Methods of concept analysis – tools for systematic concept analysis

Part 3 of 3

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Abstract

This article is the third one in a series of three articles which focus on development of concept analysis methods as an academic research method. In the first article, terminological analysis methods were contrasted with selected concept analysis methods developed in business studies and nursing science. The second article discussed a further development of *systematic concept analysis*, and outlined steps that can be taken when analyzing concepts for various purposes. This third article describes tools that could be utilized in various phases of concept analysis as well as in other phases of research. With the help of these tools the researcher can bring order in concepts, concept systems and terminology as well as in content and knowledge structures of the study all the way from the design of the study to the presentation of the results. The tools introduced here consist of a mind-map-like graphical presentation called "satellite model", and eight models that can be utilized to structure the satellite model presentation: basic, structural, origination, developmental, activity, transmission, causation, and dependency models.

1 Introduction

Analysing and clarifying concepts and their relation to each other is an integral part of any scholarly research process. In some cases, the analysis is very restricted and performed in the background at certain phases, while in other cases it may cover larger areas or even the whole research process. In the previous paper (Nuopponen 2010b), a systematic concept analysis method was presented as a method for this work. Figure 1 shows the steps of the analysis method presented. Systematic concept analysis may either be the only research method utilized or function as an auxiliary method in all phases of the research process.

This third article concentrates on some of the tools which can facilitate concept analysis at the various stages of a research process, especially at steps 2-5 in Figure 1. The tools were originally devised with terminology work in mind. In addition to concept analysis, they can be applied for other purposes. During a research process it is not only established concepts, but

also various kind of facts, information and knowledge that need to be analysed, compared, systematized and organized (see e.g. Pilke 2010; Nuopponen 2005b).

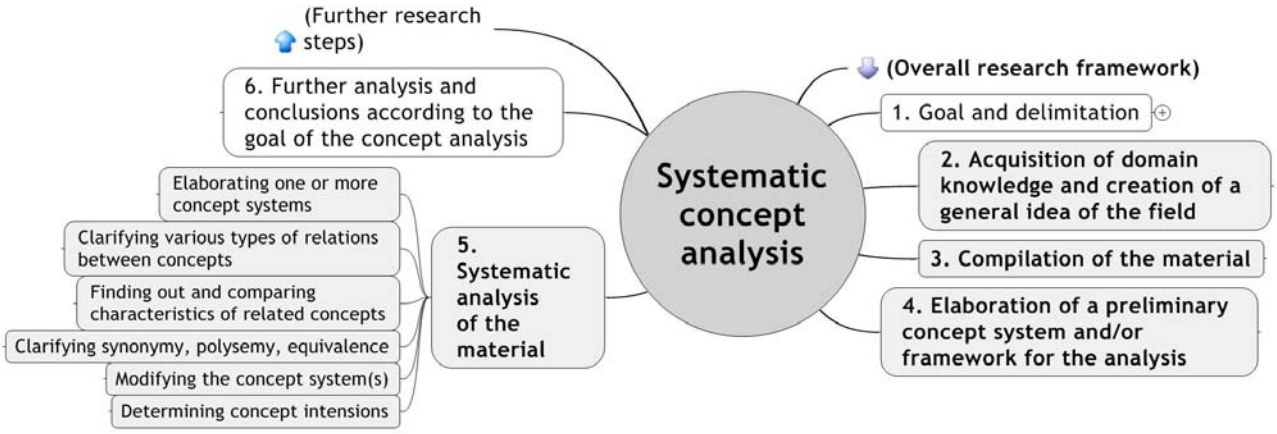

Figure 1. Systematic concept analysis (Nuopponen 2010b)

The tools to be presented in the following are a **satellite model** - a graphical mind map-like knowledge and concept presentation - and **concept relation models**: a basic model and structural, origination, development, activity, transmission, causation, and dependency models. This set of tools is based on the idea of building one or more concept maps or concept systems of the field starting from the preliminary compilation of knowledge (~ phases 1-3 in Figure 1) and structuring of the field (~ phases 3-4). For each separate map, a concept is selected as the point of departure in order to achieve a preliminary overall picture of concepts and concept systems of the target field. The branches are then scrutinized separately with the help of the models - and with separate satellite models if needed (phase 5). While doing this, the tasks listed in phase 5 are carried out. As a synthesis, a new version of the whole concept system (or ontology) is compiled (phase 6). The results can be utilised in further stages of a research process.

