14. PROFILING PEDAGOGIC FRAILTY USING CONCEPT MAPS

INTRODUCTION

Pedagogic frailty is a valuable model to enhance teaching improvement through the integration of institutional efforts. Its use can be a source of information to foster evaluation processes involving individuals (academics) and teams (departments). Profiling pedagogic frailty can produce relevant outcomes to scaffold academic development, align values and guide decision making in higher education institutions. For this reason, it is plausible to predict rapid dissemination of the model. However, a bottleneck is already foreseen at this current early stage of development.

Concept maps (Cmaps) have been selected as the preferred choice to represent the elicited academics’ knowledge during individual interviews. Kinchin argues that concept mapping can be a method in the exploration of pedagogic frailty to gain access to the yet-to-be-known (see Chapter 1). The understanding of Cmaps as dynamic constructs that reveal latent knowledge and beliefs goes beyond the typical applications we find in the educational realm, where Cmaps are seen as static summary diagrams to support the learning process. In the pedagogic frailty context, Cmaps help to frame and organise academics’ narratives, making visible subtle conceptual relationships that trigger and sustain the reflective practice. The process of charting the elements of pedagogic frailty attested the value of Cmap-mediated individual interviews (Kinchin et al., 2016).

The dependency of Cmap-mediated individual interviews is a blessing and a curse. Although they support knowledge representation, elicitation and reflective practice, the need of an expert interviewer who must combine a clear understanding of concept mapping and pedagogic frailty hinders the model’s broad dissemination and use (Figure 1). Moreover, each interview lasts about two hours without considering the Cmap revision and validation steps. These conditions are indicative of the current early stage of development, marked by theoretical refinements and small-scale pilot studies. The challenge of disseminating the model asks for a more robust solution that allows widespread availability around the clock and large-scale usage by academics around the world.

This chapter discusses the need for developing tasks to prompt Cmap construction to support academics to represent their pedagogic frailty profile without mastering the concept mapping technique. We argue this is the first step toward an on-line
computer-based system capable of making the profiling task broadly available to the higher education public.

CONCEPT MAPPING TO ORGANISE, MODEL AND SHARE KNOWLEDGE

Concept mapping is a well-established technique for the graphical representation of knowledge that enables the explicit description of mental models, that is, the explanations of one's thoughts about how something works in the real world. Cmaps have a decades-long background of research and application, dating back to the 1970s when the concept mapping tool was first proposed by Joseph Novak and his colleagues at Cornell University (Moon et al., 2011; Novak, 2010). Ausubel’s Assimilation Learning Theory (Ausubel, 2000) informed the development of concept mapping, creating a sound body of theoretical knowledge regarding its use (Novak & Cañas, 2006, 2007). Cmaps have often been explored for educational and corporate purposes and have changed the way we manage knowledge and information (Correia, 2012; Hoffman et al., 2006; Moon et al., 2011; Nesbit & Adesope, 2006; Novak, 2010).
Propositions are the essential component of Cmaps. They are formed using two concepts, linked by an arrow to indicate the reading direction. A linking phrase, that is, a clear explanation of the relationship between these concepts, must be added in the arrow to let the reader identify the precise understanding of the concepts held by the mapper. The absence of a linking phrase hinders the understanding of the conceptual relationship, producing associative node-link diagrams, such as mind maps (Davies, 2011).

The frailty model and its key dimensions can be represented as shown in Figure 2. The associative diagram (Figure 2a) puts together a set of concepts that gives some clues about the hierarchical arrangement. Pedagogic frailty is the source of the connections to the other concepts, and all of them are highly interconnected. The limited semantic content simplifies the diagram, and no further information can be obtained from it. This associative map is only a sketch of pedagogic frailty. The inclusion of linking phrases produces a propositional network (Figure 2b) that reveals the nature of all conceptual relationships. For example, the connection between “pedagogic frailty” and “regulative discourse” is now clearly stated as a proposition (pedagogic frailty - increases with lack of explicit and shared \(\rightarrow\) regulative discourse). The expansion of the semantic content produces clear and understandable statements that make Cmaps more useful to externalise, organise and share our mental models. Additional conceptual refinement can easily take place individually (the mapper revises his/her Cmap after a few days) or collaboratively (the mapper presents his/her Cmap to other people) through meaning negotiation.

