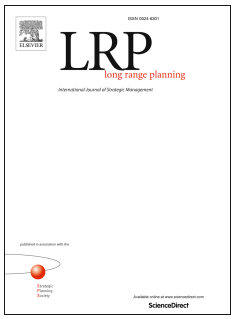
Journal Pre-proof



How digital visualizations shape strategy work on the frontlines

Bijan Azad, Fouad Zablith

PII: S0024-6301(18)30476-X

DOI: https://doi.org/10.1016/j.lrp.2020.101990

Reference: LRP 101990

To appear in: *Long Range Planning*

Received Date: 20 October 2018

Revised Date: 9 March 2020

Accepted Date: 17 March 2020

Please cite this article as: Azad, B., Zablith, F., How digital visualizations shape strategy work on the frontlines, *Long Range Planning* (2020), doi: https://doi.org/10.1016/j.lrp.2020.101990.

Bijan Azad and Fouad Zablith: Conceptualization, Methodology, Investigation. Software Data curation. Writing- Original draft preparation. Visualization. Supervision. Writing- Reviewing and Editing.

How Digital Visualizations Shape Strategy Work on the Frontlines

Bijan Azad*
Associate Professor
Director of Darwazah Center for Innovation Management & Entrepreneurship
Olayan School of Business
American University of Beirut
Email: ba20@aub.edu.lb

&

Fouad Zablith
Assistant Professor
Olayan School of Business
American University of Beirut
Email: fz13@aub.edu.lb

* Corresponding author

How Digital Visualizations Shape Strategy Work on the Frontlines

Abstract

The scholarship on Open Strategy and the role of visualization in strategy work are maturing streams of research. Open Strategy scholarship has so far primarily focused on how employees can contribute ideas to strategy making. Also, the lion's share of strategy visualization research has been on the role of visuals in strategy development by top management. Therefore, focusing on the role that specific visualization features play, especially within strategy realization work by frontline employees, can contribute to the nexus of both streams of research. We attempt to do so by drawing on a qualitative interpretive case study of how a university faculty employed digital visualizations to implement a significant organizational turnaround strategy. The focus of the faculty was on strategically transforming the undergraduate curriculum to reverse quality drift and enrollment decline, while gaining international accreditation. The study findings highlight how digital visualizations' features (i.e., incorporating non-narrative elements, network depiction, and adaptive interface functionalities) influenced the realization phases of strategy understanding and strategy enactment. In particular, the study shows that the understanding of strategy appeared to be enhanced by three affordances, namely, *affectivity*, *relationality*, and *interactivity* of the visualization tools and their associated features. Our study further shows that frontline employees' work on strategy enactment was shaped simultaneously via both *legibility* affordances (aiding the enactment of strategy consistent with the original intent) and *enunciability* affordances (enabling the enactment of strategy beyond the original intent). We contribute to the literature by showing how *digital* visualizing features work together as a bundle of affordances reciprocally reinforcing each other and influencing the strategy realization work of frontline employees, thereby enhancing the understanding of strategy and aiding in its enactment.

Key Words: Strategy Work, Visualization, Digital, Frontline Employees, Open Strategy

INTRODUCTION

The use of visuals among strategy practitioners and researchers goes back a few decades, e.g., Boston Consulting Group's 2x2 matrix, Porter's five forces, and the Business Model Canvas (Henderson, 1979; Porter, 1985; Osterwalder and Pigneur, 2010). However, scholarship on the role of visuals in strategy is more recent (e.g., Eppler and Platts, 2009; Werle & Seidl, 2015). There is a growing body of research that highlights how visualizations can be a means of influencing the strategy process, e.g., highlighting how specific visualization methods and techniques were employed as well as their contribution to strategy making (Kaplan, 2011; Mirabeau & Maguire, 2014; Knight, Paroutis, & Heracleous, 2018). The overwhelming emphasis of this research is on the role of visualizations as a whole, while the specific contribution of associated features remains under-explored.