2 Satellite model - a graphical presentation tool for concept analysis

Satellite model is a mind map-like graphical presentation, which was created with the systematic terminological concept analysis in mind (Nuopponen 1994; 1997). It is more flexible than the traditional tree diagrams presented in terminological literature (e.g. ISO 1087); new nodes can be easily added when drawing by hand or when using a mind mapping software. Actually, it is as hierarchical as the conventional tree diagram: the branches are spread around the uppermost concept (here: core concept) instead of being placed under it, allowing thus more space for the branches. The use of this type of graphical representation solves also the need to establish and to learn a different type of representation for each type of concept relation (Nuopponen 1997). This type of graphical representation is dynamic and can be expanded, modified and specified during all the analysis process. The satellite model approach takes one concept in focus at time as is done in the figures 1-8, but each of the nodes may get its own satellite nodes around it. It can even serve as a core concept in its own satellite model. A core concept may be a concept on a higher abstraction level or a concept that otherwise is central to the field in question and is able to link together the selected concepts. Depending on the concept analysis needs at hand, it may refer e.g. to a discipline or another area of expertise, or a part of these (e.g. *linguistics, lexicology, legal system,* etc.);

activity, action, process, procedure (e.g. *word formation, term extraction, legislation*); or material or immaterial object, state (e.g. *language, morpheme, legislature* etc.).

In order to keep the presentation illustrative and clear, it is recommended to utilize the satellite nodes as meta-concepts such as *parts*, *types*, *functions*, *instruments*, or include more precise expressions for the concept relations (e.g. "generic relation", "partitive relation", or "temporal relation") in the nodes. These auxiliary nodes can be left out, e.g. in cases when the type of the relation is either obvious or difficult to define. The following sections deal with different types of meta-concepts and concept relations, which will offer alternative possibilities for starting an analysis. One of the models can be taken as the initial model; e.g. if the core concept is an activity concept, the most important meta-concepts will be *actor, object, tool*, etc. The object concept may in its turn be analysed as to its origination or dependencies.

3 Concept relation models

During the first phases, the satellite model could be utilized in a mind map-like manner without putting much emphasis on the types of relations between concepts. However, in order to get a more accurate picture of the concepts of the field, more precise models can be applied. They can be utilized also earlier in order to get a quick start on concept analysis. The models presented here originate from my previous studies where I have compiled detailed classifications for the types of concept relations and concept systems for terminological concept analysis and terminology work (e.g. Nuopponen 1994; 2005a). To refine the original classification presented in Nuopponen 1994 I have utilized e.g. the hierarchy of semantic relations which has been used by Madsen et al.1 for instance for developing an ontology-based querying system. (See e.g. Madsen et al. 2001; 2002; Nuopponen 2005a). The classifications offer a top-down approach to the various types of relations there might be between concepts in any field. In order to apply them in practice, however, I have started to formulate models by grouping certain relation types together (e.g. Nuopponen 2006: activity; 2007: process; 2008: causality). Some of the relation types are to be found across different models thus resulting in mixed concept systems.

The concept relations types are (over)generalized and kept in an abstract level in order to make them applicable for all possible cases from different domains. They are based on basic structures and categorizations of the world. The terms that have been selected to designate the different relation and concept types are chosen either to be general enough (e.g. *locative relation; place*) or because they are metaphorical loans from a certain domain and express something essential of the relation or concept type in question (e.g. *ingredient relation; patient*). The purpose has been to leave space for interpretation according to the needs of the actual domain and the approach selected by the researcher.

In the figures 1 have marked the meta-concepts with capitals (e.g. COORDINATE CONCEPT), but mostly left away 'concept' in the end (e.g. PARTS, CORRELATE). The questions to be asked are focused on finding out the phenomena, the objects of reference and thus also the concept. As to the questions, the core concept is in the focus and functions as the starting point. For instance, if *research* is taken as the core concept, the question *Where is the activity performed?* can be answered with *university*, *research institute*, etc. establishing thus locational activity relations between these concepts and the core concept. In many cases the

[1]For the details of their classifications, see e.g. Madsen et al. 2001; 2002.

relations can be approached from both directions: the core concept may refer to a part in a whole or to a whole that has its own parts. In some cases both of these possibilities are marked in the models, but not in all possible cases.

3.1 Basics: types and properties

The first model combines the basic information that is needed for writing definitions for concepts - both related concepts and characteristics (Figure 2). When a phenomenon is being scrutinized, there almost always is information available about a larger group of phenomena that it could be classified in. This means that irrespective of whether concepts refer to concrete or abstract phenomena, it is possible to establish their place in a generic concept system[2]; i.e. to identify the concept's superordinate, subordinate, and coordinate concept(s) (e.g. *concept analysis: research method, systematic concept analysis, content analysis*).

