

# Searching for Wisdom. Experimenting with Visualization using the DIKW model

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## ABSTRACT:

The last 10 years have been a time of experimentation, research and intense discussion in the discipline of Information Visualization. A fundamental notion for this discipline is the Data-Information-Knowledge-Wisdom hierarchy. Even if at the top of this model, Wisdom is typically put aside: the DIKW has often become DIK. Representing and visualizing Wisdom presents cultural constraints and posed conceptual challenges. This paper presents the results of a three years research on the possible relevance of the DIKW model applied in the context of Communication Graphic Design education. It investigates how the DIKW can provide a relevant framework to help student in understanding the difference between data visualization, information visualization, knowledge visualization and wisdom visualization. Instead of reducing the model to DIK we purposely challenge students to reflect on the concept of Wisdom and experiment on possible ways of visualizing it. Addressing the concept of Wisdom visualization is an attempt to push the boundaries of this discipline toward a deeper understanding of the quality of data we visualize.

## 1. INTRODUCTION

Communication Design is a broad discipline with undefined boundaries. In the design of Visual Communication practitioners are confronted with few evident constraints if compared with other fields: production methods are long-established, experimentation is often well received and the fairly universal nature of its languages presents less restricting contextual constraints. Nevertheless, there are still territories that have been avoided for their innate complexity and have not been investigated because of the cultural challenge they present.

Visual languages possess an undeniable communicative power: they are able to condense complex knowledge, to facilitate comprehension and are highly engaging. The recent capillary diffusion of the use of visual languages has provided new understanding of an additional function. Visualizations can be not only considered as communication devices but more importantly can work as tools to explore and investigate phenomena (Scagnetti 2011).

The last 10 years have been a time of experimentation, research and intense discussion in the discipline of Information Visualization (C. Chen 2002; Scagnetti 2012). In particular the distinction between Data, Information and Knowledge visualization has generated great debate (M. Chen et al. 2009; Lau and Moere 2007; Chi 2000). Numerous attempts to cluster and classify visualization techniques have been done (Lohse et al. 1994; Shneiderman 1996; Tory and Moller 2004; Wehrend and Lewis 1990) in order to generate a more clear understanding of their potential.

Lengler and Eppler (2007) provided an overview over more than hundred visualization methods of by organizing them in a periodical table to assists researchers and practitioners alike in choosing adequate visualization methods for their needs. Lau and Vande Moere (2007) proposed an Information Aesthetic model that shows information aesthetics' focus on the three issues of: representing abstract data, providing an interactive interface, and using visual appeal to engage the user. The Information Aesthetic model analyses the intent (i.e. meaning) of a specific technique, and the mechanics that it uses to accomplish this. Masud et al. (2010) identified the Data, Information, Knowledge continuum as the key element for a framework that considers visualization as a process and not as a product. They interest focus more on the practices (the process) leading to the visualization artifact (the product) more than in the artifact in itself.

## 2. THE DIKW MODEL

The conceptual foundation of these researches is the so called Data - Information - Knowledge - Wisdom (DIKW) hierarchy. The origin of the hierarchy is debated, its paternity is commonly attributed to Ackoff (1989) in the paper "From Data to Wisdom" or to Zeleny (1987) in "Management support systems". Early references to the concepts are made in poetry by T.S. Eliot, Daniel Bell, Yi Fu Tan as well as in other authors (Cleveland 1982; Cooley 1987; Sharma 2008).