It is worthy to note that the meaning of propositions can be drastically changed with discrete modifications in linking phrases. Therefore, the mapper must recognise the possibility to select the most appropriate words to express and communicate the messages precisely. Clarity is a precondition to assess the conceptual correctness of any proposition, as illustrated in Table 1. “Higher education” and “economic development” are concepts that can be connected. However, the lack of linking phrase only associates these concepts (see 1 in Table 1). The addition of conjunctions is a common attempt that is not helpful (see 2 in Table 1). In these cases, the semantic meaning is not clear, and it is not possible to understand the conceptual relationship. Therefore, these structures are not classified as propositions.

The inclusion of a verb in the linking phrase is a rule of thumb to create propositions with clear semantic meaning (see 3-7 in Table 1). Variations of the verb to be are used to confirm this fact and to highlight that some of the propositions are conceptually unacceptable. “Higher education - is important to \(\rightarrow\) economic development” has a clear meaning and it is conceptually acceptable. Changing the verb tense to the past (Higher education - was important to \(\rightarrow\) economic development) or future (Higher education - will be important to \(\rightarrow\) economic development) keep the messages clear, but they become conceptually inaccurate. Adverbs are useful to fit the propositional meaning with the conceptual relationship perceived by the mapper. The inclusion of “not” add three more letters to the linking phrase and reserve the semantic meaning (Higher education - is not important to \(\rightarrow\) economic development). There is no
impact considering the clarity, but the conceptual correctness is missed. Quantifiers frequently open good discussions to adjust correct propositions. Some readers may prefer “Higher education - is very important to economic development” instead of “Higher education - is important to economic development”. Both propositions have clear semantic meaning and conceptual correctness. The fine-tune adjustment, in this case, will reveal different opinions about the topic.

Good Cmaps always present a focus question to keep our thoughts focused on the subject to be mapped (Figures 1 and 2b). It is the ultimate parameter to select concepts and linking phrases to set up the propositional network. Lastly, the Cmap hierarchical arrangement should consider the most inclusive concepts to start the
Table 1. Small changes cause great impact on the propositional meaning

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Is it clear?</th>
<th>Is it correct?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Higher education – ??? →</td>
<td>No</td>
<td>I don’t know</td>
<td>There is no linking phrase. The concepts are associated, but the conceptual relationship is not revealed. This structure is not a proposition.</td>
</tr>
<tr>
<td>economic development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Higher education – and →</td>
<td>No</td>
<td>I don’t know</td>
<td>There is no verb in the linking phrase. The additive association between the concepts generates a new big concept (higher education and economic development) in isolation. This is a poorly formulated proposition.</td>
</tr>
<tr>
<td>economic development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Higher education – is important to → economic development</td>
<td>Yes</td>
<td>Yes</td>
<td>There is a verb in the linking phrase to clarify the semantic meaning. It is possible to check the correctness of the conceptual relationship. The verb in the present tense is adequate.</td>
</tr>
<tr>
<td>4. Higher education – was important to → economic development</td>
<td>Yes</td>
<td>No</td>
<td>The verb in the past tense does not impair the semantic clarity. However, the proposition is conceptually wrong because higher education is still important to economic development.</td>
</tr>
<tr>
<td>5. Higher education – will be important to → economic development</td>
<td>Yes</td>
<td>No</td>
<td>The verb in the future tense does not impair the semantic clarity. However, the proposition is conceptually wrong because higher education has been important to economic development.</td>
</tr>
<tr>
<td>6. Higher education – is not important to → economic development</td>
<td>Yes</td>
<td>No</td>
<td>Adverbs can be added to the linking phrase without impairing the semantic clarity. However, the conceptual relationship can become invalid using few letters (e.g. no).</td>
</tr>
<tr>
<td>7. Higher education – is very important to → economic development</td>
<td>Yes</td>
<td>Yes</td>
<td>Quantifiers allow a fine-tune adjustment of the semantic meaning. A discussion about how much higher education is important to economic development can take place. Other quantifiers (e.g. so, moderately, little) can the used to express precisely the conceptual relationship.</td>
</tr>
</tbody>
</table>
map (at the top of the page), followed by other concepts that progressively detail them (at the bottom of the page). This approach makes easier to process the Cmap content because we can subsume the details (information) knowing the broad topic (starting concepts). The progressive differentiation was proposed by Ausubel (2000) as a mechanism to increase the stability and clarity of anchoring ideas that form our conceptual schemes (mental models).