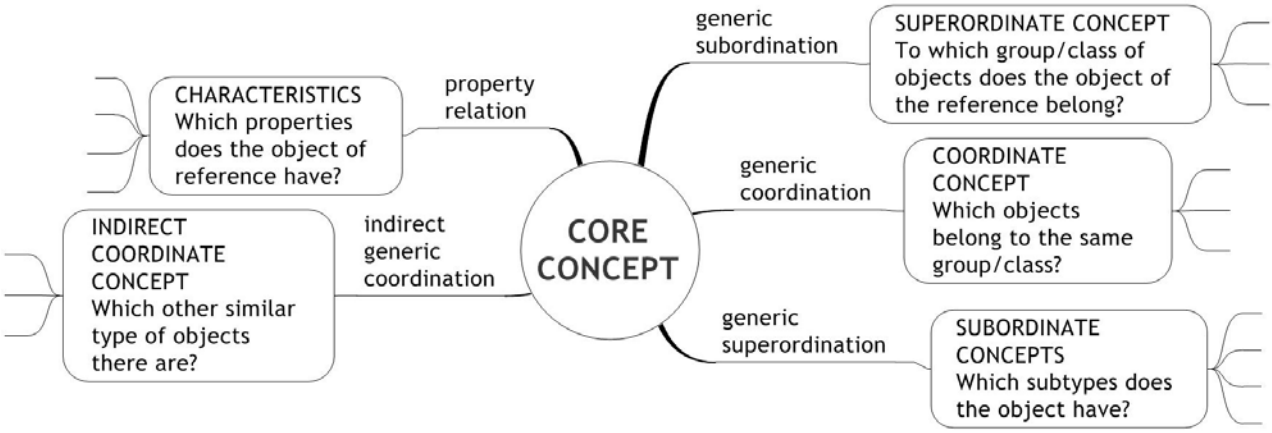

Figure 2. Basic model[3]

Even though this model might seem to be a clear cut one, it is not always easy to analyse these concepts. It may sometimes be difficult to locate a generic superordinate concept; and in other cases, alternative superordinate concepts may be found, e.g. *chadô,* the Japanese tea ceremony may be treated as a type of ceremony, ritual, art, cult, tea drinking, philosophy, religion, etc. (Nuopponen 2007) A difficulty may appear when the core concept or its superordinate concept is under discussion and not yet established in the field; or when there are several overlapping concepts which do not together form any of the models discussed here. Sometimes, they may be subordinate to the same concept but not necessarily, in which case each of them may need a separate presentation to guarantee "fair treatment". Instead of one core concept, the analysis would start then from several parallel core concepts with a purpose to find a basis for comparison.

If the concepts are not directly subordinated to the same concept on a higher level of abstraction, they may be located in the same generic concept system e.g. as indirect coordinate concepts, or in competing alternative concept systems. It is important to describe the concepts with reference to their own concept system first before comparing them to each other.

[2] Syn. logical concept system (e.g. Nuopponen 1994)
[3] The figures are to be read clockwise and started from 1 o'clock. The term *object* is used as a synonym to *object of reference* in the figures. Both refer here to the object of reference of the core concept.

In order to be able to define concepts, it is necessary to identify the characteristics that distinguish from each other and the neighboring concepts on the same abstraction level. Therefore, I have included in this basic model also characteristics, i.e. answers to the question *Which properties does the object of reference have?* The answers may be expressed with lengthier extracts from the sources or more concise expressions. Some of them express also various types of relations to other concepts. Satellite nodes for characteristics can be added to each of the concepts and their subordinate concepts - not only to the core concept as in the model in Figure 2. In this way it, is possible to get a preliminary overview of the contents of the related concepts and compare them. Additionally matrices or tables may be used for more accurate comparisons.

3.2 Structure: composition and location

The second model comprises mostly concept relations that refer to some kind of spatial contact in between the referents of the related concepts (Figure 3). Here, the key information concerns partitioning of the referent in its components, elements, or properties etc. Questions like *Which wider whole does the referent belong to?* lead to information on the partitive superordinate concept of the core concept. Other concepts will be found with questions: *Which other parts belong to the same whole?* or *Which parts or components does the referent consist of?* In addition to the actual components, it is possible that some extra parts can be attached to the object of reference, e.g. *e-mail – attachment*. When analysing concepts that refer to abstract phenomena, it may not be possible to make any difference between partitive and material component relations (e.g. friendship, trust).