In a related context, we also want to underscore the fact that there is an emerging consensus criticizing the conventional wisdom on strategy research on two fronts: first, that the focus has been too much on strategy making by the upper part of the organization (e.g., Hrebiniak, 2006; Vaara & Whittington, 2012); second, that when the research focuses on strategy realization (as opposed to strategy making), it largely treats frontline (non-managerial) employees' role within strategy realization as that of pure executors or "choice-less-doers" (Martin, 2010; but there are exceptions, e.g., Balogun, Best, & Lê, 2015). In response, Open Strategy scholars and others have attempted to address these criticisms at least partly by focusing on research that emphasizes the inclusion (who is involved) and the transparency (what information is provided) dimensions of strategy process (e.g., Hautz et al. 2017; Arnaud et al. 2016; Mack & Szulanski, 2017). However, the lion's share of research in the latter area is mainly concerned with the contribution of ideas by non-managerial employees to strategy development (e.g., Baptista et al. 2017).

Building on the Open Strategy and visualization research so far, there is an opportunity to tease out the role of frontline employees, not only in contributing ideas to strategy development, but also on how technology can aid their participation in the realization and implementation of the strategy. More specifically, it is valuable to focus on how the use of *visualizations*[1] and their distinctive *digital features* can shape the strategy realization process that involves frontline employees' participation. Therefore, our research question is proposed as follows: *How do digital visualization features influence the work of frontline employees in the strategy realization process?*

To answer this research question, we studied frontline employees' perspectives and actions during a strategic change initiative in one division of a large organization—faculty members at an internationally accredited (by the Association to Advance Collegiate Schools of Business) business school in a leading regional Eastern Mediterranean university (8,000 students, 1,000 academic staff). The case involved how the business school implemented a critical strategic turnaround to counter: (a) the drift in its core curriculum product, (b) the commensurate poor student engagement, (c) the threat of decline in enrollment, and (d) the dire negative financial consequences for the university. The strategy aimed to address the latter by focusing on reducing overlap among courses as a way to transform the curriculum, thereby achieving greater integration and better coordination in the organization. The strategic significance of this activity was underscored by the fact that it was an integral pre-requisite for re-accreditation of the school. Data were collected to implement the curriculum transformation strategy based on observations of committee meetings and video recordings of instructors' practices. We focused on how digital visualization tools and their features were enrolled in the actual process of realizing the curriculum transformation strategy. The digital

[1] We employ a set of visualizations that build on digital semantic web-based data representation as well as open-source tool kits that allow flexible designs and are described later.

tools included Sankey, Forced Node, Treemap, and Mapping Table diagrams serving as maps visualizing relations among courses in the curriculum. The features of the digital tools included colors, shapes, widths, network graphics, links, drilling up/down, popups, etc. We analyzed the use of these tools and studied how the distinctive features of digital visualizations and the associated affordances could play a potential role in the strategy realization work of frontline employees.

Our paper contributes to research at the nexus of digitality, visualization, and strategy process in two ways. First, we demonstrate how key granular visualizing features (non-narrative symbols, network structure depictions, and highly interactive interfaces) enhance the frontline employees' *understanding* of the strategy via their *digital* integration and mutual reinforcement. These processes take place via the bundle of three affordances, i.e., *affectivity, relationality,* and *interactivity*. Second, we suggest how the same digital visualizing features can aid the frontline employees' mode of participation in the *enactment* of strategy by simultaneously guiding it via *legibility* affordances or by sparking a strategy re-design via *enunciability* affordances.

THEORETICAL FOUNDATIONS

From Using Visualizations to Studying their Features' Role within the Strategy Process

In strategy theory and practice, the field has been imbued since its inception with the use of visualizations and diagrams to highlight strategy development and strategy implementation (e.g., Henderson, 1979; R. S. Kaplan & Norton, 2001; McGee & Thomas, 1986; Porter, 1985). For example, one of the most well-known and perhaps oldest strategy diagrams among practitioners is the Boston Consulting Group's 2x2 matrix (Henderson, 1979). Also, Michael Porter depicted his theory of five forces of competition via four circles highlighting the qualitative impact of product substitutes, bargaining power of suppliers,

threat of new entrants, and bargaining power of customers. These all exert influence on rivalry, depicted as a circle in the center (Porter, 1985). The Strategic Group Maps illustrate on the X-Y axis the relative placement of rival firms with similar competitive approaches against their positions in the same market (McGee & Thomas, 1986). The Balanced Scorecard framework visualizes in a 2x2 matrix the four elements of a company's performance internal processes, customer satisfaction, financial health, and innovation/learning, which are driven by vision and strategy in the diagram's center (Kaplan and Norton, 2002).

