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Framework analysis for Vision Scientists: a clear step-by-step guide

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Abstract

Vision sciences has traditionally been a quantitative discipline. However, to fully capture all aspects of clinical vision care, researchers increasingly need to be conversant in both quantitative and qualitative methodologies. This has resulted in qualitative methodologies becoming more common in vision sciences research literature. From the authors' perspective, vision researchers often struggle to identify suitable qualitative methodologies when coming from a tradition of a realist ontology, or the view that independent truth exists. This study explores the ontological and epistemological considerations when approaching qualitative research in vision sciences and proposes framework analysis as a qualitative methodology that is accessible for vision scientists. Framework analysis is a flexible and highly utilitarian qualitative analysis method which complements quantitative methodologies. This paper also presents a step-by-step guide for conducting framework analysis in a logical, transparent, and repeatable way that will provide a clear audit trail of how results are obtained from subjective data. This is done using a worked example from a recent eye care study.

Keywords: Qualitative, framework analysis, methodology, vision science

Introduction

Research can generally be divided into two distinct methodologies — quantitative and qualitative (Jolley, 2020). With increasingly sophisticated research techniques becoming available, researchers should select a methodology from their tool kit that is most appropriate for the research they are conducting. Vision sciences has traditionally been a subject dominated by quantitative research as the physical properties of light and its application lends itself well to quantitative measurement and exploration (Jones & Jefferis, 2017). Equally, measuring the success and impact of refractive procedures to correct refractive error (Ferreira et al., 2022), surgical interventions to manage cataracts (Louison et al., 2019) and glaucoma (Kuerten et al., 2015) is routinely undertaken by capturing quantitative research data including distance and near visual acuity (VA) (Chang et al., 2021), and intraocular pressure (IOP) at baseline and at defined time points following the intervention.

However, the application of light to the human experience, for example visual perception and the practice of optometry, requires that we understand more than the objective properties of light or the change in clinical parameters, but also how the entire world of sight and its place in healthcare is experienced by individuals. Such considerations are increasingly favoured by funding bodies such as the National Institute for Health and Care Research (UK) (2022) and the National Institutes of Health (USA) (2022). A number of studies that used qualitative methods have been published in major vision sciences journals such as Ophthalmic and Physiological Optics (Kumaran et al., 2021; Scheffer et al., 2022), Optometry and Vision Science (Narayanan et al., 2017) and Clinical and Experimental Optometry (Kandel et al., 2017; Moghimi et al., 2014).

Qualitative research is one way to collect such data to complement purely quantitative measurements. The necessity of qualitative research becomes apparent when research questions involving experience and belief are investigated (Green & Thorogood, 2018). Examples of these questions might include why patients refuse sight-saving interventions or why a new piece of optometric equipment is disliked by practitioners or patients. Experience and perception may initially appear to be relatively vague concepts, but are qualities best explored using an approach where the subjective experiences can be used as data. This can sit uncomfortably with clinicians or researchers coming from a traditionally positivist viewpoint who strive for objectivity in every step of their practice or research (Green & Thorogood, 2018). Qualitative research can also appear opaque without a robust set of guidelines and little indication of how the output of analysis was achieved from the raw data. The numerous qualitative research methods available can seem overwhelming as the terminology used for qualitative methodologies can be unfamiliar and can seem vague to those used to rigid definitions and transparency.

Framework analysis is one qualitative methodology that has proved popular with healthcare researchers (Ward et al., 2013). This paper argues that the framework analysis approach uses a research philosophy compatible with more traditionally realist ontology. It therefore provides an in-road into qualitative research for more quantitative-minded vision scientists although will require an appreciation of more subjectivist epistemologies. Using framework analysis, phenomena can be examined in great detail through a logical and repeatable series of steps, enhancing and improving the understanding of the application of vision to the human experience. This paper seeks to help researchers familiar with quantitative methodologies to understand the need for qualitative methodologies as another research tool. This paper also seeks to explore the relationship between a realist ontology and qualitative research, and proposes these are compatible, although a flexible approach to epistemology is required. Once the underpinning philosophical stance is understood, framework analysis is suggested as a user-friendly and robust method of qualitative analysis suitable for scientists with a realist ontology, and a step by step worked example is given. This paper aims to generate wider interest among vision researchers in exploring qualitative research methodologies and to stimulate future applications in mixed-methods studies to provide a more comprehensive evaluation of vision outcomes in patients. This paper proposes that the logical and repeatable nature of framework analysis lends itself well to mixed-methods research where quantitative and qualitative methodologies can complement each other in answering different aspects of larger research questions. The paper also lays out a step-by-step approach to analysis that vision scientists can refer to when conducting a piece of qualitative research.