The hierarchy originates in the context of information systems and knowledge management but has become a fundamental notion for many different fields. Different disciplinary contexts have contributed to a heterogeneous literature on the topic. From the analysis of this body of literature we can clearly state that there is no consensus on the definition, on the coherence or even on the validity of the hierarchy. The discussion centered around four main issues:

- **The definition of each element** - What is data? What is information? What is knowledge? and what is wisdom?  
 This is definitely the most debated topic concerning the model. An extensive research has been done by Zins (2007) who collected 130 definitions of data, information, and knowledge formulated by 45 scholars and mapped the major conceptual approaches for defining these three key concepts. Some authors argue for the need to generate more solid consensus, while others acknowledge the fact that the meaning of each concept varies when addressed by different disciplinary domains.
- **The shape of the model** - pyramid vs. upended pyramid vs. continuum.  
 The original shape of a pyramid has been extensively criticized; its redesign (from a pyramid to a continuum) has been widely accepted. Rowley (2007) suggests the pyramid should have been designed upside down as "a wisdom funnel, where data naturally becomes more concentrates, but the whole edifice is delicately balanced on wisdom and will collapse without sufficient wisdom". Choo (2001) proposed a continuum but adds signals before data and ignores wisdom; Bellinger et al. (2004a) use a continuum as well with the original elements but with understanding as a moving force between the axis; Jacobson (2000) proposes a so called "Understanding Spectrum" and suggests research methods for the user to address each phase (see next chapter).
- **The relationship between the elements** - How to move from one category to the other? Is each lower category a subset of the following one?  
 Bellinger et al. (2004a) suggested that understanding (originally proposed by Ackoff as an additional level between knowledge and wisdom) supports the transition from each level to the next. Connectedness is the variable on the y axis, while understanding goes on the x axis. And they specify: from data to information involves "understanding relations", from information to knowledge involves "understanding patterns" and moving from knowledge to wisdom means to "understand principles". Many factors have been proposed as variables on the vertical line: Meaning and Value (Chaffey and Wood 2005); programmable/non programmable and algorithmic/non-algorithmic (Awad and Ghaziri 2004), just to quote some.
- **The validity and relevance for contemporary discourse and other disciplines.**  
 Frické (2009) strongly criticizes the pyramid as an "unsound and methodologically undesirable construct originated in the dated and unsatisfactory philosophical positions of operationalism and inductivism". He argues for the abandonment of the model proposed by Ackoff because of its inability to address the complexity of its own categories. An interesting approach is the one from Bernstein (2011) who uses the DIKW model to understand the hierarchy's antithesis: Missing data, Misinformation and Error, Ignorance; Folly and Stupidity. His analysis provides an unconventional point of view that provides interesting insights to the topic.

### 3. THE CONSTRAINS OF WISDOM

Even if at the top of this model, Wisdom has been avoided due to the impossibility to achieve consensus and understanding of its meaning: the DIKW has often become DIK. Representing and visualizing Wisdom presents cultural (and almost theological) constraints and posed conceptual challenges. At the same time - especially when discuss in comparison with data, information and knowledge visualization - it provides an exciting platform to experiment with creativity and to explore the possibilities in Information visualization.

In most of the literature discussing the DIKW model, wisdom has been put aside and disregarded. The reasons are different and highlight different constraints.

Firstly a disciplinary constraint: this concept is considered to be beyond the domain of the researchers who address the DIKW model. They do not see information and knowledge contributing to wisdom or capable of being interpreted into wisdom (ROWLEY 2007).

Secondarily, we have a philosophical constraint: the idea of wisdom in itself is often directly linked with speculation, religion or a state of the intellect achievable by superior minds. Discussing wisdom outside the philosophical realm seems taboo.

Confucius proposed three methods to learn Wisdom: the Noblest method achieved by Reflection, the Easiest method by imitation, the Bitterest method by experience. All those methods belong to our everyday practice; but even if Wisdom is described as a gift that humankind can enjoy, reachable through several paths in life, there is a tendency to depict it as inaccessible.

