common meanings in the ways people talked about their experience with X (commonality among "different things").	Identify the variation among the views of the "same thing" X).

	Marton's first phenomenography combined with Bowden's Developmental Phenomenography (Australia) [3], [6], [9]	**Marton's second phenomenography (Sweden)** [3], [6]–[8]
Researcher's stand	First-order perspective. Researcher relies on data obtained in the interview	Second-order perspective The researcher relies on data obtained in the interview, in her/his interpretation of the interview, and the deliverables created by the participant.
Data analysis	After reading several times, sort transcripts into groups, from less powerful to most powerful. Iterate to find the variation and its outcome space structure.	After reading several times, find quotes that show what needs to be known and "throw" them in a "pool of quotes." Read the quotes several times and identify all of those that are related to an aspect that looks important for addressing the task. Repeat and find more aspects and the outcome space structure.
Outcome space	Not necessary hierarchical	Hierarchical

Using each approach brings challenges. Researchers have expressed, for example, their difficulties in the first approach (Marton + Bowden) in data collection when trying to reach saturation or the "dichotomy between seeking to describe phenomenon totally and the inability to capture it completely" [28]. Marton's approach on the other hand, according to developmental researchers [5], [6], has a weakness when defining the hierarchy of the different levels of awareness of the critical aspects because it is based on judgment and not in empirical evidence as it is Bowden's approach. These difficulties and others are presented in table 2:

Table 3 - Difficulties in Marton's first + Bowden's approach and Marton's second phenomenography

Topic	Marton's first + Bowden's approach	Marton's second phenomenography
Data collection	(1) Ensure that "all participants are commenting and reflecting on that particular phenomenon of interest," or participants voicing experiences of others because they thought were expected by the researcher [28]	A similar or equivalent difficulty has not been reported in the literature
Reaching saturation	(2) Since participants are describing their experience with X that is based on their perception and experience of what X is, it is difficult to know when you reach saturation.	A similar or equivalent difficulty has not been reported in the literature
Finding Variation and the different levels of awareness	(3) Perceive the similarities across the variation of experiences reported by the set of participants [28] Sometimes deciding if a script goes in one category or specific level of variation is challenging because one person could be describing "things" that are part of different ways of experiencing [6].	The critical aspects are found, however, finding the different levels of awareness of the critical aspects is difficult (learning trajectory) because the quotes do not provide all the context. Pieces of the puzzle rely more on researchers' interpretation and judgment [6]
Finding the hierarchical	The structure is not necessarily hierarchical, which increases the doubts in the researcher	The hierarchical structure is built based on the researcher's

structure and supporting it with evidence	when deciding to which category of description a whole script belongs. Åkerlind expresses that the same transcript can be part of two or more categories [9], while other researchers have whole scripts in only one category [6].	judgment of which set of quotes represent higher awareness of the critical aspects. [6], [7]. Additionally, "connecting the dots" to describe the learning trajectory and be able to base and defend such judgment is also difficult (first author experience with the method).

Blended Phenomenography

The blended phenomenography methodological approach we are presenting here uses Marton's "second phenomenography" in the first phase of the study, and Bowden's developmental phenomenography in the second part. Marton's second approach is used to guide for data collection—for example, when creating the interview design that includes one or more tasks (depending on the kind of evidence the researchers want the participant to produce), and a non-structured interview in which the participant is asked questions about what he/she did while addressing the task. Marton's second approach is also used in the first phase of the data analysis section, seeking to "discover" the critical aspects or dimensions of variation and the respective variation within them(critical features) through the creation and analysis of a pool of quotes. Bowden's developmental approach is used to identify the hierarchical structure of the outcomes space, or in phenomenographic terms, the learners' increasing awareness of the dimensions of variation identified in the Marton's second phase.

Using a blended approach allowed us to mitigate the difficulties mentioned previously in Table 3. In Table 4, you can see how these two approaches mitigate the difficulties:

Table 4- Blended phenomenography and the mitigation of difficulties

Topic	Advantages of the blended phenomenography approach
Data collection	All participants experience the same "thing" or the same instance of the object of learning so that researchers can compare the participant's experience with the same object of learning [8].
Reaching saturation	Since participants are experiencing the same phenomenon and sharing the same experience, you reach saturation with that group of specific people and describe the phenomenon as is experienced by the participants in the study.
Finding Variation	Through the quote analysis process, the researcher differentiates the critical aspects and their variations become evident.
Generating the different levels of awareness	Use the whole scripts to build incremental awareness of the critical aspects based on evidence.
Finding the hierarchical structure and supporting it with evidence	In the whole transcript, you can see different levels of expertise of a participant, which is reflected in their awareness of the critical aspects. Identifying what critical aspects a participant can "see," smooths the definition of the structure of the developmental path. Additionally, since the data collection was made by asking participants to experience the "same thing" (Marton's second approach), it is easier to identify the variation in the participant's awareness of the different critical aspects or dimensions of variation.