NOT SO EASY: INDIVIDUAL INTERVIEWS AND THE NEED OF AN EXPERT

One’s skills in making Cmaps and the understanding of the task-relevant knowledge are critical aspects to achieve the benefits of organising, modelling and sharing knowledge using concept mapping. When these conditions are met, Cmaps are likely to be helpful to achieve such benefits. A closer look at the Cmap-mediated individual interviews that have been used to chart pedagogic frailty reveals the following concurrent cognitive tasks:

• Knowledge representation (KR), related to the Cmap construction.
• Knowledge elicitation (KE), related to the emergence of task-relevant knowledge from the academics’ mental models.
• Reflective practice (RP), related to the critical evaluation of the mapped knowledge for professional development purposes.

These tasks must be handled by the limited cognitive resources available in working memory (you are using this memory system to read, process and understand this text right now). Mapping conceptual relationships about pedagogic frailty can be considered a complex task because the output has a particular format (Cmap) that must be constructed from elicited knowledge to foster a self-reflective process. In such a situation, the task outcome is impaired because the working memory resources are not enough to cope with these concurrent tasks simultaneously. Cognitive load theory (Sweller et al., 2011) offers important inputs to understand and describe why an expert must conduct Cmap-mediated individual interviews. Figure 3 represents the working memory resources (white box) allocation to handle this task with and without an expert.

Most of the academics have little (or no) experience in concept mapping. KR is the first obstacle to be overcome, and they probably will invest their cognitive resources to find out how to set up Cmaps. There will be little working memory resources available to deal appropriately with KE, and the obtained Cmap will be a poor representation of the academics’ mental models (Correia & Aguiar, 2014). As a consequence, RP will be hindered due to the quality of the Cmap produced. Cognitive overload occurs when the working memory resources are not enough to execute a high-complexity task, resulting in a poor outcome (Figure 3a). You can feel the cognitive load changing while you are reading this chapter. Processing familiar contents is easier than understanding the passages with new concepts. The
more prior knowledge you have about a subject, the less cognitive load is imposed on working memory. This relationship explains why new contents, such as concept mapping, are burdensome to novices.

The expert role during Cmap-mediated individual interviews is critical to avoid cognitive overload for two main reasons. The KR task (Cmap elaboration) is transferred to the expert. Academics can focus only on KE during the Cmap construction. The division of responsibilities decreases the cognitive resources required for both participants, and generative processes (G) can occur during the task (Figure 3b). Such processes involve schema manipulation and construction that are critical to ensuring an in-depth KE. As a consequence, the Cmap obtained after an expert-mediated interview has high-quality features, and it is useful to foster RP.

The expert can also organise the dialogue flow to avoid concurrent tasks (Figure 3b). Oral prompts keep academics focused on the task at hand. KE dominates during the Cmap construction phase, whereas RP is likely to occur mainly when the represented knowledge becomes available. Moreover, the prompts help to organise the content of each key area of pedagogic frailty. A particular Cmap is created of regulative discourse, pedagogy and discipline, research teaching nexus, locus of control, and pedagogic frailty itself. This sequential approach contributes to ensuring generative resources for the academic during the entire interview.
Cmap-mediated individual interviews are useful to represent academics’ knowledge related to pedagogic frailty. However, there are a limited number of experts that have a clear understanding of concept mapping and pedagogic frailty. The model dissemination requires a different strategy to make the profiling task broadly accessible.