According to Confucius wisdom cannot be told by oneself unless asked for by another: a wise man never tells his wisdom unless asked person to person. If wisdom cannot be told it feels even more inappropriate to discuss its definition or visual representation. None of us can claim to be wise, so none of us can attempt to understand what wisdom is - or even less try to visualize it. Because it is not clear what wisdom is, even if we would visualize it

"correctly", it would be impossible to evaluate the appropriateness of that visualization. It is considered socially (and academically) futile to discuss something that cannot be achieved, or proved to be achieved. There is a delimitation of the realm of possibilities to be explored posed by our fear in front of an activity that can be hardly evaluated and measured.

Some argued that the definition of wisdom is not relevant for the problems that researchers in information systems and knowledge management address; but the majority of the authors refer to their inability of addressing the topic; none of them stated its inutility.

In Information Visualization there are even more constraints to be addressed.

There is a tendency to identify Information Visualization as a discipline that deals with computer based visualization. Even if the name "Information visualization" literally means the "visual representation of information," the definition commonly understood implies the use of computational tools for generating visual representation. The first dedicated page of Wikipedia written in 2005 used to define Information Visualization as a subject belonging to Computer Science, built on theory in information design, computer graphics, human - computer interaction, and cognitive science. Indeed the discussion among Wikipedia contributors has led to a definition that removes the direct reference to Computer Science, underlining the different disciplinary contributions to the field: "Information Visualization has emerged from research in human-computer interaction, computer science, graphics, visual design, psychology, and business methods." (BEDERSON AND SHNEIDERMAN 2003)

If we consider Information Visualization as a discipline that deals with information digitally processed and "computers do not have and will never have the ability to possess wisdom" as Belliger (2004B) states, then there should be no need to debate wisdom at all.

Furthermore in the field of Information Design, when we talk about data we always refer to quantitative data, attempts to visualize qualitative data are rare. Digital humanities and other disciplines (CHANG ET AL. 2009; LATOUR 2005; MANOVICH 2008) are recently creating a demand to address the intimidating topic of qualitative data but still the InfoVis community despises incomplete, fuzzy and non-quantifiable entries.

Because Information Visualization does not refer only to computer generated visualization and moreover, behind visualization there is (still) always a human mind, so I believe discussing and training students who are able to attempt representation of wisdom is of great relevance, even more today.

Addressing the concept of Wisdom visualization along with data, information and knowledge visualization is an attempt to push the boundaries of this discipline toward a deeper understanding of the quality of data we visualize.

The aim of this research is not to provide an evaluation of the DIKW model in its self but to evaluate how this model could play a fundamental role in the development and

understanding of visualization techniques for higher education in Design.

#### 4. RESEARCH METHODOLOGY AND RESULTS

The research analyses the work of three classes of students in the second year of the Bachelor program in Communication Design (class of 2011, 2012, 2013), Chulalongkorn University. The proposed brief was to design four-pages folded spread, narrating a family story. The decision of addressing the topic of family narratives comes from the assumption that families are the social group where knowledge transfer happens the most and consequently particularly suitable for a deep reflection on knowledge in each form.



Fig 1. Jacobson's model in Information Design (2000)

The four pages are a base on the DIKW continuum model, each page corresponds to one section of it. The model proposed by Jacobson (2000) in Information Design (Fig1) provided the methodology for developing the brief:

- In page 1 students are asked to Research, Gather, Discover and then Visualize Data about their family;
- in page 2 to Present, Organize and Visualize Information about their family;
- in page 3 to Comprehend, Tell the story and Visualize Knowledge they learn from their family
- in page 4 to Contemplate, Evaluate, Interpret and Visualize their family Wisdom

The students are strongly encouraged to understand which graphic languages better serves the purpose of communicating the content of each page, morphing one language into the other.



Fig 2. Household accidents by Panivarin Kongmahasanti.

