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Imágenes

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- Suele plantear algunos problemas… pero se puede:
  - Hay que llevar cuidado con los formatos que se usa
  - Hay que llevar cuidado con el formato de salida (PDF o PS)

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\usepackage{graphicx}
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```latex
% Para generar el documento final tanto con latex como pdflatex
\usepackage{ifpdf}

% Permite incluir imágenes de ficheros externos
\ifpdf
 \usepackage[pdftex]{graphicx}
\else
 \usepackage[dvips]{graphicx}
\fi
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% Extension de los ficheros de las figuras
\ifpdf
 \DeclareGraphicsExtensions{.pdf,.jpg,.png}
 \graphicspath{{./figuras/png/}}
\else
 \DeclareGraphicsExtensions{.eps,.ps,.jpg,.png}
 \graphicspath{{./figuras/png/}}
\fi
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```latex
% Uso
Como podemos ver en la figura~\ref{fig:ejemplo},

\begin{figure}
\includegraphics[width=0.7\textwidth]{imagen}
\caption{Mi imagen}
\label{fig:ejemplo}
\end{figure}
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\renewcommand{\figurename}{Imagen}

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- \begin{figure}[pos]

- h: here
- t: top
- b: bottom
- p: page
- !: forzar

- ¿Dónde se sitúan normalmente las imágenes en un libro correctamente diseñado?

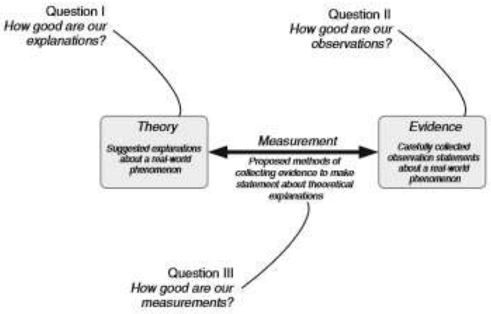

Fig. 2.1 The body of knowledge

is useful and easy to use. In Chap. 3 below, we will return to the question of how we arrive at better theories in more detail.

2. **We can improve our collections of scientific evidence**. For example, we may be able to collect data about a phenomenon where no observations existed to date. A prime example is the famous voyage of Darwin on the Beagle, where he encountered and systematically described many previously unknown species of plants and animals. This evidence in turn allowed him and other scholars to refine their theories about plants and animals. In fact, it laid the groundwork for a whole new theory, the theory of evolution. Arriving at this theory was only possible because firstly systematic statements about observable facts were created through careful exploration and observation. We return to methods of observation later in this book (in Chap. 5).
3. **We can better our methods for collecting observations in relation to theory**. Again, let me give you an example from the history of science. One of the most important contributions Galileo Galilei made was through the improvements he invented for telescopes, which initially were invented by Hans Lippershey. Galileo made a telescope with about 3× magnification and later made improved versions with up to about 30× magnification.

   Through a Galilean telescope the observer could see magnified, upright images of the earth or the sky, a greatly improved measurement compared to previous instruments, which largely relied on the naked eye. It was only through these refined instruments that Galileo noted how the positions of some "stars" relative to Jupiter were changing in a way that would have been inexplicable if they had been fixed stars (the current theory at the time). For one thing, he discovered that the "fixed stars" at some points in time were hidden behind Jupiter.

   The improved measurements of the satellites of Jupiter created a revolution in astronomy that reverberates to this day: a planet with smaller planets orbiting it did not conform to the principles of Aristotelian Cosmology – the then prevalent astronomical theory, which held that all heavenly bodies should circle the Earth.[3] Still, we know now that Galileo was right and that this breakthrough was possible because he initially did not refine the theory or the observations but instead improved our ability to measure relevant phenomena.[4]

The above examples are meant to illustrate the manifold ways in which scientific progress can be achieved. Yet, it does not answer the question of how recognisable progress can be achieved. To that end, we need to look at the process of scientific inquiry and the postulates of the scientific method.

2.2 The Scientific Method

In Chap. 1, we ascertained that in doctoral research we are asked to learn and execute studies that comply with two key principles of scientific research, namely, the research work contributes to a body of knowledge and the research work conforms to the scientific method.

We then illustrated several ways in which one can contribute to the body of knowledge through the scientific output created. Let us now turn to the notion of the scientific method. The scientific method describes a body of techniques and principles for investigating real-world phenomena with the view to adding to the body of knowledge.