Paradigm

Before a step-by-step approach is described to undertake any type of qualitative analysis, a thorough understanding of ontology and epistemology is required. Vision scientists coming from a traditionally realist and positivist background may need to take time to consider their philosophical stance before conducting qualitative analysis. Although it is important for all researchers to adapt their methods of research to the research question, the philosophical approach of the researcher is one element of research that may be difficult to change. This can be

called the research paradigm and consists of the personal ontology and epistemology of the researcher (Kuada, 2012). Ontology refers to the researcher's personal opinion on the nature of reality or what we believe to be true. Epistemology refers to how we know the nature of reality. In research, ontology can often be boiled down to whether one believes that objective truth exists or not: if there is a truth that is independent of whether we believe it or not. In vision sciences, this is often the approach that clinicians and scientists take, that independent truth exists, also known as a realist viewpoint (Green & Thorogood, 2018). The epistemology is often positivist, meaning it is believed this objective truth can be observed and measured, for example in an experiment (Kuada, 2012). In studies with a positivist epistemology, researchers are careful not to introduce subjectivity or bias in observation or measurement that can cloud the reality they are trying to explore. This realist ontology along with a positivist or empirical epistemology is often a tacit assumption in the teaching of vision sciences: that we approach an objective world in an observable way and only what is proven by science is trustworthy (Bahari, 2012).

Some of the underlying concepts are described in the following paragraph. For readers unfamiliar with the terminology, a table with the most important definitions is provided (Table 1). A realist ontology is not something that necessarily needs to change in the course of our life or career. Our upbringing, our personal experiences, even theology come into our view of the world and subsequently our ontology, and it can be an essential part of who we are. Aspects of epistemology however, should be more flexible for researchers. Even if we believe that objective truth exists and that it can be measured and that subjective experience must be minimised to get as close to the truth as possible, what if the subject we seek to understand is itself a subjective experience? For example, a new intervention for myopia control has undergone extensive study and has proved effective but in the real world subjects are not completing treatment and practitioners are not adopting the techniques required. Knowing an intervention can work is not the same as it actually working. Understanding why human beings do certain things is essential to implementing ophthalmic interventions and is, by its very nature, not an objective phenomenon. Whether objective truth exists or not is not the issue at this stage, but a recognition that qualitative data is subjective in its telling and subjective in its interpretation by a researcher is essential (Hammersley & Atkinson, 1995). So, if the subject in question is by its very nature a subjective experience or what we may call a phenomenon, then it is impossible to approach this research with our traditional epistemology, i.e. that subjectivity must be eliminated. Instead, it is necessary to look at qualitative methodologies. The subjective telling may correlate with objective truth, if this exists, but either way the positivist notion of observing an objective truth cannot be achieved in qualitative research since participants cannot "objectivise" what is subjective in nature, i.e. the phenomenon in question (Kiernan & Hill, 2018). The data itself therefore cannot be criticised for being subjective because it is by its very nature just that. However, the analysis and inferences drawn from this data can be scrutinised for the subjectivity of the researcher shading the voice of the participant.

Vision scientists coming from a realist ontology can feel uncomfortable with qualitative methodologies because the philosophy underpinning much qualitative research is not realist. Instead, qualitative methodologies often approach knowledge relativistically, suggesting reality is socially constructed and there is no objective truth (Green & Thorogood, 2018). While rejecting the existence of truth may be unfamiliar for many vision scientists, this does not make all qualitative methodologies unapplicable to them. Approaching research from a realist (truth exists) ontology, does not mean one cannot explore subjective phenomena. Instead, researchers need to use a methodology that recognises epistemologically that this objective reality is viewed only as experienced subjectively by participants. It is the research question that must determine the most appropriate methodology. If the research question seeks an explanation of human behaviour or understanding of human reasoning, a flexible epistemology should recognise the subjective nature of the question and select an appropriate qualitative approach. This pragmatic approach does not require a paradigm shift in the researcher's personal view on the nature of reality (ontology) but requires an acceptance of the subjective nature of certain data and an understanding of how to approach it.