Despite more than four decades of using visuals to drive home points of strategy development and implementation, the scholarly study of the visualizations' role in strategy is relatively recent (e.g., Eppler and Platts, 2009). Thus, it is not surprising that visuality and visualization in the study of strategy work are beginning to gain a dedicated research following. For example, Knight et al. (2018) have highlighted the power of PowerPoint as a means of providing strategic visibility within the strategy-making process at the top of the organization. To produce greater precision and specify how visuality in strategy work makes a difference, there are calls for focusing on the particular role that visual features play in generating a cognitive impetus for strategy and aiding the implementation of strategy (Knight & Paroutis, 2019). Building on the general conclusion that visualization artifacts are salient in the meaning inferred during the strategy-making process, finer-grained aspects of the visuals (e.g., size of objects, line thickness, and shapes) can be analyzed to understand their specific contribution to strategy work. The importance of this granularity is that each visualizing feature can potentially be an instance of how it affords specific action possibilities in the process of strategy realization. Indeed, we intend to focus on the role of granular visualization features in the strategy realization process and how they influence the participation of frontline employees in it.

Role of Digital Visualization Features in Frontline Employees' Engagement with Strategy Realization

The study of strategy until recently has continued to emphasize strategy making over strategy realization, despite documentation of the need to analyze the latter four decades ago (Mintzberg, 1978; and Burgelman, 1983). Also, scholars have directed our attention to the process and "the how" of strategy, stressing that strategy realization does not always align well with "the intentions of top management" (Mirabeau & Maguire, 2014, p. 1204; Van de Ven, 1992 Balogun & Floyd, 2010). From this perspective, we can see three things at once: first, strategy realization is within the purview of the whole organization; second, the role of agency at the lower levels is highlighted; third, actions taken in realizing strategy may not be consistent with the intended strategy.

Currently, the work of Open Strategy scholars has begun building on the above arguments, highlighting the need to go beyond the top management and to consider the participation of non-managerial employees in the strategy process (e.g., Hautz et al., 2017). In particular, Hautz et al. (2017) propose that the Open Strategy scholarship focuses on two key dimensions of strategy openness that are particularly worthy of further elaboration, namely, inclusion (who is involved and how) and transparency (what information is shared and how). Regarding both dimensions, digital technology is thought to promote inclusion and transparency, especially in regards to the participation of stakeholders inside the organization (e.g., Bjelland & Wood, 2008; Stieger et al., 2012). For example, in this context, Baptista et al. (2017) focus on the contributions of blogs and wikis in providing greater transparency to the strategy process inside the organization. However, currently, Open Strategy research is primarily focused on the role of employees in strategy making and how they could contribute their ideas through digital technologies. Therefore, research that focuses distinctively not only on the participation of the frontline employees but also on how they may influence the

strategy realization process via the features of digital visualization tools can potentially contribute to Open Strategy's dual dimensions.

Role of Visualization in Strategy Work via Affordances-Symbolic Interactionist Theories

For our empirical analysis of visualization's influence on strategy realization, we draw on the affordance theory and the Symbolic Interactionist (SI) theory. We rely on these theories because of their parsimoniousness and their explicit emphasis on (1) an object's materiality-function providing action possibilities for the actor, and (2) the motivating social actions induced by those meanings (Blumer, 1986, 2004; Charon, 2001; Faraj & Azad, 2012; Gibson, 1979).

We start by illustrating what we mean by affordances (of digital tools) (Gibson, 1979). Here we draw on the notion of affordances as the same material features affording different functions via actors' roles or practices (Treem & Leonardi, 2012; Faraj and Azad, 2012). For example, within a digital search tool such as the Google Scholar search engine, a screen search box with distinctive material functionalities (e.g., tick boxes) affords lawyers the possibility of doing a case law search while allowing scientists to do a scholarly article search. In other words, the same artifact may have many affordances, a multitude of functions as the basis for action possibilities or potentialities (Fadel and Maier, 2009).