In page one (left) the student represented Data in form of dates (captions: 1996, 1993, 1994), in page two (second from left) she represents Information describing what happened (captions: cotton stuck in the nose, the bedspring stabbed my sister's foot, Chewing gum stuck in my hair), in page three (second from right) she explains the Knowledge her dad used to solve the problems (captions: Olive oil removes chewing gum from my hair, Vaseline removes cotton, Betadine first aid antiseptic) and in the last page (right) she visualize her family wisdom (Caption: It develop the bond among my dad, my sister and me)

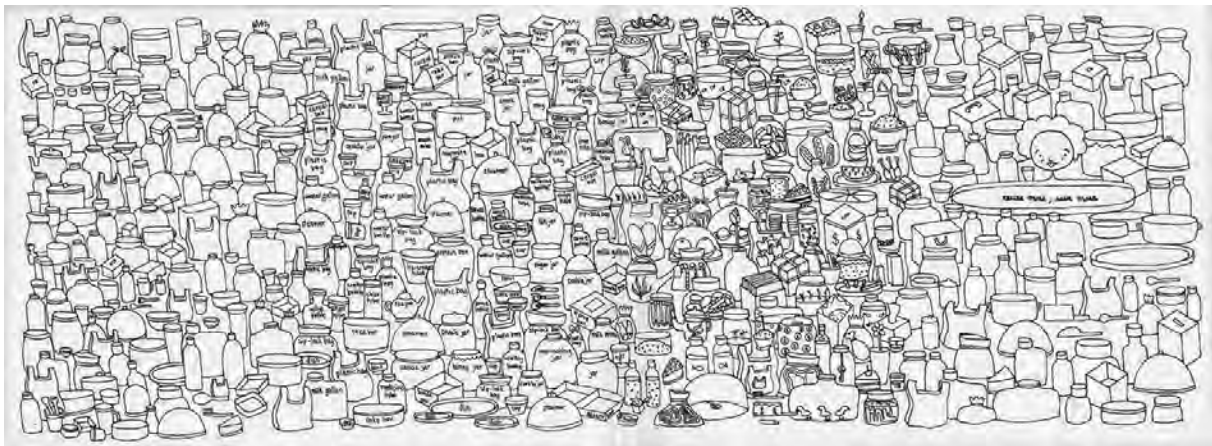


Fig 2. We are hoarders by Worakit Phuksaphiphat.

In page one (left) the student represented Data in form of blank objects, in page two (second from left) the object descriptions transforms data in Information, in page three (second from right) he explains how they reuse the object they keep to perform a new function (see details Fig. 3) and in the last page (right) he visualize his family wisdom (Caption: Reuse more, save more)

The format is inspired by the Thai/Chinese traditional accordion book so called because it folds into pleats and resembles the bellows of an accordion. In Asia paper scrolls and accordion books were used almost exclusively after the 5th century CE (HARRY RANSOM CENTER 2007). In this type of formats the storytelling takes place in one long linear structure and does not get interrupted by the action of turning the pages (as in western books). I collected 130 students' works and analyzed, classified and evaluate the design outputs in order to understand the success of the brief in providing an educational framework to develop their skills in the use of Information design and graphic visual languages. Despite the lack of academic consensus on the exact definition of each category, students feel comfortable with the fuzziness of the concepts. The students in each year find easy to grasp the difference between Information and Knowledge; they effortlessly came out with examples that fit these two sections; in most of the cases after deciding which family story they want to represent they start from planning page 2 and page 3. The visual representation of these two pages comes as well without much struggle.