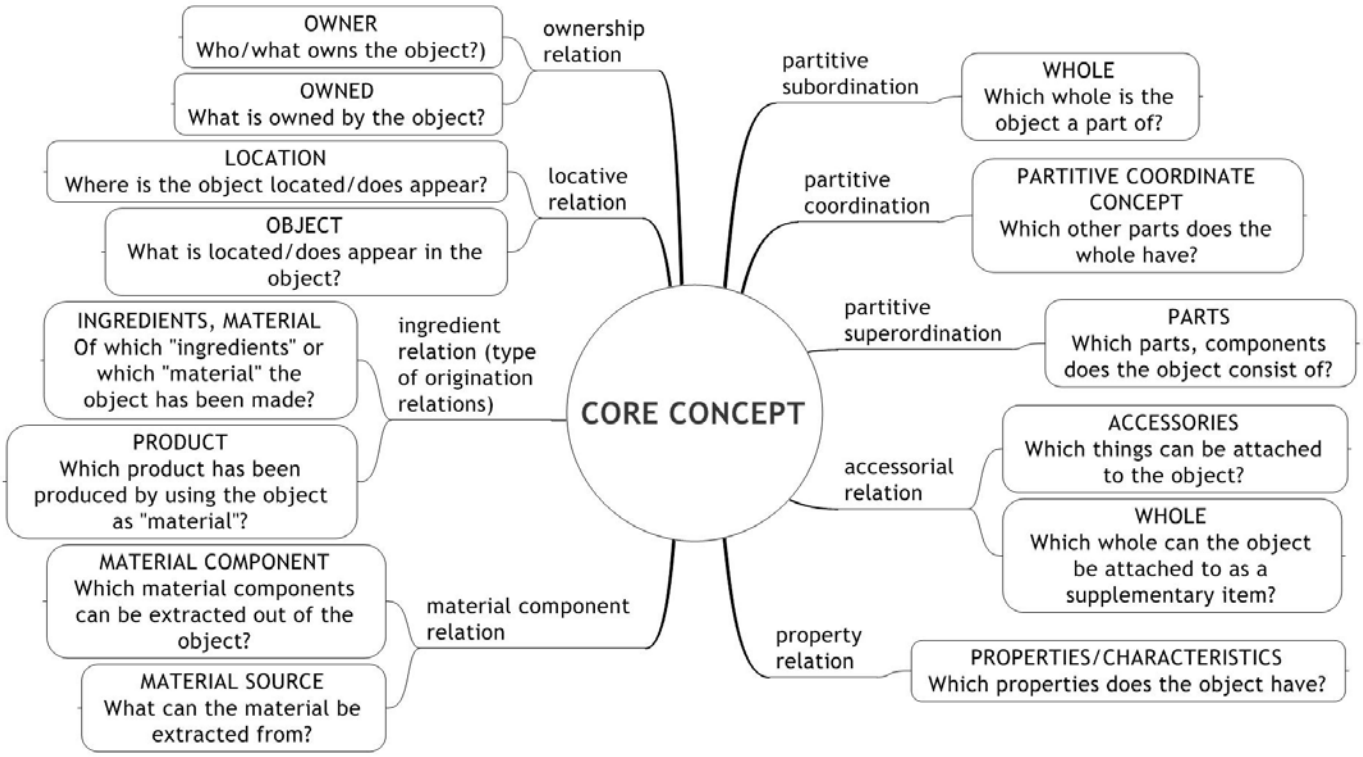

Figure 3. Structural model

Accessorial (or enhancement) relation is not always distinguishable from partitive relations, but it may be useful to treat it separately. It refers to the relation between two entities, one of which can be attached to the other one without being an actual part of it (e.g. *car - trailer; computer - memory stick*). The p**roperty** relation that was integrated also in the previous

model, concerns here relations like *silk - strength*; *wind power - sustainability*. **Material component** refers to the material that the object contains or which can be extracted from it (*coffee - caffeine*), and is often different from the material that is used to make the object (**ingredient** relation). An example of **location** could be *coffee plant - coffee plantation*. **Ownership** relation has to do with the owner and the object, e.g. *coffee grower - coffee plantation*.

3.3 Origination, development and processes

Models with origination, developmental and process relations help e.g. to sort out various types of background information on the research object (stages, place of origin, initiators etc.). For instance, textbooks, encyclopedia and dissertations start the description of a phenomenon by giving details of its origin and development. **Origination** relations are based on relations between the referent of the core concept and other phenomena that have to do with the origin e.g. of a product: *producer, place of manufacture, purpose for manufacturing, manufacturing method, used material, instrument, manufacturing time,* etc. (Figure 4). It could be historical and hypothetical connections (e.g. *universe - Big Bang*) or something that is happening all the time (e.g. *vowel - tongue*). All of these may have several alternatives, e.g. place of origination in case of *vowel - front/near front/central/near back/back of the mouth*.