Table 1: *Table of key terms with meanings.*

Term	Meaning
Paradigm	The overall description of a worldview that involves both ontology and epistemology
Phenomenon	A subjective experience that is the object of qualitative research
Ontology	Philosophy regarding the nature of reality, i.e. does objective truth exist?
Epistemology	Philosophy regarding how we can discover truth, i.e. can truth be measured objectively?
Realism	A research ontology in which objective truth exists
Positivism	A research epistemology in which objective truth exists and can be measured by removing subjectivity from the research process
Empiricism	Philosophical approach in which only that which can be measured through science can be regarded as truth
Constructivism	A family of paradigms in which objective truth does not exist and cannot be measured as the phenomenon is only constructed through subjective processes
Framework analysis method	A method for analysing qualitative data that is flexible regarding ontology and attempts to explore phenomena in a robust and transparent way

This scrutiny of subjectivity in the process of analysis relates to the validity of the research. Policy makers must have confidence in the findings of research especially when it can be difficult for some to trust the validity of qualitative findings. As Kiernan and Hill (2018) put it, "If qualitative evidence is to be regarded seriously… it must be at the very least rigorous, systematic, and proportionate in its claims." This can be achieved using a combination of methods including reflexivity of the researcher and by using a qualitative analysis method that provides accountability for each step of the process. The data will always remain the subjective account of the participant, but transparency in auditing to show how data was recovered demonstrates validity in a way more in tune with realist ontology, producing a matrix-style output similar to that found in quantitative research (Pope & Mays, 2009). The validity is therefore not measured against an objective truth but should be measured against the accuracy in recording and transparency of inferences made. Reflexivity also helps to give an account of how the research process has influenced and been influenced by the researcher in order to show that subjective judgements are open to inspection. What is needed is an analysis method that demonstrates accuracy, repeatability, accountability and transparency.

Popular qualitative analysis methods include thematic analysis (Braun & Clarke, 2006), and qualitative content analysis and framework analysis (Ritchie & Spencer, 1994). A criticism of thematic analysis is that there is sometimes little transparency in the method of obtaining themes from the data (Herzog et al., 2019). When this process is not described in detail, it calls into question the trustworthiness of this method (Nowell et al., 2017). Equally, qualitative content analysis can be criticised for

its reliance on intuitive actions of the researcher affecting its transparency (Elo et al., 2014). Framework analysis was developed for applied policy research to overcome some of these problematic areas, and it is therefore the transparency and potential repeatability of framework analysis that is attractive and aligns with traditional vision science perspectives. The ability to audit results based on the robust organisation of data and the production of a matrix-style output similar to that found in quantitative research makes it recommended for vision scientists (Pope & Mays, 2009) and potentially highly complementary when conducting mixed-methods research. Framework analysis is a suitable method for part time research because the analysis can, in fact, become more meaningful when over-immersion is not a factor (Smith et al., 2011; Ward et al., 2013). It is also largely pictorial, which may suit the personal data processing style of a researcher; it can be used both inductively and deductively, and is also relatively simple for novices (Gale et al., 2013; Smith & Firth, 2011; Srivastava & Thomson, 2009).

Framework analysis

Framework analysis, developed by Ritchie and Spencer in the 1980s (Ritchie & Spencer, 1994; 2002; Ritchie et al., 2013) is a qualitative analysis method from the same broad family as thematic analysis. Analysis methods from this family use themes as the output of the analysis. These are the broad concepts contained in the data and the meaning to participants of these concepts (Gale et al., 2013; Smith & Firth, 2011). Framework analysis also shares elements with grounded theory in that it uses a constantly comparative method, but unlike grounded theory does not seek to produce theory. Instead, it seeks to draw out explanatory conclusions from data centred around themes and has as its defining feature a matrix-style output where these themes are presented (Gale et al., 2013). It was first used in the context of Applied Policy Research for commissioned research projects with highly specific aims. This is important as it means this method was specifically developed for projects that begin with a focussed question. However, it has become popular in broader medical science research especially nursing and psychology, as it also allows for exploration of unexpected themes (Parkinson et al., 2016; Ritchie et al., 2013). The main benefit for researchers of framework analysis is the ability to explore phenomena in depth while creating a transparent audit trail, countering some of the arguments commonly made against other qualitative methods that they lack depth and transparency (Attride-Stirling, 2001; Smith & Firth, 2011; Ward et al., 2013). It also allows for rich description of a phenomenon whilst paying attention to the complex layers of meaning and understanding in the original context (Popay et al., 1998). Examples of healthcare studies using framework analysis include experiences of disease (Midgley et al., 2015), barriers to implementation of new health initiatives (Heath et al., 2012), and understanding of health promotion (Wood et al., 2010). It can be used for a variety of data including interviews, focus groups, and observational data (Goldsmith, 2021).