Research design using blended phenomenography

In our study using the Blended approach, we sought to investigate the incremental awareness of what is needed to effectively address a design problem in a complex-socio-technical system [31]. Figure 1 shows a sketch of how Marton's second phenomenographic approach was applied to the first part of our study for the data collection and the first part of the data analysis phase (this figure was first published [31]).

The data collection section shows our work focused on defining an interview that would elicit all the critical aspects and critical features that the participant was able to "see" when addressing the task. In our case, since we were identifying awareness of what people need to learn related to the ability under investigation, we asked the participants to work on two different tasks that allow us to separate the ability on a specific task, from the ability under investigation as suggested by Dr. Marton in an e-mail the first author exchanged with him when designing the study [32]. Since the selection and development of appropriate tasks is a crucial aspect of this study, we tested five and selected two of these that, based on a set of criteria proposed in the literature for design tasks, and phenomenographic tasks [7], [8], had the potential of eliciting a higher number of critical aspects.
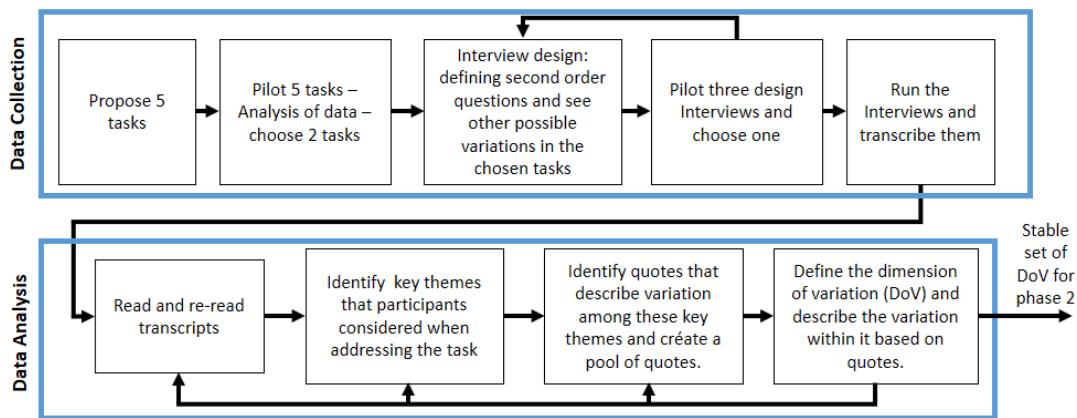

Figure 1 - Research design phase one using Marton's phenomenographic approach

Figure 1 also shows the use of Marton's approach in the data analysis section to obtain a stable set of critical aspects (or Dimensions of Variation) and their variation within. For our project, we conducted 11 iterations for phase 1. For some, the first author performed by himself, while in others, the other co-authors play the role of the "devil's advocate" asking for further validation and new iterations were needed (literature accepts either one researcher or teams of researchers for phenomenographic research [6]). In total, we found nine (9) "Dimensions of Variation" (DoV) or "Critical Aspects" in this phase, which means that for each dimension of variation, we found two or more critical features or ways in which the critical aspect varies. One example borrowed from our study is the dimension of variation related to how participants were able to "see" the time variable when addressing the task. We named this critical aspect "Time as a Factor," and the critical features for this critical aspect can be found in Table 5. The remainder of the critical aspects can be found in [30].