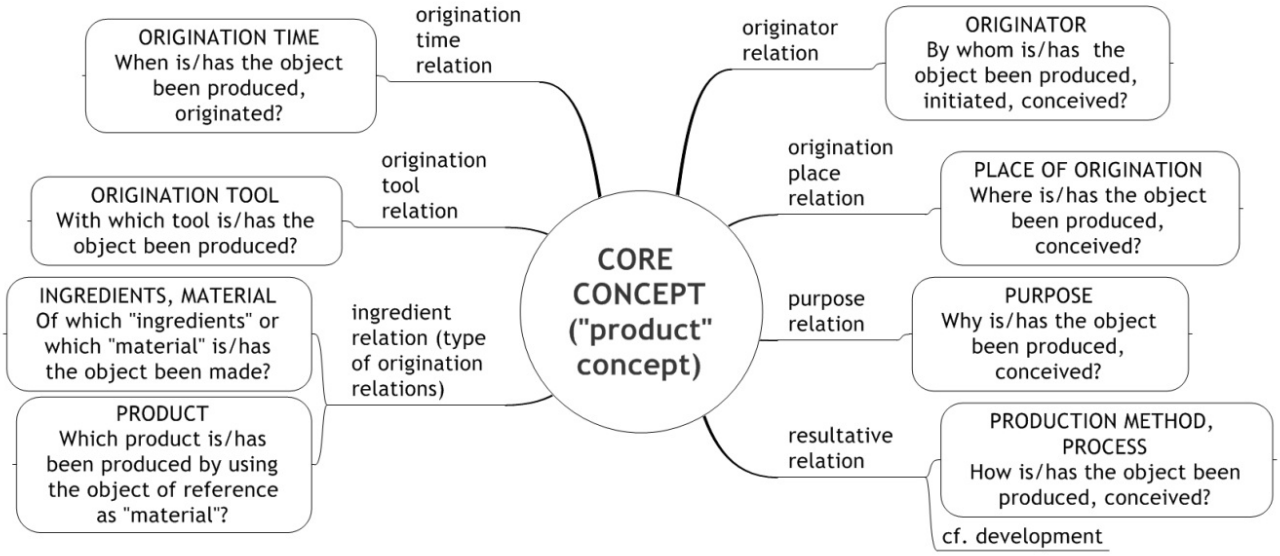

Figure 4. Origination model

It may be easier to find this information when analysing a concrete phenomenon compared to an immaterial phenomenon e.g. an activity. **Ingredients** that e.g. cappuccino is made of are *espresso* and *foamed milk* while e.g. Japanese tea ceremony (when regarded e.g. as an art form) is "made of" ingredients from various religions, architecture, other art forms such as ikebana, calligraphy etc. which have steered the development of the tea ceremony.

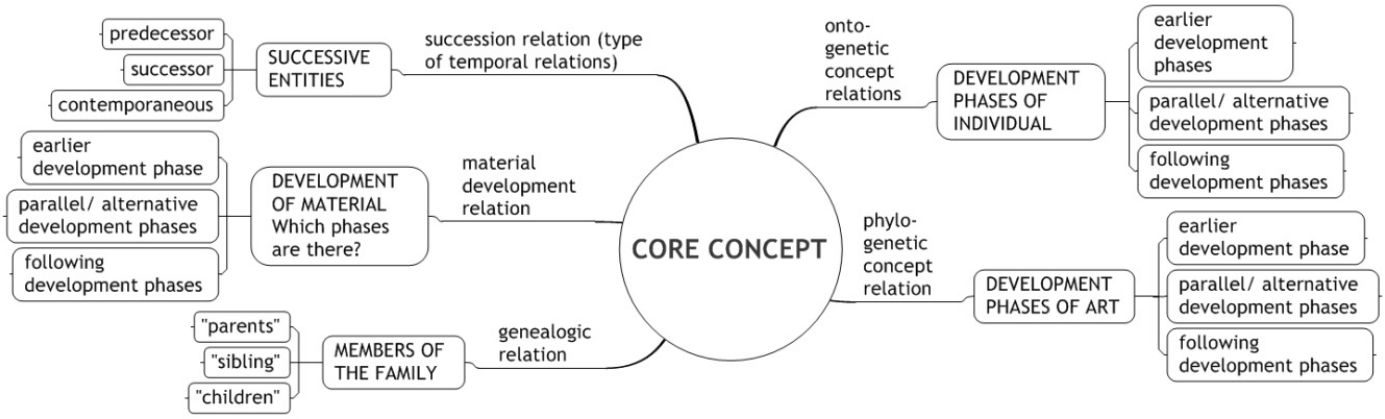

Figure 5. Developmental and temporal model

Developmental relations (see Figure 5) supplement the previous model with origination relations. In this model the purpose is to analyse various developmental phases of an **individual** (e.g. *child - adult*), a **species** (e.g. *grey wolf - domestic dog*), a **family** (*mother dog - puppy*), or **material** (e.g. *dough - biscuit; water - ice*). In addition to these developmental relations, also various types of **temporal** relations may be analysed in this context, i.e. which phenomena or events precede, succeed, or co-occur or co-exist without being "genetically" related to each other.

3.4 Activity

Activity relations (see Figure 6) help bring together many separate concept systems and fragments of systems in a larger concept system or an ontology of the field. In the activity model, an action, an activity or a phase of a process is taken as the starting point for the analysis.

Activity relations are based on a connection between an *activity* concept and phenomena involved in the activity and the questions to be asked concern e.g. *agent, object/patient, tool, location, time, purpose, result, etc.*). For some activities it is possible to distinguish a route (e.g. *cycling - cycle lane*), or a source and a target (location), e.g. for translation, *source language* and *target language*.[4] The model has been supplemented with **phase** relations that are a type of temporal concept relations and can function as a link to a more extended series of activities.