In order to provide this transparency in analysis, framework analysis utilises a robust method of cyclical analysis that can be followed step by step. This allows for the comprehensive interpretation of data whilst providing a process for analysis where the results can be traced back to the original data and are repeatable by another researcher. The process is similar to qualitative content analysis (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004) in that it centres around themes or categories being lifted from the data and develops these into main themes and subthemes. It differs from other types of qualitative analysis in that it does not use codes or labels to do this, but synthesises material through summarising data and attempts to retain strong links to the original material. There are five steps involved in framework analysis as described by Ritchie et al. (2013), which are familiarisation, identifying a thematic framework, indexing, charting, and mapping and interpretation. Framework analysis in the context of vision science has been limited (Al-Attas et al., 2010; Lacey & Luff, 2009), but it was adopted recently as part of a mixed methods approach (Macfarlane et al., 2022). None of these studies detailed their experiences of conducting framework analysis in the context of vision science, although a number of other studies in the wider context of health research have (Gale et al., 2013; Parkinson et al., 2016; Smith & Firth, 2011; Ward et al., 2013). They have used varying nomenclature to describe the steps involved and the thematic output, but a summary of the steps and a suggested nomenclature are outlined here, along with practical examples of its use in a recent vision science study.

Steps in Framework Analysis with Worked Example from Vision Research

As indicated, framework analysis involves five steps: familiarisation, identifying a framework, indexing, charting, and mapping and interpretation. These steps can be easily followed in the context of the research process (see Figure 1). To assist vision researchers interested in the method, a detailed worked example will be described from a study undertaken in 2021 to address the problem of the lack of human resources for eye health in rural areas (unpublished data). The study involved a comparison between two countries with similar structures of eye care that both have issues in recruiting and retaining mid-level eye care workers. The World Health Organisation recommended that improving recruitment/retention and task-shifting were two ways to do this, but it was unknown what effect task-shifting and recruitment/retention may have on each other. To explore these phenomena in more detail, a qualitative study was conducted that used semi-structured interviews with 20 participants (10 in Scotland, 10 in Ghana) to explore experiences and perceptions of task-shifting and rural eye care working. Framework analysis was used on the transcripts of the interviews and examples of the process is detailed here.

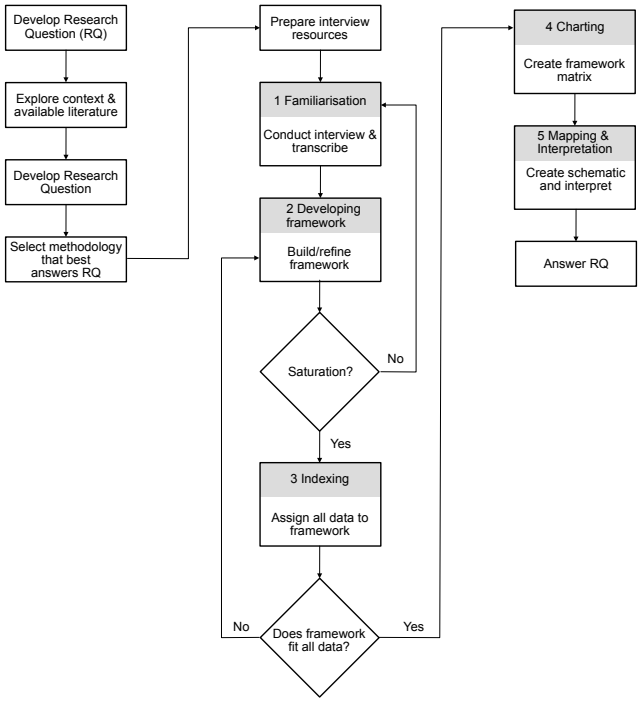

Figure 1: *Flowchart showing research process using Framework Analysis as the analysis method.*

Step 1: Familiarisation

Familiarisation involves immersing oneself in data in a similar way to other qualitative approaches with the purpose of getting an overall holistic sense of the phenomenon, i.e. what topics are the participants talking about? (Parkinson et al., 2016). Examples of how practically this can be done include conducting the interviews personally, the researcher typing their own transcriptions, re-listening to the interviews during transcription and reading and re-reading the transcripts (Silverman, 2006). It is also useful at this stage to note down initial thoughts and impressions as a way to develop the initial themes used in the next step (Parkinson et al., 2016). Gale et al. (2013) recommend the use of a tree diagram at this stage to cluster these initial ideas into initial themes in an attempt to begin the process of abstraction of the data.

In the eye care study, despite the large amount of data collected and the availability of automated transcription software, all transcripts were transcribed personally by the researcher. This fulfilled the purpose of changing the data from audio to text for analysis but also provided the researcher with the familiarity with all participants and the general tone of their experiences. It was possible to write notes on transcription and to provisionally highlight important passages in the text as the research question was kept in mind through the transcribing process. This was done by keeping an "analysis diary" where interesting points or questions were noted down for consideration at a later stage in analysis. Silverman (2006) describes transcription of data as an integral part of the research process as it aids familiarisation. Transcription by hand is therefore recommended as it aids the deep familiarity with the data required in framework analysis.