Above we argued ambiguity in the connotation of the term "research" and that a doctoral program is about one type of research only, the class of scientific research. For research to be called scientific, the scientific method postulates that the inquiry must be based on gathering empirical and measurable evidence subject to specific principles of reasoning.

Although research procedures vary from one field of inquiry to another, the scientific method provides us with some common features that distinguish scientific inquiry from other methods of obtaining knowledge. Most notably, scientific inquiry is generally intended to be *as objective as possible*, to reduce biased

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[3] We should note here that Galileo initially endured significant resistance against his findings, because his measurement was not trusted as a scientific instrument. It took decades of *replication* (another scientific principle), until his findings were confirmed to the extent that they were trusted as valid observational evidence.

[4] Refining measurements is still very much prevalent to date. To note just one example: the improvements in neuroscientific measurement methods such as fMRI scanners provide much more precise measurement of brain activities than any other measurement instrument used in cognitive psychology to date.

the ability to interpret complex material in a sense-making process, a procedure that, by its very nature, is not independently repeatable as it is subject to the individual performing the inquiry.[5]

2.3 Essential Concepts in Information Systems Research

One of the most frequently occurring problems that I encounter with doctoral students is that, simply put, our conversations are hampered by us using "standard" research concepts and terms in different denotations. In a way, the problem is not so much that the theoretical construct, operationalisations, measurements, and observations we are discussing are not precise enough; rather that our definitions of terms such as construct, concept, variable, etc. differ.

To resolve this problem, let us have a close look at the way that I define some essential concepts for usage in this book. I have tried to relate them in Fig. 2.2.

First, we need to define the term *concept*. A concept describes an abstract or general idea inferred or derived from specific instances that we perceive in the real world. Concepts are thus mental representations that we develop, typically based on experience. Concepts can be of real phenomena (dogs, clouds, pain) as well as of some latent phenomena that we can agree upon (truth, beauty, prejudice, usefulness, value, and so forth).

We use concepts as a language mechanism all the time to describe general properties or characteristics that we ascribe to certain things or phenomena. For example, we use the concept of weight to describe the force of gravity on objects. Weight is a general property that applies to all tangible things in the real world. But we can also use the same concept, weight, to illustrate the psychological state of someone experiencing stress, tension, and anxiety as we do when we refer to the "weight on their shoulders". We sometimes also develop new concepts to describe a new or newly discovered property. Emotional intelligence, for example, is a concept that purports to describe our self-perceived ability to identify, assess, and control the emotions of oneself, of others, and of groups. This concept has gained some prominence in a debate regarding whether it is a personality trait or form of intelligence not accounted for in currently prevalent theories of intelligence or personality (which, by the way, are also concepts).

As abstract units of meaning, concepts play a key role in the development and testing of scientific theories. They give us a vocabulary to reason about some real-world phenomena (or the linkage between real world phenomena, as shown in Fig. 2.2) and a means to ascribe characteristics or properties to those phenomena and their relationships. Concepts can be linked to one another via propositions – suggested tentative or conjectured relationships between two or more concepts

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[5] Note again that these statements do not qualify these research inquiries but are merely used to distinguish different strands of research.

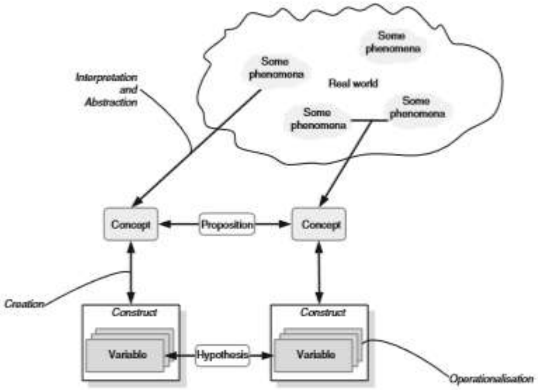

Fig. 2.2 Essential concepts in the research process

that are stated in a declarative manner, more intelligence leads to better decisions, for example.

Note the key words *suggestion*, *tentativeness*, and *conjecture* that I apply to the notion of a proposition. These terms characterise the fact that propositions are proposals for an explanation about how phenomena are related. Whether or not the propositions hold true is an entirely different question and typically, an empirical one that we need to answer carefully through dedicated research methods.

The problem with concepts is that many of the *phenomena* we are interested in such as satisfaction, empathy, intelligence, anxiety, skill, and so forth, are fuzzy and imprecise. This is mostly because most phenomena of interest are not directly observable, and instead rather abstract and difficult to capture, define, or visualise. It is also because in the social sciences we often are concerned with understanding behaviours, processes, and experiences as they relate to "information technology in use".