[4] Activity relations and concept systems have been treated more thoroughly in Nuopponen 2006.

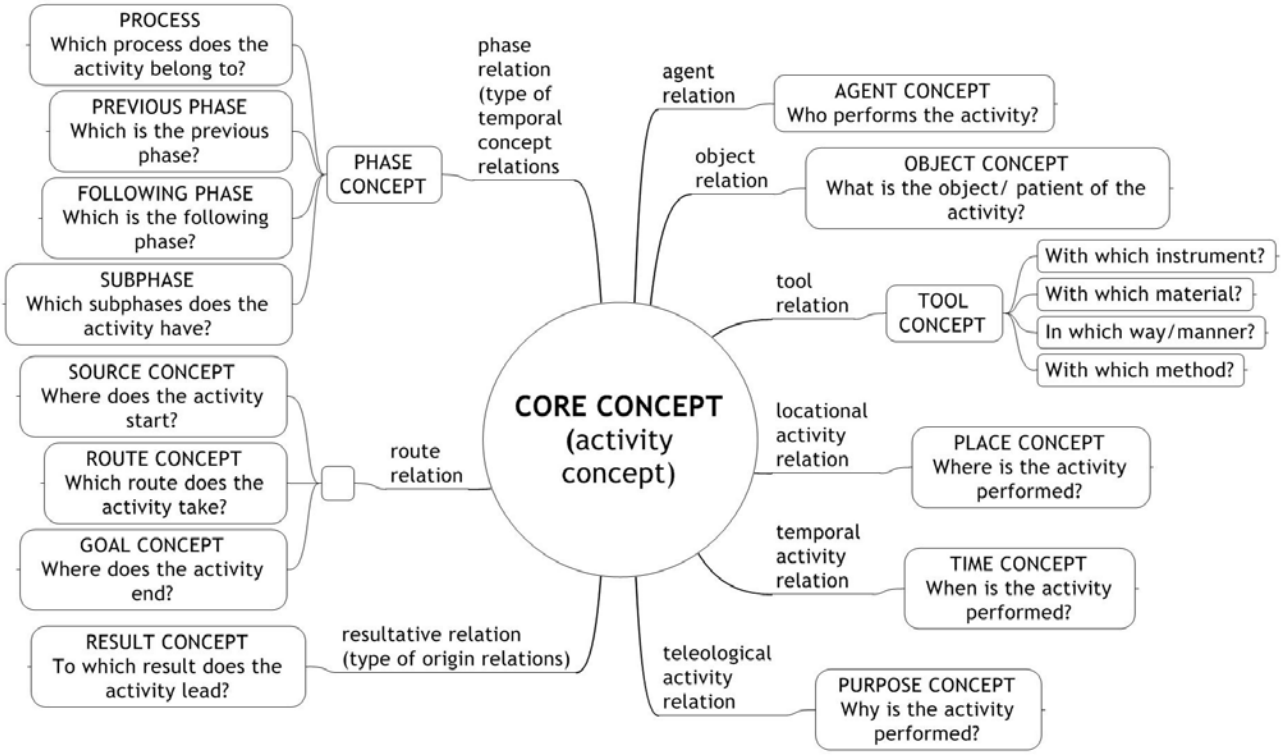

Figure 6. Activity model

3.5 Transmission

One type of activities is made of different types of transferring or **transmission** processes (see Figure 7). This is dealt with as a separate model because these processes bring more complexity. If a concept referring to a transmission process is taken as the core concept, the activity model can be applied to a certain degree. In transmission concept systems, however, any other concept may be taken as the core concept, e.g. the concept referring to the object to be transmitted or transferred as in Figure 8.