The related notion of a bundle or field of affordances, which comes from ecological psychology and enactive cognitive science, is important to highlight. This perception highlights that affordances usually exist as a "field of affordances," but it is possible to analytically focus on "affordances that stand as relevant for a particular individual in a particular situation" (e.g., de Haan, Rietveld, Stokhof, & Denys, 2013; Rietveld & Kiverstein, 2014). In other words, there is usually a bundle of affordances in the actor's field of action.

However, a specific affordance solicitation may be contextually (e.g., spatiotemporally) the focus of the actor's attention. This affordance, therefore, draws an actor to a particular action due to its current relevance, i.e., the way that it stands out in the perceptual field—in the context of the currently unfolding action sequences. For example, if my apartment doorbell rings, the door suddenly becomes solicitous in the sense that it becomes the most relevant object to guide my action to obtain the pizza that I ordered. As I get close to the door, the doorknob becomes more solicitous for what I need to do, and so on. The field of affordances is bundled together and exists as such, regardless of the context focus of my actions—in this case, the doorbell sound, the doorknob, the door, its opening, etc. This serves to illuminate the fact that, save in trivial situations, we experience affordances as a bundle in the background (I assume they exist as a background "invisible" within the context of modern apartment living practices), e.g., anchored in "bundles of features" that enable multiple affordances in a given context (Faraj & Azad, 2012).

However, the affordance theory, though implying action possibilities, is often silent on the follow-on action that is taken by the actor. As such, we would like to augment the affordance theory by also drawing on Symbolic Interactionist theory's singular focus on the object-symbol-meaning-action constellation. SI theory tells us that a chair has meaning for an actor taking the action of sitting on it within a given milieu[2]. Each object—in our case, an organizational strategy—has a meaning(s) in terms of the symbolic representation and the subsequent meaning it has. It can be concrete, such as a "bump" sign on the side of the road signifying a bump lies ahead, or abstract, such as the word "freedom" symbolizing a state of

[2] Think of a chair. It has material features that give it seatability affordances for urban folks. But a nomadic people, used to squatting, with no knowledge of chairs, or never having seen or heard of them, would not see a chair in this light if it were suddenly brought into their field of vision. They would see it as some other kind of object, possibly a weapon or a rack on which to hang things, but not as a chair. The kind of object it would be (its meaning) for them would depend on how they were initially prepared to act toward it—in large part due to what it symbolizes for them.

being unrestricted. This parsimonious emphasis on object-symbol is a boon for our analytical scaffolding.

Now, however, once the object and its symbolic representation exist (e.g., a strategy as a mission statement; or for example, a picture of Einstein with the words "Be Different" next to it along with the Apple logo), it can be used as a basis for action; one can understand the strategy, point it out to someone else, talk about it, and so forth. This latter kind of action would not be possible were the strategy not meaningful and perceived to be so (i.e., an object with a certain symbolic representation and thus a specific meaning) (Blumer, 2004; Charon, 2001). Therefore, to summarize, SI argues that there are two broad stages in interacting with an object: (1) an initial meaning given to the object via symbolic representation that induces understanding by an actor; and (2) a subsequent form of conduct carried out by the actor based on this understanding (Blumer, 2004, p. 44). It is important to see the latter separation between understanding and action as an analytical notion since the two are highly intertwined in practice.

RESEARCH METHODOLOGY

Theoretical and Empirical Rationales for Site as well as Case Selection

The objective of our research is to study the distinctive role of *digital visualizing features* in the work of *frontline employees* when implementing *strategic change* within an organizational environment. It was of critical importance to employ a case site where the phenomenon under study provides "cartographic relief" to each of the above elements and facilitates their examination—what is often referred to as a "revelatory" case (Yin, 2014). The study of strategic change in pluralistic contexts, such as healthcare organizations and universities "characterized by multiple objectives, diffuse power, and knowledge-based work

processes" (Denis et al., 2007) implies that organizations may often be less reliant on their hierarchy to achieve objectives, especially strategic changes (Cunha et al., 2011).

Our study of strategic change in a university faculty's teaching mission carried out by instructors (professors) on the frontlines, performing knowledge-based work within a very loose power structure and often trying to satisfy multiple objectives, offers a good fit with the above requirements. Indeed, our choice of university-based strategic transformation is in line with the work of several leading scholars who have relied on academia as a beneficial site to study strategy with a focus on elaborating key theoretical questions, e.g., sensemaking and strategy-as-practice (Gioia et al., 1994; Gioia & Thomas, 1996; Jarzabkowski, 2004,; Jarzabkowski & Seidl, 2008).