Table 5 - Example of Dimensions of Variation (critical aspects) with their critical features

Dimension of Variation (or Critical Aspect)	Critical features (or variation within a dimension of variation)
Time as a factor	An expectation of a short-term activity Consideration of a longer span of time Awareness of time delays Using time as a variable in a simulation of different scenarios

In the second phase, inspired by Bowden's developmental approach, we used the whole transcript to identify a possible learning trajectory of the different Dimensions of Variation identified in the previous phase. Figure 2 depicts how Bowden's approach was used in the second phase of the study (this figure was first published in [30]).
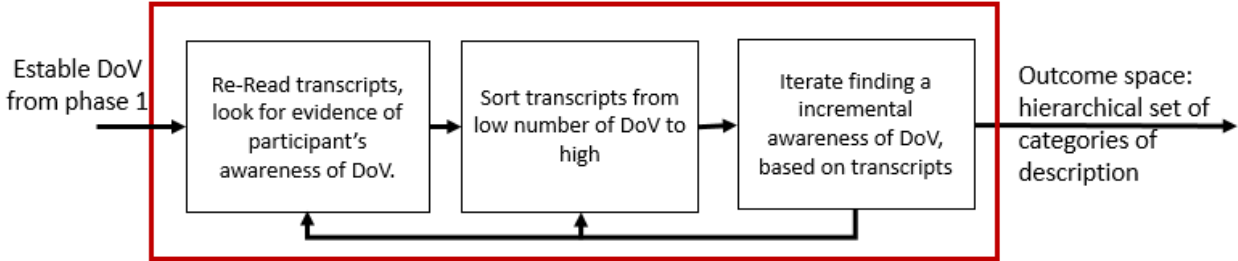

Figure 2 - Research design phase two: using the developmental phenomenographic approach

In this phase, the co-authors performed 6 iterations to develop an outcome space represented in a bidimensional table in which the dimensions of variations are located in the columns in which the different features that show the variation of the dimension are arranged from less advanced to the most advanced. In total, we found 8 different ways in which a learner can experience working on developing a solution for a problem in complex socio-technical systems (the object of learning). The rows represent the different ways of experiencing the object of learning (addressing a problem in complex socio-technical systems), which are composed of the awareness of critical aspects and critical features. For example, the third way of experiencing addressing-a-problem-in-complex-socio-technical-systems is composed of the first two critical aspects and in each, the learner would recognize the first two critical aspects, and some of their features (see Table 6). Because the focus of this paper is to describe the methodology and not the findings from this specific study, we present only a portion of the outcome space in Table 6. The full structure can be found in [30].

Table 6 - Example of Outcome Space

Ways of Experiencing *addressing a problem in complex socio-technical systems*	Critical aspect 1 (DoV1)	Time as a factor (DoV2)
Way 1	Critical feature 1 of DoV1 (no variation is perceived)	The expectation of a sequential short-term response (no variation is perceived)
Way 2	Critical feature 2 of DoV1	

| Way 3 | Critical feature 2 of DoV1 | Considering a longer span of time |

Table 6 shows a possible outcome space. In row one, "Way 1" is the way of experiencing the phenomenon with an awareness of the existence of a topic related to dimensions of variation 1, but no awareness of different possible values in that dimension, or using Marton's words, the dimension is still closed to this learner's awareness. In "Way 2", there is awareness of two dimensions of variation, but the learner is only aware of the variation in only the DoV 1, meaning that this dimension is opened to the learner, while the other is still not. "Way 4" would be the most advanced one, and in this case, the learner will be aware of the variation on all dimensions of variation and will recognize all the critical features in each dimension of variation.

Ensuring quality when using blended phenomenography

Sin [29] proposes several applications of the rigor and quality criteria for qualitative research to phenomenography. Considerations for validity, generalizability and transferability, objectivity and reflexivity, and reliability in phenomenographic research are proposed by the author.

This blended phenomenographic approach is consistent with these considerations. In terms of validity, the main concern is about the quality of the interview data and the possibility that what the participant says is different than what the participant means (trustworthiness). According to Marton, the participant may pretend that they had a lower level of awareness than the one they have. However, they cannot pretend to be more skillful or aware of advanced critical aspects if these are not in their level of awareness. In blended phenomenography, we propose the use of two tasks and a follow-up interview. By using a data collection method that includes at least two tasks and after that an interview, as we did, future researchers would have more chances of finding the dimensions of variation they seek.

Another validity concern is usually the number of people involved. Åkerlind [6] has identified that phenomenographic research can be performed by one or more researchers and that there are no right or wrong outcome spaces, but instead, less and more complete outcome spaces, and that "any outcome space is inevitably partial, with respect to the hypothetically complete range of ways of experiencing a phenomenon" [6, p. 121] and the research results obtained by one individual still contributes to the understanding of the phenomenon. In our case, our team is partially contributing to the understanding of how the learners experience an object of learning by using blended phenomenography.