Step 2: Identifying a Framework

Identifying a framework is the second step in framework analysis. The purpose of this step is to develop a framework to organise or rearrange the data in a more useful and meaningful way (Gale et al., 2013; Parkinson et al., 2016). At this stage, interpretation of the data can be tempting, but the data should first be organised and rearranged. Instead of having the data structured by participant (e.g. a transcript containing all of participant 1's data) the goal is to have the data restructured by theme or topic. To do this, some initial, flexible themes must be decided upon, which is called the framework. Since framework analysis was developed specifically for research from organisations that came with a priori issues, for example a specific work-based problem, initial themes can be gained from these pre-determined issues (Srivastava & Thomson, 2009) but can also come from the results of a literature review or from the initial notes taken in step one. The idea at this stage is not to interpret the data but to manage it (Parkinson et al., 2016). A good way of developing the initial themes at this stage is to read transcripts and ask oneself, "what subject is the participant talking about here?". Since the data is not being interpreted yet, the themes are likely to change and therefore should be broad but robust. This can be done by beginning with flexible themes, testing them on transcripts, reviewing other transcripts in the light of emergent issues and reviewing again (Smith & Firth, 2011). If framework analysis is conducted as a team, it is important at this stage that regular team discussions are held so that flexible themes are agreed upon and the team embarks on the subsequent steps with a mutual understanding (Parkinson et al., 2016). Refining initial themes is critical whilst continuing to be grounded in the original data in order to demonstrate how the raw data is translated into themes (Smith & Firth, 2011; Srivastava & Thomson, 2009). This leaves the researcher with an initial thematic framework with the idea that this can now be applied to the data in the next stage.

In the example eye care study, the familiarity gained in the first step allowed this initial framework to be developed. It consisted of numerous initial, flexible themes decided upon by asking the question: "what were the participants talking about?" during the first phase of familiarisation by transcription and re-reading. These were initially jotted down freehand, not in any order:

- contentment with scope of practice
- incentives
- salary
- impact of scope of practice on business
- financial security
- family commitments
- easier to find work in rural area
- out-of-pocket payments

The names of the initial topics were refined and improved and then organised under broader themes (see Table 2). For example, it was realised that when participants were talking about their experiences of out-of-pocket expenses, their salary, and their feelings on financial security, that these could all be broadly categorised as "finances". In this way, an initial, broad and basic framework was established. At this stage it was important that the themes be broad enough to incorporate as much of the topics as possible but streamlined enough to not make the initial framework overwhelming to work with. As more data was analysed, more themes and sub-themes were added until there was an initial matrix, in this case consisting of ten key themes, each with their own sub-themes.

Table 2: *Table showing extract from initial framework showing refining of topics into themes and sub-themes.*

Sub-themes	Key Themes
Salary	Finances
Remuneration from NHS (GOS fee)	
Out-of-pocket expenses	
Financial security	
Financial incentives	
Impact of SOP on stress	Scope of practice
SOP benefit to patients	
SOP impact on optics as a business	
SOP difficult to increase	
Enjoyment found in wider role	
Contentment with SOP	
Professional isolation	Isolation
Achieving CPD	
Logistic difficulties of isolation	
Personal isolation	

Step 3: Indexing

Once the framework of key themes with their own sub-themes has been created, indexing is the third stage in framework analysis and involves applying the framework developed in step 2 to the data in a systematic way (Gale et al., 2013). This is done by using a method called "indexing" where each initial theme is given a number and each transcript is read again. Each section of data (this may be anything from a phrase to a whole paragraph) is given a number based on which theme the participant is talking about. Again, at this stage there is no interpretation, the data is just being organised by theme. Occasionally some excerpts may be assigned two themes as they reflect on more than one issue, and it useful to have an "other" theme as recommended by Parkinson et al. (2016) in order to remain respon-

sive to any data that was important but did not fit well with any of the initial themes. At this stage it is important to remain responsive to the data and refine the themes as the process is cycled back and forward. Themes can become merged or separated based on re-reading of the transcripts and new themes developed as understanding of the phenomenon deepens. At this stage, conducting framework analysis in a team is advantageous as discussion about where "difficult" themes should fit can improve accuracy (Parkinson et al., 2016).