A CMAP-BASED TOOLKIT TO PROFILE PEDAGOGIC FRAILTY

The near future seems to require an on-line computer-based system capable of scaffolding the construction of Cmaps that are currently obtained during individual interviews mediated by experts. Instructional design can guide the development of tasks to accomplish KR, KE and RP, without face to face interactions with the expert.

For many years, Cmaps were drawn by hand. Creating iterative revisions of a Cmap was cumbersome and time-consuming. Collaborative concept mapping sessions, such as individual interviews, could be facilitated using post-it notes. The possibility of exploring concept mapping online launched an entirely new world of applications and uses for concept mapping as exemplified by the CmapTools software, which was developed by the Institute for Human and Machine Cognition (Cañas et al., 2004). Undoubtedly, CmapTools have enhanced the power and applicability of Cmaps in educational and corporate settings (e.g. Moon et al., 2011; Novak, 2010).

The digital concept mapping approach using CmapTools allows the creation of more than isolated Cmaps. The idea of knowledge models leverages the possibility of mapping information and organising knowledge by constructing a set of hyperlinked Cmaps that include associated resources (any digital file can be linked to any concept) about a particular domain. The resultant hypertext structure is similar to a website and is user-friendly even for first-time users. Knowledge models can be explored by navigation icons (links) that appear below the Cmap concepts (Figure 4).

The knowledge model is a well-structured environment that can be constructed to represent content about complex issues (e.g. pedagogic frailty). Knowledge models allow the implementation of the hierarchical reductionism approach when mappers are faced with a complex set of interconnected information (Correia et al., 2014). Hierarchical reductionism is a safe way to produce acceptable answers to complex problems (Dawkins, 1996). The main idea is to describe complex systems using a hierarchy of organisations, each of which is only expressed regarding objects (concepts) one level down in the hierarchy. This strategy ensures that all explanations about the system are generated by a step-by-step approach and contain a manageable number of elements (concepts) to be processed. In this context, systemic thinking is strengthened because it is possible to connect the parts with the whole system continuously. Therefore, hierarchical reductionism seems to be useful for mapping pedagogic frailty, which attempts to support the simultaneous focus on the main dimensions of the teaching environment (Kinchin, 2016). The latent connectedness among pedagogy frailty and its components (regulative discourse, pedagogy and
discipline, research teaching nexus and locus of control) can be easily represented and perceived using digital Cmaps to set up a knowledge model.

The possibility to hyperlink Cmaps is an additional advantage associated with the foreseen on-line computer-based system to profile pedagogic frailty. Figure 4 shows the knowledge model structure that can be produced to profile pedagogic frailty. The level-1 Cmap contains unifying concepts that are critical to depict the broad view of the topic. It is the starting point to more focused level-2 Cmaps, which details the four key pedagogic frailty areas. Concepts can be used to create two different hyperlinks among the Cmaps (Correia et al., 2014). Vertical links involve Cmaps from different levels and express the overarching structure of pedagogic frailty. Horizontal links include Cmaps from the same level (level-2), revealing conceptual connections among the pedagogic frailty key areas. These links capture latent knowledge and beliefs that are critical to profile academics, making digital Cmaps more useful than paper-and-pencil counterparts.
SCAFFOLDING TASKS

The on-line computer-based system will be useful to disseminate pedagogic frailty if it facilitates KE and RP to create Cmaps (Figure 3). The scaffolding tasks must mimic the dialogue sequence adopted during the Cmap-based individual interviews. Therefore, the interventions done by the expert interviewer should be useful to devise what, how and when to make specific demands. A prospective exercise involving scaffolding tasks resulted in the diagram presented in Figure 5. The on-line process of making Cmaps can be divided into three different moments that require specific prompts:

- KE from a blank screen (KE1).
- KE from the Cmap preliminary version (KE2).
- RP from the Cmap intermediate version.