For example, take the simple proposition "education increases income". The concepts of education and income are, by definition, abstract and could have many meanings. Conclusively, there are many, potentially unlimited ways in which such a proposition could be tested – and in turn, many different results could be obtained. Therefore, a proposition (also called a conceptual hypothesis) cannot be tested. They need to be converted into an operational hypothesis.

As per Fig. 2.2 above, we note that hypotheses are suggested linkages between constructs. *Constructs* are operationalised concepts, where we attempt to take the

- All men are mortal
- Socrates is a man
- Therefore, Socrates is mortal

Similarly to induction, deduction has potential drawbacks. The most obvious challenges in deduction are related to deductive soundness and validity. Consider this deduction:

- Everyone who eats steak is a quarterback.
- John eats steak.
- Therefore, John is a quarterback.

We can see here that the deductive reasoning as it is applied is logically sound (the conclusion about John being a quarterback), however we don't actually know whether the final statement is valid. The reason for this is that the premise "Everyone who eats steak is a quarterback" may or may not actually be true. In other words, we can deductively reason in good faith but still end up with incorrect conclusions.

Each of the principles *observation*, *induction* or *deduction* that we use to reason about phenomena, facts, or assumptions in our effort to generate new knowledge, will be insufficient in itself. Observations are useful to developing an understanding of a domain or a phenomenon but are not sufficient for explaining or reasoning regarding phenomena. Induction is useful for theorising from observations and other singular facts and evidence, but insufficient for demonstrating the validity of any emergent theory. Deduction in itself can be used to test theories using some or many individual cases but it must rely upon the formulation of a robust set of premises to begin with.

Sound research design, therefore, should strive to employ *combinations* of observation, induction, and deduction. That way we can achieve a meaningful mix of **exploration** – where we build an understanding of the phenomena that interests us, **rationalisation** – where we begin to make sense of the puzzle or problem that interests us, and **validation** – where we appropriately subject our emergent or developed theory to rigorous examination.

One aspect worth highlighting regarding exploration, rationalisation, and validation is that they are not necessarily related in a linear or temporal manner. Instead, good research typically moves back and forth between them, as shown in Fig. 3.1.

Exploration of a phenomenon of interest can provide the basis by which we can begin to rationalise the phenomenon. For instance, based on observations we can rationalise a solution to a problem, or explain a specific behaviour. The rationalisation process, in turn, might create the demand for further exploration (as shown by the arrow moving from rationalisation back to exploration). We may find that in order to explain a particular behaviour, we need to collect further observations about other behaviours that we didn't deem relevant in our initial exploration. We can also interpret the interplay between rationalisation and exploration as providing the set of initial evidence against which we can test the outcomes of our rationalisation process or evaluate the set of tentative propositions between constructs that capture the phenomena. The rationalisation should be valid in light of any observations that were collected.

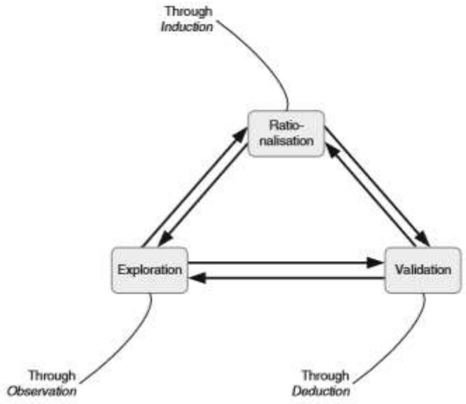

Fig. 3.1 Exploration, rationalisation and validation in research design

Once a rationalisation has been achieved, in which tentative general propositions are created through inductive reasoning from observations, we can proceed to validation, where we deductively derive testable hypotheses from our general theory. These can be subjected to further empirical tests using specific new or existing cases. In light of the results or evidence collected, we may need to revise our rationalisation (moving from validation back to rationalisation). The validation also employs as a basis the findings from the exploration. This can be done by defining the sample frame, target population, or other contextual parameters that emerged as important through initial observations, (thus, moving from exploration to validation). Likewise, the results might prompt further exploration of the phenomenon (moving back from validation to exploration). For instance, observations can be collected that can be used to refine specific results, such as those that are on the surface contradictory to the developed theory.

3.2.2 *Selecting a Research Design*

The discussion above provides common ground to all types of research designs; in the sense that good research design typically includes work that combines

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% Modifica el nombre de la lista de figuras
\renewcommand{\listfigurename}{Índice de figuras}
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