In the eye care study, once the initial framework, consisting of themes with their own sub-themes was decided upon, indexing the data involved re-reading the transcripts and applying the framework to the data. This was done using NVivo software (version 1.5, QSR International Ltd, Denver, USA), but could also have been done by hand. In NVivo, colours can be assigned to each theme and sub-theme and text highlighted so that each piece of text can be linked to a sub-theme. The length of texts ranged from as short as a few words to as long as a paragraph. At this stage it was important that the themes were refined again and again as more transcripts were indexed, as it was vital to remain responsive to the data, i.e. open to new ideas emerging or paring down older ideas. For example, this meant that if a new passage was read that did not fit in with a current sub-theme, then a new one was added. During this stage themes were added, themes were combined, and themes were renamed. For example, "relationship with ophthalmologists" and "relationship with eye hospital" were originally two separate themes, but it became apparent the participants used these interchangeably as they viewed the hospital eye departments and the ophthalmologists in them as the same entity. The sub-theme "moving home" was renamed "home and rural upbringing." It was originally called "moving home" because many participants described the sense of "home" as a motivating factor in moving to a rural area. However other participants were found later whose home was in an urban area but who spent some formative years in a rural location. It was decided that both types of participants were describing the same phenomenon and the name of the sub-theme should be refined to accommodate both experiences. This study sought experiences from optometrists in two different cultures: Scotland and Ghana. Some themes applied only to one context, e.g. out-of-pocket expenses for consumables were a peculiarly Ghanaian theme. However, other themes that appeared context-specific were actually combined upon reflection. Ghanaian participants spoke about unreliable electricity and lack of accommodation as key problems with rural life. Scottish optometrists described difficulties with parcel delivery and long commutes. Although these problems were context-specific, they all described difficulties with rural life and were combined under the theme "rural living."

Step 4: Charting

Charting is the fourth step in framework analysis and is about organising the data in a more manageable chart format to aid the final step of the analysis, which involves interpretation. After each fragment of transcript has been assigned a colour or number, they are now grouped together according to theme rather than by participant. Computer software such as NVivo can do this easily, or it can be done physically by cutting out each excerpt and rearranging. Even though the software is able to group all the fragments together under each theme, this still involves displaying a large amount of data, as one excerpt may be as long as an entire paragraph. To assist the manageability, the original excerpts are instead summarised and placed into a chart so all the data can be looked at in one go in a more manageable way (Gale et al., 2013). Although summarising can mean the complexities of the participants' descriptions can become faded in this stage, the summarised data is always linked back to the original transcript, so original data will not be lost and can be easily accessed (Srivastava & Thomson, 2009). Where possible, it is best to summarise the data by a verbatim excerpt known as an in-vivo code that enhances the proximity of the analysis to the raw data (Smith & Firth, 2011). The end product then is the characteristic framework analysis chart or matrix where participants' pseudonyms are located in the left column and the themes are arranged across the top (see Table 3). This allows an observer to read down the chart to see each participant's contribution to a single theme or read across the chart to see a single participants' contribution to each individual theme (Gale et al., 2013). For example, in the eye care study, the chart can be read downwards to see what each participant said about "family and friends" or the chart can be read across the way to see "Coffie's" contribution to each theme.

Step 5: Mapping and Interpretation

Mapping and interpretation is the final stage in framework analysis. This stage moves beyond data management and finally into an attempt to understand and interpret the data. The matrix produced in the previous step provides the opportunity for the researcher to see patterns in the data in a simplified, more visual way, and enables interpretation of the "whole" from identifying the key characteristics in the matrix. Interpretation can be approached from a variety of phenomenological standpoints including hermeneutic phenomenology. Smith and Firth (2011) recommend starting by referring back to the original data to reduce the chance of misinterpretation. Srivastava and Thomson (2009) recommend at this stage that a schematic diagram of the phenomenon should be produced. The themes are now clarified and given descriptions. The "final themes" at this stage are the "interpretive concepts or propositions" that attempt to explain the data (Gale et al., 2013). The opportunity is also present at this point to create typologies, develop over-arching themes, establish relationships between themes, predict behaviours, and propose strategies for intervention or practice (Gale et al., 2013; Ritchie & Spencer, 2002).

In the eye care study, the matrix that was produced in the "charting" stage was scrutinised for mapping. This involved searching for patterns in the themes, relationships between themes and the characteristics of the participants who related different themes. For example, all Ghanaian participants described experiences of lacking technology in terms of basic equipment, whereas Scottish optometrists described the lack of network connection and software as more significant. Both Ghanaian and Scottish optometrists found that the isolation of rural life made continuous professional development more challenging. The importance of family in decision-making was discussed by both male and female participants but it was only female participants who described experiences of moving job because their spouse had found work elsewhere. At this stage, the aims and objectives were reviewed in light of the data in order to stay grounded in the purpose of the study. Various maps or schematics were considered by drawing them on a whiteboard in order to obtain the best visual representation of the most amount of data possible. It was decided that a "field" of themes was the best approach, with the location of the theme within the square corresponding to whether the theme applied to Ghana, Scotland or both, and whether the theme was highly motivating, highly demotivating, or neither. The schematic produced (see Figure 2) helps the viewer see at a glance the relative importance and impact of sub-themes and serves as a grounding connection between the aims of the study and the experiences of participants.