We chose as our case site an AACSB accredited school of business (1,400 students) within a medium-sized but elite, 160-year-old international university (8,000+ students) in the Eastern Mediterranean. The undergraduate teaching program brought in significant revenue, and the school was a net positive financial contributor to the rest of the university, giving back more than 200% of its costs. As such, the business school perceived a laser-sharp focus on the teaching mission as critical to its survival. Within the immediate past strategic planning cycle, the school's management had identified "drift" in the integration and coordination of the teaching process and discernible quality slippage. Furthermore, it had highlighted this drift as a significant cause of weak student engagement after holding focus groups with students. The problems seemed particularly acute as the school size grew from five full-time faculty members in 1992 to 50 in 2014 (this number had risen to 62 as of

2019)[3]. There appeared to be a drop in quality as the organization size had grown more than ten-fold, and the number of courses had increased.

A visible sign of this quality drop among students (who are customers of the organization in a "market" sense) was their view that there was repetition among the courses. Students perceived there were inefficiencies in the curriculum, i.e., "Why are we taught the same topic more than once?" This concern was further confirmed during the re-accreditation activities that the school completed in 2014—the report of the visiting committee stated that for the next cycle, the school should improve student engagement and reflect it in a revamped curriculum. The phrase that characterized this situation, both in the student focus groups and following the accreditation visit, was that there was "overlap among undergraduate core courses." To the management of the school, this confirmed the drift in quality control, due to poor coordination of teaching content and processes between departments.

To make matters worse, it was not a secret that such a slippage in the delivery of a high-quality and focused curriculum would conflict with the elite premium tuition students were paying. As such, it was thought that if the school did not reverse this drift soon, it could see a dip in enrollment with significant negative financial implications for both the business school and the university. Therefore, a curriculum transformation to solve the problem of course overlap was needed for a strategic turnaround of the school—a change that was akin to a fundamental strategic product or business model change in a company (e.g., Casadesus-Masanell & Ricart, 2010).

[3] The impact of the curriculum transformation was at least partially reflected in the significantly improved ranking of the school 3 years later, in 2018-2019, in the QS (https://www.topuniversities.com/university-rankings).

Multi-Course Curriculum Mapping as a Tool for Strategic Change

Over the last two decades, the use of curriculum maps as artifacts and curriculum mapping as a process has become commonplace for educational organizations as a way to understand their current curriculum contents better and transform them (Ervin et al., 2013; Rawle et al., 2017). These maps have come to augment or supplant syllabi topic lists and core textbook tables of contents (ToC) because they help provide a more holistic view of the curriculum and are less time-consuming to use.

Generally speaking, a "map" is a visual representation artifact and can be in the form of tables, links-nodes, or various other types of information (Wijngaards-de Meij & Merx, 2018). The analogy to a geographic map pinpoints the capability of maps in whatever format to serve as a representation of the underlying item and, at the same time, to provide links that connect one piece of information to another. Professional fields utilize maps in a variety of ways to present information (e.g., a map of a genome or a diagram of health disciplines). A curriculum map identifies how a curriculum aids the development of competence through instructional means, e.g., course connections, gaps, and areas for improvement.

Archambault and Masunga (2015) have emphasized the role of curriculum maps as a potent strategy development and implementation tool at the university or faculty level for better insight into overall curricular and instructional objectives. They point out how developing curriculum maps and reviewing them by conducting focus groups with faculty can be an effective way of refining the curriculum and transforming it strategically. Furthermore, these researchers propose developing a curriculum map to identify courses that represent strategic points for interventions in the teaching mission of the university/faculty by focusing on a systemic perspective across and within courses. Consistent with our orientation, they further advocate a visualization-based approach via software to depict the paths and

requirements of "how instruction efforts can be best re-directed" to undergo strategic transformation (p. 6).