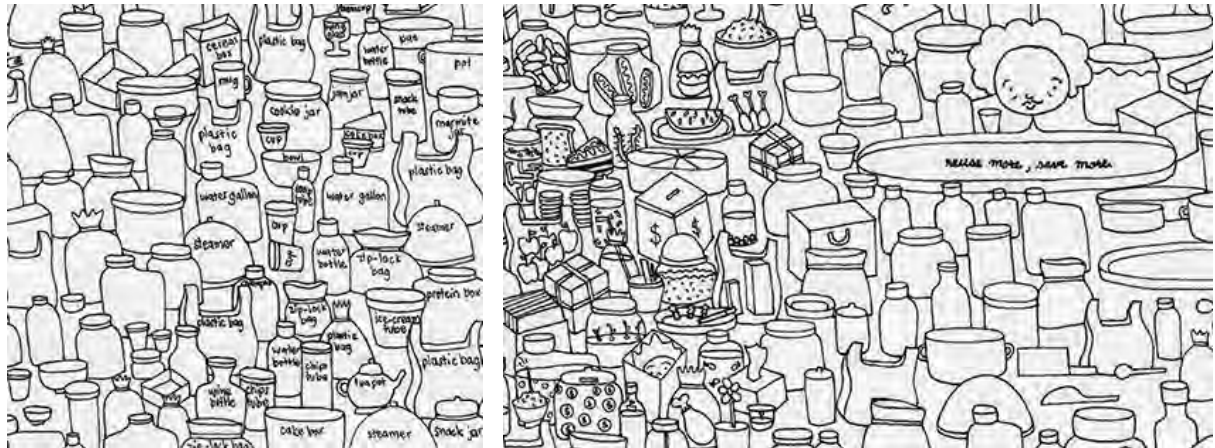


Fig 3. We are hoarders by Worakit Phruksaphiphat (details).

Transition between page 1 Data and page 2 Information and between page 3 Knowledge and page 4 Wisdom

Information is presented in the majority of the cases as contextualized data, typically visualized as a drawing element with a description text. Sometimes the level of details increases and the elements of the composition are correlated and interact in a coherent visual story telling structure (see fig.4). For each of the story they propose to visualize, they can imagine multiple options that would fit the categories of Information and Knowledge. Knowledge is also easily understood conceptually.



Fig 4. Boarding school abroad by Harn Srisuwan.

In 2003 students parents send him to boarding school (left), from Thailand he move to New Zealand where he enjoys childhood (second from left), during the year of high school he discovers his passion for design and drawing manga cartoons (second from right), he decided he wants to excel in the field to make his parents proud (right)

Students present a clear understanding of the difference between tacit knowledge and explicit knowledge (POLANY 1967) as well as know that and know how (CARR 1981; RYLE 1945; SNOWDON 2004) or declarative vs procedural (ANDERSON 2013; NEWELL AND SIMON 1972); probably due to their education in Design where they daily experience the coexistence of both knowledge typologies.

Most of the students identify and classify declarative knowledge (Know that) as Information. For page 3 on family Knowledge, some opted for a visualization of explicit knowledge (know how) and some for visualizing tacit knowledge.