The difficulty to start writing from a blank sheet also happens when we start to make a Cmap. The blank screen may be challenging even for experienced mappers. The KE1 tasks must probe relevant concepts and conceptual relationships to the topic to be mapped. Academics are not used to the pedagogic frailty model, and concept lists (see 1 in Figure 6) can be useful to establish the boundaries of regulative discourse, pedagogy and discipline, research teaching nexus, and locus of control. The selected concepts can be organised into a hierarchical associative arrangement (see 2 in Figure 6). Other question formats can ask academics to complete statements, judge comments (agree-disagree), and evaluate scenarios. All the tasks gather information to create the Cmap preliminary version, that is, an expanded version of the associative arrangement with linking phrases (see 3-4 in Figure 6). KE2 tasks explore the Cmap preliminary version using prompts to guide academics to review the concepts and linking phrases. Specific questions about the suitability of the selected verbs to express conceptual relationships can promote changes to adjust the propositional meaning to represent the academics’ mental model precisely. Missing key concepts can be offered to check if the Cmap can be expanded to convey more meaningful details about the subject. The search for cross-links through the addition of new propositions can be an exciting creative challenge to check the overall conceptual network. Lastly, a tentative focus question can be shown to ask the academic to revise the overall Cmap content. The goal is to define what is the best focus question addressed by the propositional network. The Cmap intermediate version is obtained as a result of KE2. It is worthy to note that each KE steps must be repeated for each one of the five Cmaps that comprise the knowledge model about pedagogic frailty (Figure 4).

RP tasks foster a critical evaluation of the Cmap intermediate version, which acts as the starting point to considerations about the professional identity and experiences. Explanation and exemplification prompts (Figure 5) stimulate an
### Figure 5. Examples of online scaffolding tasks to support Cmap creation

<table>
<thead>
<tr>
<th><strong>Knowledge Elicitation 1</strong></th>
<th><strong>Knowledge Elicitation 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>List of Concepts</strong></td>
<td><strong>Linking Phrase Revision</strong></td>
</tr>
<tr>
<td>Select the most important concepts from a pre-defined list</td>
<td>Check if the verbs precisely express the conceptual relationships</td>
</tr>
<tr>
<td><strong>Complete the Statement</strong></td>
<td><strong>Suggestion of Concepts</strong></td>
</tr>
<tr>
<td>Complete statements to make them closer to academic’s point of view</td>
<td>Evaluate the inclusion of suggested key concepts to improve the Cmap</td>
</tr>
<tr>
<td><strong>Agreement/Disagreement Judgements</strong></td>
<td><strong>Suggestion of Cross-Links</strong></td>
</tr>
<tr>
<td>Judge statements using an agreement scale</td>
<td>Evaluate the inclusion of new propositions to reveal cross-links</td>
</tr>
<tr>
<td><strong>Scenario Evaluation</strong></td>
<td><strong>Suggestion of Focus Question</strong></td>
</tr>
<tr>
<td>Choose the option that represent your probable action for specific professional scenarios</td>
<td>Evaluate the validity of the suggested focus question and make changes, if necessary</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Reflective Practice</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation Prompt</strong></td>
</tr>
<tr>
<td>Ask comments about the overall Cmap and the role of key concepts (think aloud is suggested)</td>
</tr>
<tr>
<td><strong>Exemplification Prompt</strong></td>
</tr>
<tr>
<td>Ask comments about professional situations to illustrate the Cmap most relevant parts (think aloud is suggested)</td>
</tr>
<tr>
<td><strong>Search for Horizontal Links</strong></td>
</tr>
<tr>
<td>Compare level-2 Cmaps to create links among them (when all Cmaps were available)</td>
</tr>
<tr>
<td><strong>Search for Vertical Links</strong></td>
</tr>
<tr>
<td>Compare level-1 and level-2 Cmaps to create links among them (when all Cmaps were available)</td>
</tr>
</tbody>
</table>
internal dialogue to delve into to the yet-to-be-known (see Chapter 1). Think-aloud protocols may be useful to register self-discoveries and insights that enlighten the academics’ pedagogic frailty profiles. The same objectives are pursued when the search for horizontal (between level-2 Cmaps) and vertical links (between level-1 and level-2 Cmaps) are suggested as scaffolding tasks (Figure 5). The difference here is the focus on the overall structure of the knowledge model (Figure 4) to produce more insights through the examination of pedagogic frailty as a whole. Explanations for each added link between Cmaps can be related to creative leaps that capture latent knowledge and beliefs that deserve to be recorded for future reflection by the academics. All the scaffolding tasks proposed from the Cmap intermediate version apply concept mapping to develop reflective practice while constructing knowledge structures that support the evolution of adaptive expertise (see Chapter 1; Bohle Carbonell et al., 2014; Salmon & Kelly, 2015).