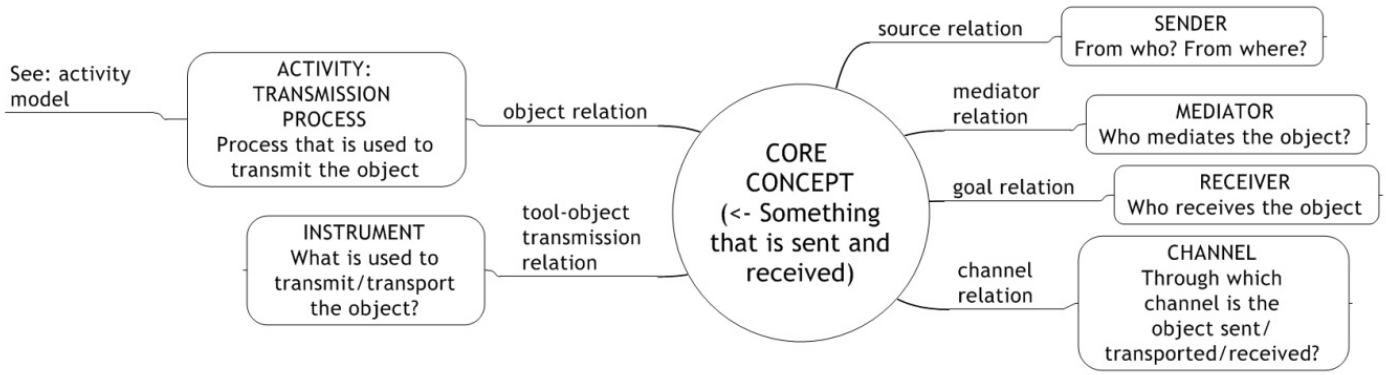

Figure 7. Transmission model

Transmission relations are based on the basic transfer: A gives/sends/transmits something to B (e.g. *transmitter - receiver, coder - decoder*). Other relations involved are source relation (*sender/place - entity*) and target relation (*entity - receiver/ place*). In the activity model, these relations were used not only to refer to sender and receiver, but also to the place of departure and destination. However, it may be necessary to distinguish between these two sets of concept relation in some cases (Nuopponen 2008). In addition, Figure 8 includes also a relation between the core concept and the concept the referent of which is a *mediator*, i.e. someone that is neither the original sender nor the final receiver.

3.6 Cause and effect

Causal relation is often seen as a relation between the concepts of cause and effect (causal sequence), but this is only the basis for a complex concept system that is often involved. In causal concept systems, it is possible to distinguish between concepts referring to various types of **causes** and various types of **effects**. The causes may be an **agent** causing something, an **event** that may start a whole chain of events, or **state**, condition or circumstance that can have a decisive role in the whole process of causation. There is always "a patient", i.e. something in which the effects show and appear as **symptoms**.[5]

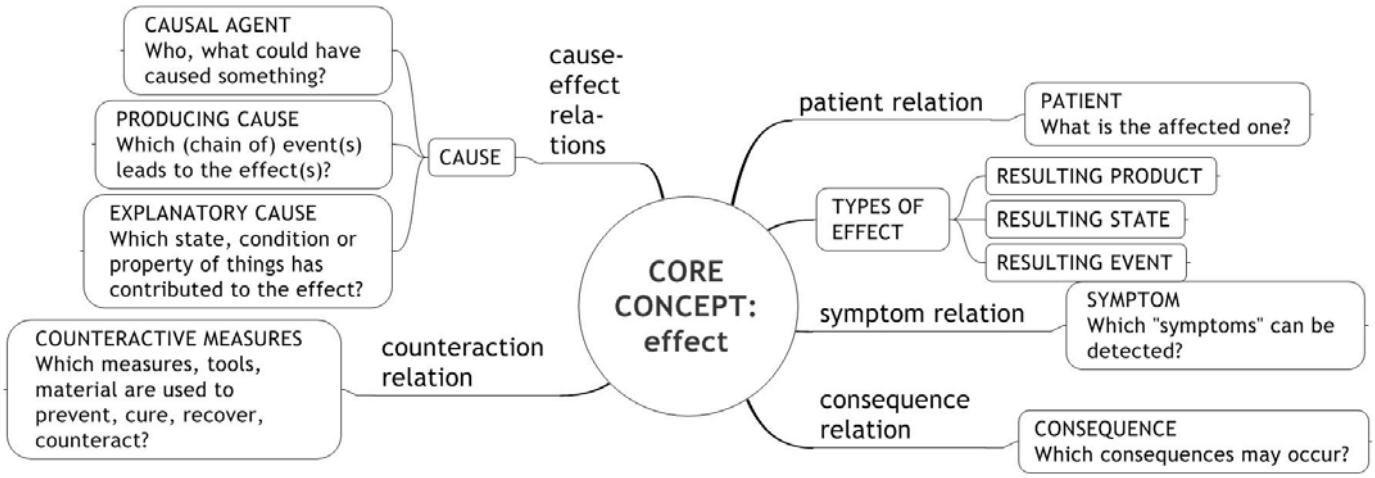

Figure 8. Causation model

The effects may be product, state or an event and can lead to consequences. On the other hand, there are various types of countermeasures to prevent the causation chain or the effects to appear, or cures for the symptoms, effects and consequences. In a study where there is some kind of cause-effect relation to be detected, this model may function as a starting point for organizing the concepts (e.g. various types of *communication failures* and their causes and countermeasures as well as consequences). The research question may also be an opposite one: to find out why something was successful, what were the causes, what kind of positive effects occurred, and which consequences did they have.