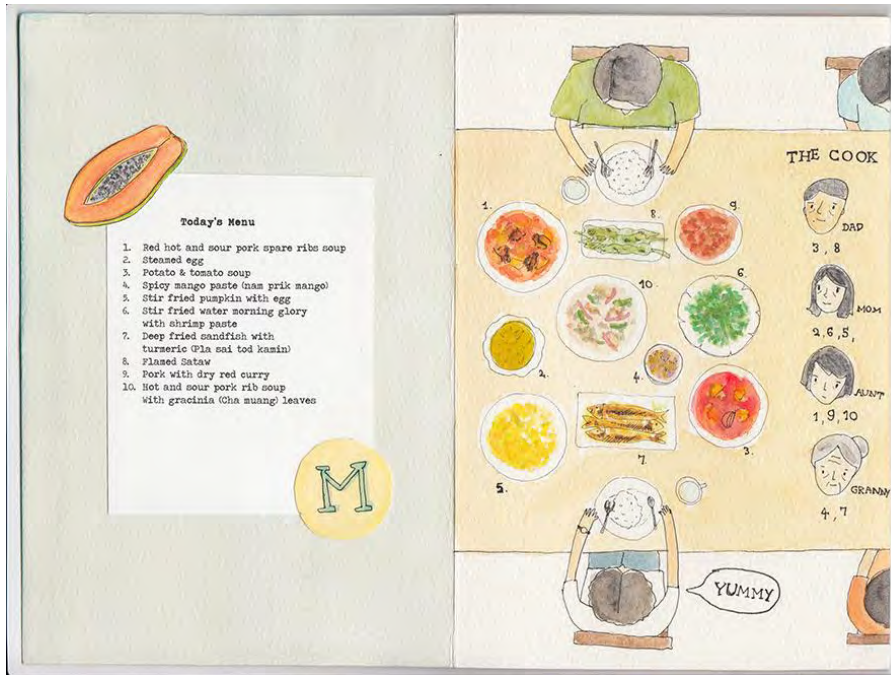


Fig 4. Dinner by Mei Onwara (page 1 and 2).

Data are represented as list of dishes, Information as the relation between each dish and the person who cooks it

In a very interesting case related to the topic of food, even procedural knowledge is classified as information. Often students choose the topic of food as a theme for their design, most of them identify ingredients as Data, recipes as Information, secret tricks or special methods of preparing food as Knowledge and the meaning of food as care as Wisdom. It is interesting that a procedural knowledge as the receipt for a dish is considered Information. I found it quite thought provoking because - as many of them argued - "if knowing how to prepare a dish means reading the recipe, we will all be chefs".

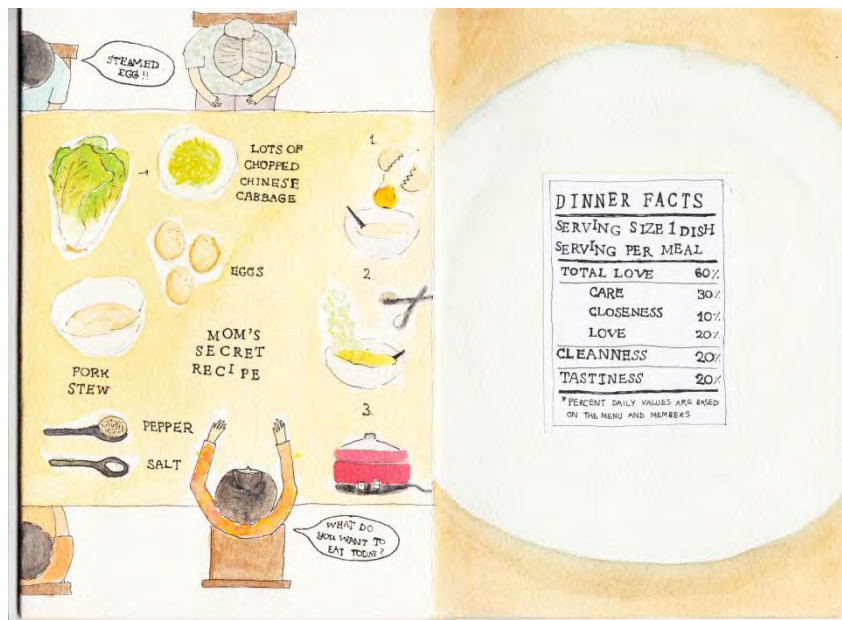


Fig 4. Dinner by Mei Onwara (page 3 and 4).

Knowledge is Mom's secret recipe and wisdom are the percentage of feelings involved and the meaning of having dinner together

Data and wisdom instead presented the same level of adversity but in the exact opposite

domain: wisdom seems very easy to visualize but difficult to find: they seem to grasp what wisdom is but it takes longer to identify a relevant example; once they find it they almost in all cases represent it through a short sentence.



Fig 4. Grandmother and I by Tarin Khumruangrit.

The story narrates the evolving relation between the student and his grandmother and how they take care of each other

On the contrary, data seem difficult to grasp conceptually, it takes time to be comfortable with identify something meaningless. Once they overcome this confusion, they easily find examples but then they struggle again with the visualization: it is difficult for them to visualize elements out of context.