EXAMPLES OF SCAFFOLDING ACTIVITIES

Four scaffolding activities are presented below to illustrate a sequence to promote KE1. The academics’ answers are collected to inform the automated Cmap creation. Figure 6 represents the evolving mapping process from the blank screen to the Cmap preliminary version.

1. Choose from the list the most important concepts to represent the features of the professional academic realm.

- Ability
- Environment
- Resilience
- Adapt
- Evaluation
- Stress
- Changes
- Inability
- Students
- Complexity
- Integrate
- Teachers

2. Choose the alternative that is closer to your point of view.
   - Usually, the teaching environment is
     - Boring
     - Complex
     - Defiant
     - Stressful
   - If the challenges posed by the teaching environment increase we should
     - Adapt
     - Change
     - Give up
     - Integrate
   - Making changes in the teaching environment involve
     - Ability to adapt
     - High levels of stress
3. Judge the following statements using an agreement scale.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are one source of stress.</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>The constant need of change stresses me.</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Students are negatively affected by my lack of resilience.</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>I can quickly adapt from imposed changes.</td>
<td>☑</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

4. Analyse the following scenario and choose the alternative that represents your behaviour.

Imagine that the curriculum of the course you are used to teaching was entirely modified by the institution. This happened without your participation and just before the beginning of the semester.

In this case, you probably would be:

☐ Calm and confident, because you always can use the same materials, strategies and assessments that you have used to apply in the classroom.

☐ Calm and confident, because you know you have the abilities to change whatever it was needed rapidly.

☐ Stressed, because you need to work hard to choose new materials, adapt strategies and activities and prepare new assessments.

☐ Stressed, because you know that it is impossible to adapt or change all the materials, strategies, activities and assessments in time.

☐ Highly stressed, because you decided not to make any modifications due to the lack of institutional discussion and information.

CONCLUSION AND PERSPECTIVES

Concept mapping is the best choice to make knowledge structures visible during the process of profiling academics’ pedagogic frailty. Despite being a valuable model to enhance teaching improvement, the expert-mediated individual interviews hinder the broad dissemination of the pedagogic frailty model among the higher education community. This chapter presented a promising pathway to the development of a Cmap-based toolkit as a robust mechanism for rapid model dissemination in the next few years.

An on-line computer-based system can foster knowledge representation, elicitation and reflective practice, mimicking the mediating actions used by the expert during individual interviews. Moreover, the connectedness among pedagogic frailty and its key areas (regulative discourse, pedagogy and discipline, research teaching nexus...
Figure 6. Evolving mapping process from the blank screen to the Cmap intermediate version, considering the academics' answers to the KE scaffolding tasks.
and locus of control) can be fully captured using the CmapTools software to create five digital Cmaps to set up a knowledge model.

The toolkit asks academics to respond to simple activities that scaffold the Cmap creation and revision. After obtaining a high-quality representation of your mental models, a set of prompts foster reflective practice to put the academics into an internal dialogue to delve into to the yet-to-be-known about their professional development. The think-aloud approach is recommended to augment this reflective process to support the evolution of adaptive expertise. Considering all these promising features, research efforts to prototype this Cmap-based toolkit seem to be the next step to ensure the widespread availability of the pedagogic frailty model around the clock and around the world.

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