3.7 Dependence and comparison

The model in figure 9 combines relations that are not forming any coherent concept system, nor functions as a basis for a satellite model as such. It rather accounts for various types of

[5] For examples see Nuopponen 2008.

concept relations that combine concepts referring to objects that are being compared or are dependent on each other. The relations presented here may be integrated in other models according to the needs. For a researcher they may offer further ideas e.g. for how to analyse the collected material. In my concept relation classifications these are classified mainly as contact or interactional relations. Role relation is added here to cover not only the role change relation (between consequent roles of the object of reference) from the earlier classifications but also the relations between the core concept and various role concepts referring to object's roles related to time. [6]

Ownership relation appeared already in the contact model but can belong also here. It is based on the connection between the owner and something that is owned. These relations are often near partitive or accessorial (or enhancement) relations, but may be applied in some cases when the ownership is particularly focused, e.g. *copyright - copyright owner*. Sometimes "owner" must be taken as a metaphor.

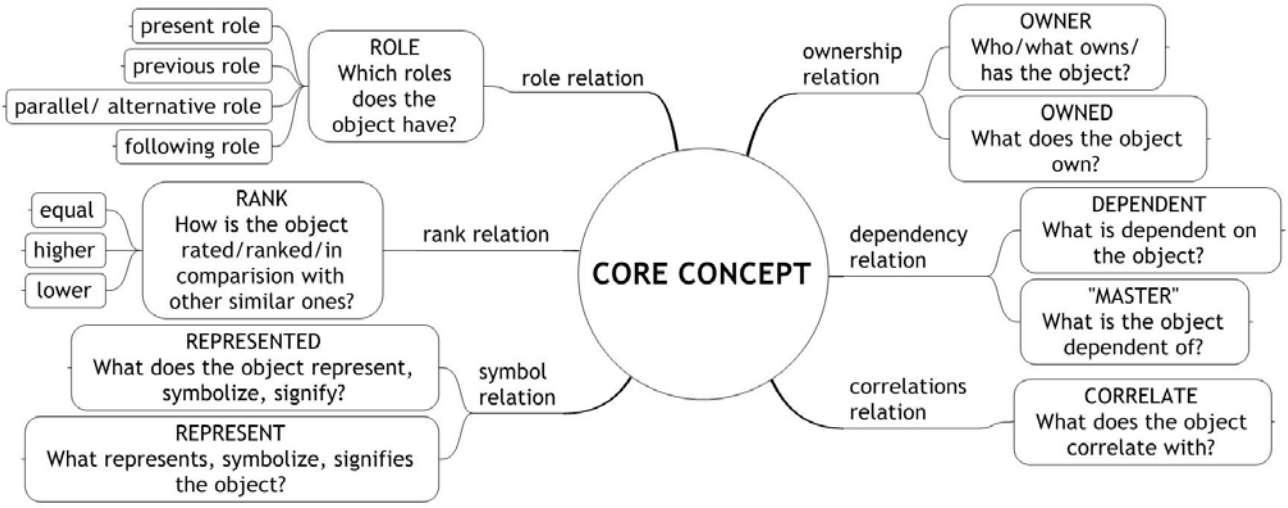

Figure 9. Dependency model

An example of **dependency** relation is *lender - borrower*. These types of relations are based on various types of economic, legal and other similar relations which may exist between different parties. **Correlation** relation may be otherwise rare type of concept relation, but is often needed in a research process. It refers to a reciprocal relationship between entities (variables), e.g. *oil price - stock market*. **Representational** relation has to do with the relation between an entity and its representative (e.g. *meaning − word, people − parliament*). **Rank** relation is based on comparing, rating or ranking phenomena as to some of their property, e.g. different levels in military: *sergeant - corporal - private*, or in taxonomy: *species - genus - family - class*. **Role** relation depends on the role of the phenomena, e.g. *professor - supervisor; journalist - gatekeeper*.

[6] See more in Nuopponen 1994; 2005.

4 Conclusion

The idea behind the systematic concept analysis is that "no concept is an island" - to modify John Donne's[7] statement. Every concept analysis involves other concepts and the relations need to be scrutinized. When doing research, however, much of the concept analysis is done by thinking, and the results are presented by discussing for instance different views, definitions, or classifications. In this paper, however, a set of "tools" was presented to make concepts and relations between them visible in a graphical diagram. The tools consist of several models that are built on previous research and bring together various types of concepts and concept relations across more formal typologies to form mixed concept systems (see e.g. Nuopponen 1994, 2005a).

The models are meant to give ideas for structuring and comparing concepts during different phases of a research project regardless of whether concept analysis is utilized as the main method for analyzing the research material or only as an auxiliary method e.g. for clarifying concepts of the theoretical framework or the background information of the research object (cf. Nuopponen 2010a, b). Components from all of the models can be integrated in one single concept map model as a satellite system, or they may be represented separately. During the systematic analysis, the emphasis may shift from the core concept to another concept which combines more concepts around it than the original concept. Separate alternative satellite models are needed when comparing concepts according to various theories, methods, previous research results etc. to create a basis for comparison in the same way as when concepts and terms of two or more languages are analysed. With the help of the models the researcher can show the differences and suggest his/her own structuring of the concepts and terms and motivate the choices done (see Nuopponen 2010a, b).

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