Interpretation involves interpreting the meaning behind the patterns in the data and interpreting the deeper meaning participants attached to themes in a wider sense. The first area of

Table 3: *Extract from framework matrix showing data organised by participant and by theme.*

	Theme	Collaboration and Teamwork			Family & Relationships	
	Sub-theme	Relationship with HES	Relationship to management	Inter-professional relationships	Family and Friends	Relationship issues
Participants (pseudonym)	Abina	Come to be "accepted" by other eye professionals	Management must provide the necessary working conditions — instruments and a good team — for motivation		"Moving to a rural areas would prevent "development" of family members. Proximity to family is a motivating factor"	"one of my fears in the rural area... am I able to meet a suitor?"
	Coffie	"That relationship is there. So, it makes the work much more easier"		Makes work easier. Mutual respect is important.	Being away from family life is difficult: "sometimes you miss your family. You really miss them"	
	Adjo	"once you are paired with an ophthalmic nurse or an ophthalmologist you are virtually limited in your scope of practice" "lack of recognition" exists		Motivated to stay by good interprofessional relationships at place of work	Being happy with location means having friends and family there. A better life for family is a motivating factor	"I met my wife at the hospital... So that's one advantage of working in a rural area!"

interpretation was given over to the a priori, or pre-determined issues arising from the literature review. For example, views on participants' scope of practice. If a funding body or a research aim demands the answer to a specific question, then this can first be addressed. In this study it was possible to see from the matrix and schematic that participants were content with their scope of practice. The important element of the interpretation phase is asking what does this really mean to participants in a deeper sense? Participants were content with their scope of practice because they felt it allowed them to fulfil their main motivational driver which was patient care. Without an increased scope of practice, participants felt a deeper ambiguity towards their existential purpose and felt the dissonance between being acutely aware of the needs of rural populations and not being able to solve many of the problems. A wide scope of practice on the other hand improved this dissonance and allowed optometrists to work towards solving the problem they identified.

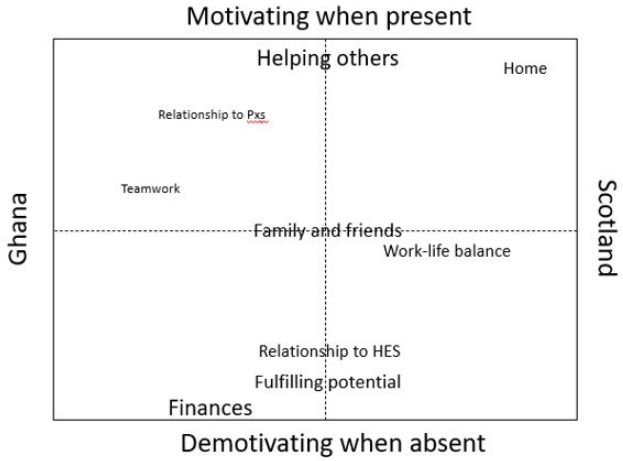

Figure 2: *Example schematic attempting to display relationship between sub-themes, location and motivational category.*

Themes that were not a priori issues and that were discovered "organically" from the data are arguably a more important source of interpretation and discussion as they necessarily demonstrate the presence of themes in the originally data. Participants were not asked specifically about altruism or family relationships in interviews, but it became a recurring topic amongst the majority of participants in both countries. This gives weight to what was an unexpected theme and allows for consideration of this in the discussion. Unexpected answers to standard questions is another way to highlight important findings. Participants were asked indirectly about remuneration in all interviews and it was surprising that the vast majority of participants did not rank remuneration highly in their motivation in their profession. The discussion is therefore based on consideration of the interpretation phase of framework analysis.

Limitations of framework analysis

In qualitative research, there are a number of methods and approaches that can be taken for the analysis of data including thematic analysis, qualitative content analysis, and grounded theory (Green & Thorogood, 2018). Each method comes with its own set of strengths and weaknesses, and framework analysis is no different in this regard. As with any method and despite the many apparent benefits of framework analysis, there are limitations. It could be argued that framework analysis is more time consuming than other types of qualitative analysis as it involves more stages. The early stages can also be difficult for novice researchers when it is tempting to interpret from the beginning. Resisting the temptation to interpret and to solely organise data in the early stages reaps rewards of logical and accurate interpretation in the later stages. There is also a lack of theoretical underpinning that marks other approaches, like grounded theory or ethnography (Smith et al., 2011). However, these aspects must be weighed against the benefits of framework analysis, namely that it provides a novel depth of (subjective) data, which can add value by complementing quantitative data and by presenting patients' or practitioners' perspectives. From the authors' perspective, qualitative research approaches can provide meaningful and informative data in vision sciences, provided careful consideration is given to the analytical techniques employed.