Design of Digital Visualization Features to Enable Curriculum Transformation

Our interest is to study the role of digital visualizing features in the rectification of overlap among core courses as a strategic organizational initiative, with an emphasis on the frontline employees' actions within this process. In particular, we want to uncover key visualization factors that could be related to this effort. Towards that end, we focused on two relevant streams of literature, viz., semantic web visualization designs (e.g., Dadzie & Pietriga, 2017) and digital curriculum mapping (e.g., Dyjur & Lock, 2016) in university environments. In particular, we focused on: (a) how to represent the existence of common concepts as a potential instance of overlap among courses via entities and relationships that can be visually displayed and manipulated, and (b) how to offer a means of examining, assessing and rectifying the course overlap.

Based on feedback from the Curriculum Committee members, a consensus emerged that some people preferred more sophisticated features while others would opt for simpler ones. The design team further explored existing tools and their accessibility (low cost/relatively good support).[4] A key realization was that off-the-shelf visualization tools did not lend themselves to the task at hand. In essence, critical functionalities of curriculum mapping for course overlap detection were not available. Thus, the design team converged on four custom-designed tools[5] based on two essential requirements: the positive response of

[4] Curriculum data were assembled via a Semantic MediaWiki (Krotzsch et al., 2006) that helped us capture courses, topics, and related concepts (https://linked.aub.edu.lb/collab/). The key feature of this software environment is its semantic web/linked data layer. It offers two broad sets of capabilities for: (a) capturing linkages among the curriculum data elements with explicit semantics, and (b) retrieving such links and their connected entities to visualize them through open-source interactive tool kits (e.g., JavaScript).

[5] Initially, six visualization tools were designed. However, two were rarely employed by users. Thus, we considered only four in our analysis.

curriculum committee members to the initial demonstration of commonly used visualization tools, and designers' assessment that they could represent the course concepts and the relationships among them fairly seamlessly and with little effort. Almost all the instructors eventually used these four cross-course digital visualization curriculum maps. We refer to the visualizations as Forced Node, Sankey, Mapping Table, and Treemap, each of which had a different set of features and data. Table 1 illustrates the visualization tools that we included in our study, with a selection of their digital visual capabilities. The visualizations show the connections among courses, topics, and concepts, and thus provide more visibility to the curriculum as a whole and enable a more in-depth visual understanding of cross-course contents and relations.

Collecting Data on Frontline Employees' Strategy Work using Digital Visual Tools

For our research, we conducted sessions where we asked instructors to tackle the "rectify course overlap" issue. Twenty-five faculty members volunteered to be observed while engaging in the process of rectifying course overlap. Their task was to work on the "rectify course overlap" issue relevant to their respective course. We instructed them to use any of the four digital visualizing curriculum maps and textbook ToCs, as well as syllabi topic lists. We "primed" the instructors in the working session as follows:

> "Students are claiming that more than 25% of [selected Course A] overlaps with [selected Course B]. Please eliminate this course overlap."

We explicitly "quantified" the degree of overlap as 25 percent (which is an exaggerated statement and not a representation of the actual situation across the board) to all participants "to provoke a visible response." Then we "traced their response" to this claim, and how they tackled it—while noting their actions when/how they engaged with the problem and used the text-based and digital visualization tools. We video-recorded the sessions and captured the computer screens. We adopted a think-aloud technique (De Souza, 2005; Prates

et al., 2000), and encouraged the participants to express and be verbose about their actions while working on the given task. We developed a protocol that was closely followed by the session moderator to ensure consistency among the sessions.

Visualization	Zooming in on Selected Digital Visual Capabilities	Description
<<<<INSERT Table_1_Figure_a HERE>>>> Forced Node	<<<<INSERT Table_1_Figure_b HERE>>>>	The Forced Node visualization employs sophisticated linked data capabilities provided by the software platform to display items interactively. This digital map represents courses and concepts as nodes and the connections among such nodes as links. The paths among all courses and concepts are visible. Selected nodes turn red, and the size of a node reflects the number of links to other nodes.
<<<<INSERT Table_1_Figure_c HERE>>>> Sankey	<<<<INSERT Table_1_Figure_d HERE>>>>	The Sankey diagram is designed to highlight how concepts flow from a specific course to other courses in the curriculum. Sankey represents courses and topics as nodes, with common concepts among courses displayed in the center. The explicit links highlight existing connections. Links are rendered in gray, and courses/topics are colored differently to create contrast. The line width reflects the number of concepts shared between the nodes.