Regarding the generalizability of the results, Sin [29] discusses that, in phenomenographic research, the results should be evaluated for transferability instead of generalizability. To ensure transferability, it is crucial to maximize the variation among the background of experiences the participants have with the object of learning (e.g. from less skillful to experts), and consider the context in which the results can be used, to include participants from that context. In our study, using blended phenomenography, we followed these practices. We collected data using purposeful sampling and included in our sample members from the different contexts from which we wanted our study to be useful. We also shared our preliminary results with

professionals in one of the contexts we wanted the results to be useful. We suggest following a similar approach when using blended phenomenography in other studies.

Additionally, instead of trying to bracket ourselves to be objective when using blended phenomenography, we adopted Marton's vision for embracing our background knowledge and experience when analyzing the data [7], [8]. We realized that when looking for the meaning of participants' actions and reflections, which are evidence of their awareness of the object of learning, our previous experiences, and knowledge of others experiencing it, was crucial for identifying the variation in the critical features. In that way we built the construct of the critical aspects. Furthermore, to keep the data reliable, the first author wrote a reflective journal in which he kept notes of all the thoughts and decisions he was making individually, and collectively with the other co-authors. Such commitment to reflexivity is key to ensuring quality in phenomenographic research [29].

Finally, when considering replicability in phenomenographic research, Marton says that phenomenographic results are not replicable because it is a discovery that is reached after a process, and discoveries do not have to be replicable [4], [29]. In this respect, Cope [30] argues that the outcome in phenomenographic studies carried out by different researchers with the same data could reach a different outcome because the researchers' background "is an essential part of the relationship developed" [with the data]. Still, Sin proposes "interpretative awareness" and "maximum fidelity to the data," [27] which both were tackled in our investigation with the reflective journal kept by the first author that allowed him to keep a record of the data-driven decision-making in the process.

Discussion

Blended phenomenography is a second-order qualitative research method that we used to discover the different ways in which a learner could experience being able to address a problem in a complex socio-technical system. As with any other qualitative method, planning and calibration are crucial. In terms of planning, blended phenomenography proposes that the participants are asked to engage in a task in which they can use all the knowledge and skills they have about the object of learning. For our study, through a personal email with the first author, Dr. Ference Marton suggested that the participants should be engaged in "at least two performance tasks" in which the participant was thinking aloud followed by a reflective interview. He emphasized the need to pose the same problem to all participants and "find the critical differences in how different people handle (and experience) the same problem." [31] He also explained that two tasks would make it easier for us during data analysis to be able to discern the participant's actual knowledge and skills that they can apply related to the object of learning, from their knowledge on how to perform the task. We tested 5 different tasks and chose two of these following these recommendations from Dr. Ference Marton. This approach was beneficial for our study and we recommend following such an approach of using at least two tasks. Similarly, our data collection protocol also included a follow-up interview, as proposed by Marton, in which we sought to find the meaning of participants' actions. In that interview, we asked them why they did what they did. Such a second-order perspective from the participant facilitates the researcher's analysis when looking for quotes that reveal participants' awareness of what needs to be done, in our case, to address a problem in a complex socio-technical system. Having two tasks also allows you to keep, in Marton's words, a background of sameness while

looking for the critical aspects and the variation among them. When the first author tried to apply Marton's first phenomenography to find the meaning of the participant's experience, he did not reach the "click" moment (in Åkerlind's words [9]) in which you understand such meaning. The pilot interviews using Marton's second phenomenography were best for perceiving that it was feasible to find the critical aspects.

After the data collection, the critical aspects (or DoV) were more evident after reading all the transcripts several times, selecting the quotes, and reading them several times as well. Printing the transcripts on paper, and using scissors to cut out the quotes to be able to group them in piles that were categorized by similar "topics" of meanings was the strategy that worked for the first author after trying software packages designed for qualitative research (e.g. NVivo), or simpler ones like Excel. This is because the piles were arranged in terms of meanings and the variation among them, and such meanings only can be interpreted, at this time, by humans, and it was easier for the first author to manipulate the quotes, move them, and re-arranged them when on physical paper.

Finally, we realized that it was really important to understand the concept of incremental awareness of the object of learning, and in our process of defining the methodology for our study, we increased our awareness of what it means and how to do a phenomenographic study. This is because we were able to perceive the variation among the different studies, and realizing that variation allowed us to define this new blended approach. Accordingly, we suggest that to succeed in qualitative research, researchers should become real experts in the methods they are intending to use. This means reading seminal publications, reading the work, and especially the reflections of researchers after using the methods, experiencing the methods, reflecting, and iterating.

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