Conclusions

Scientists should not ignore qualitative research, as qualitative methodologies can help to answer questions that are not adequately addressed by quantitative research approaches alone, and allow for in-depth exploration of issues that are by their very nature subjective and that are important to patients, clinicians, research funders, and policy makers (Green & Thorogood, 2018). Before conducting qualitative analysis, careful consideration of ontology and epistemology should be made, especially for vision scientists coming from a realist and positivist tradition. Having a realist ontology does not mean one cannot conduct qualitative research, as even though the data collected will be subjective in its telling and subjective in its interpretation, it

can still be considered as a subjective representation of an objective truth. However, careful consideration of epistemology and the nature of subjective data should be given. It is not possible to eliminate subjectivity from qualitative data and therefore a positivist epistemology cannot be appropriate. Reliability can be demonstrated in other ways, including the use of a robust and repeatable method of analysis. Framework analysis is therefore proposed as a method which is suitable for scientists with a traditionally realist and positivist viewpoint as it is transparent, repeatable and helps fulfils the criteria of good quality qualitative research.

Conducting framework analysis involves five steps. The first four involve organisation of the data with the final step involving interpretation. Researchers must bear in mind that although framework analysis concentrates a great deal of time to data organisation, the ultimate aim of analysis is the important final step of interpretation of the phenomenon. Although time-intensive, framework analysis is robust, flexible and provides for investigation of a priori and unexpected topics. The use of qualitative software can significantly simplify the process of indexing and charting. The example given demonstrates how to conduct each step using real data from the field of vision science. Using this step-by-step approach, vision scientists can conduct framework analysis which will add to their catalogue of evidence and leave a transparent audit trail of how the final output was achieved from the raw data.

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Rammeverksanalyse for synsforskere: en enkel steg-for-steg metode

Sammendrag

Synsvitenskap har tradisjonelt vært en kvantitativ disiplin. For å fange alle aspekter av klinisk synshelsetjeneste fullt ut, må forskere imidlertid i økende grad være kjent med både kvantitative og kvalitative metoder. Dette har resultert i at kvalitative metoder har blitt mer vanlig i synsvitenskapelig forskningslitteratur. Fra forfatterne av denne studiens perspektiv sliter synsforskere ofte med å identifisere egnede kvalitative metoder når de kommer fra en tradisjon med en realistisk ontologi, eller oppfattelsen om at det finnes en uavhengig sannhet. Denne studien utforsker de ontologiske og epistemologiske betraktninger når man nærmer seg kvalitativ forskning innen synsvitenskap, og foreslår rammverksanalyse som en kvalitativ metodikk tilgjengelig for synsforskere. Rammeverksanalyse er en fleksibel og nyttig kvalitativ analysemetode som utfyller kvantitative metoder. Denne artikkelen presenterer også en trinnvis veiledning for å utføre rammeverksanalyse på en logisk, transparent og repeterbar måte som vil gi en tydelig endringslogg for hvordan resultater oppnås fra subjektive data. Dette gjøres ved å bruke et bearbeidet eksempel fra en fersk øyehelse studie.

Nøkkelord: Kvalitativ, rammeverksanalyse, metodologi, synsvitenskap

Strutta dell'analisi per scienziati della visione: una chiara guida passo dopo passo.

Riassunto

La scienze della visione ha tradizionalmente un approccio alla disciplina di tipo quantitativo. Ciononostante, per comprendere pienamente tutti gli aspetti della cura della visione dal punto di vista clinico, i ricercatori devono incrementare anche il lato quantitativo come quello qualitativo nei metodi. Questo e' risultato per i metodi qualitativi in divenire piu' comuni all'interno della letteratura scientifica della scienze della visione. Dal punto di vista degli autori, i ricercatori nel campo delle scienze della visione spesso fanno fatica ad inviduare le metodologie qualitative quando si sono sempre basati su una tradizionale ontologia realista, o sulla visione che la verita' indipendente esiste. Questa ricerca esplora che le considerazioni ontologiche ed epistemiologiche quando si approcciano alla ricerca qualitativa nelle scienze della visione e propongono una struttura di analisi come metodologia qualitativa accessibile agli scienziati della visione. L'analisi strutturale e' flessibile e i metodi qualitativi di analisi altamente utilitaristici per condurre un approccio strutturale sono logici, trasparenti, e ripetibili in modo da garantire una traccia chiara di come i risultati sono ottenuti da dati soggettivi. Questo e' stato fatto considerando un esampio ottenuto da un recente studio di salute dell'occhio.

Parole chiave: Qualitative, analisi strutturale, metodologia, scienza della visione