In the following matrix I represent three obstacles student face during the project and how these obstacles relate to the four categories.

	<i>Data</i>	<i>Information</i>	<i>Knowledge</i>	<i>Wisdom</i>
<i>Theoretical understanding</i>	<b>Difficult</b> What is data?	<b>Easy</b> Information and Know that	<b>Easy</b> Know-how and tacit often coming from experience	<b>Easy</b> Asian educational context
<i>Identifying a relevant example</i>	<b>Easy</b> 163 cm, 1993, elements	<b>Easy</b> Project starting point	<b>Easy</b> Secret tricks and personal practice	<b>Difficult</b> Need reflection and meditation
<i>Visually representing the concept</i>	<b>Difficult</b> Refrain to express context	<b>Easy</b> data + visual, saying something about one element	<b>Easy</b> Instructions and Representation of learning	<b>Easy</b> Fundamentally text based

Table 1: Difficulties encountered by students in the brief

These reflections have the potential to foster the discussion on the DIKW model, but the aim of the paper is not to contribute to the definition of the pyramid elements. Students seem to deal with lack of consensus in the definition quite well and the model clearly demonstrates to be able to successfully deep their understanding of these concepts.

There is no doubt that the hierarchical structure is not an appropriate visual representation for the model; the continuum suits the unclear boundaries between the concepts much better than the pyramid and supports for a more flexible understanding of its elements.

## 4. CONCLUSIONS

This paper present the results of a three years research on the possible relevance of the DIKW model applied in the context of Communication Graphic Design education. It investigates how the DIKW model can provide a relevant framework to help student in understanding the difference between data visualization, information visualization, knowledge visualization and wisdom visualization.

Instead of reducing the model to DIK we purposely challenge students to reflect on the concept of Wisdom and experiment on possible ways of visualizing it.

The objective of this paper is not to revisit the definition of these categories, nor to account for a consensus on the pyramid but to discuss if the model can foster the understanding of



visualization techniques in communication design education.

Students' works were analyzed, classified and evaluate in order to understand the educational value of this model in developing their skills in Information design.

The results were encouraging, students demonstrate to enjoy the project deeply. Information Design is made more accessible to them by this experience. Visualizing a story through the DIKW model does not clear all their doubts about the meaning of each elements and their relationship but enable the rising of a class debates and discussion on the topic. Student seems to be comfortable with the grey areas in the definition of data, information, knowledge and wisdom. And they use this fuzziness as a source of creativity.

The relation between the process of planning the contents and visualizing them highly depends on the personal characteristic of each student; in general the visualization informs and supports the understanding of the DIKW model, and the DIKW model facilitates the understanding of different visualization techniques. The students with more abilities in diagrammatic thinking or with more visual mindset tent to start from the visualization and develop theoretical understanding through the practice; students with more conceptual mindsets tent to struggle to visualize what clearly have in mind. Not separating the two phases but developing them in a oscillating process between practices and planning has demonstrated to be the best strategy to get the most out of the brief.

From this experience I can claim that the DIKW model is a winning framework that can play a fundamental role in the education of information designers; taking into account the previous critiques to the model and the debate that they arise, I believe the model should not be abandoned but actually integrated in the curriculum of those educational programs where Data visualization is relevant topic. In a time where Big Data is a fancy term (ab)used in many transdisciplinary contexts, DIKW can provide a platform for deepen the understanding of its meaning. It is a fundamental step to develop a complete understanding of the discipline of Information Visualization and an essential step for education of practitioners who approach this topic from within or outside the design discipline.

In this perspective I strongly suggest for a courageous approach to the model that do not avoid to discuss Wisdom and its visualization, not only because a discussion on wisdom is an important step to a personal growth but because a step toward addressing the qualitative value of the data we visualize is more than necessary for our discipline.

Furthermore, this brief has been used as a platform to experiment with qualitative data visualization and to visualize (without fear) what has been consider impossible to communicate.

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