Visualization	Zooming in on Selected Digital Visual Capabilities	Description
<<<<INSERT Table_1_Figure_e HERE>>>> Mapping Table	<<<<INSERT Table_1_Figure_f HERE>>>>	The Mapping Table displays the occurrence of concepts in courses and topics. Courses and concepts are gray, topics are yellow, and the concepts shared between courses are in red. Nodes are rendered in the table's first column and headers, and links are represented by "X" marks. The number of Xs reflects the number of times a concept occurs in the curriculum.
<<<<INSERT Table_1_Figure_g HERE>>>> Treemap	<<<<INSERT Table_1_Figure_h HERE>>>>	The Treemap visualization reflects the distribution of concepts at the various levels of the curriculum: subjects, courses, and topics. Colors and sizes of each rectangle in the Treemap are rendered dynamically and are relative to all other nodes on the map. A node is visually represented by a rectangle and may represent subjects, courses, or topics. Nodes are linked from the "root" to the "leaf" levels to represent the hierarchy and connections among the three curriculum levels.

Table 1 - Illustrations of the Digital Visualizations with a Selection of their Digital Capabilities

The sessions included a short training and introductory portion. There was a follow-up part wherein each instructor freely used the tools provided to engage with the tools and verbalize their experience. This part forms a significant share of our data analysis and findings. Finally, the session ended with a discussion and interview after they had finished working with the artifacts and started reflecting on their experience—which also formed a critical part of our data analysis. We designed the sessions to last around an hour. The sessions resulted in a total of 25.25 hours of video recordings. We transcribed all the videos, which generated a substantial and rich corpus of text and video data for our analysis.

Data Analysis: Protocol, Process, and Categories

We analyzed frontline employees' reflections on their usage of the digital visualizing curriculum maps to resolve the course overlap. We paid particular attention to analyzing their expressed logic of action as well as their real-time articulation of the utility of the curriculum maps' features and associated affordances during their engagement with them.[6] The objective of the analysis is to investigate how digital visualizations and their features influence the work of frontliners in the strategy realization process. We processed the "reflective interview" and the video transcription portion. We relied on the affordance theory's tenet that an object has action possibilities which helped us conceptualize distinctive capabilities provided by digital visualizations (Gibson, 1979). We then, combined this with the notion that the latter object's affordance operates through an object-symbol-meaning-action constellation to potentially trigger understanding and mobilize action as suggested by Symbolic Interactionist theory (Blumer, 2004).

[6] It is important to note that textbook tables of contents as well as syllabi topic lists were made available to instructors as course maps. However, these were "single course maps." We monitored their usage by instructors and found they were not employed at all by 13 of our participants. The remaining 12 attempted to use them, but usually stopped after a short period of time. We asked these 12 instructors why this was the case. They tended to answer that it was difficult if not impossible to link the common concepts among courses via ToCs and syllabi (i.e., it took much more work). This led us to focus in our study on analyzing the use of digital visualizing tools.

The intertwining of the Affordance-SI perspectives served as a sensitizing device (Klein & Myers, 1999) for analyzing an actor's engagement with the strategy visualization artifacts as "images" or "symbols." That is, these visualization artifacts, as well as their features, are a special kind of symbolic representation of the object, i.e., an "image" of strategy. These images can provide affordances: (a) that form a "cognitive impetus" highlighting specific meanings and understandings (and not others); (b) that mobilize or "incite" action towards that image or object. In summary, the visualization features' affordances induce, enable, or facilitate a set of activated understandings; these activated understandings can subsequently translate into a form of overt (or covert) action. Furthermore, our analysis and coding were inspired by the Gioia et al. (2013) approach. We present in Figure 1 the data collection and analysis activities.

<<<<INSERT FIGURE 1 HERE>>>>

Figure 1 – Data Collection and Data Analysis Activities

Our initial analysis of the data zeroed in on the key visualizing features that the instructors had highlighted in their references to their use of visualizing tools, as well as the notes we made when watching the videos and studying the transcripts. These references often pointed to noticing features like dimensions, colors, shapes, sizes, arrows, line width, animation (e.g., of a jellyfish), self-configuration, paths, traces, drill-downs, etc. Next, we made another pass through the features to reduce these and derive higher-level categories of visual elements that provided utility to the frontline employees to understand the curriculum transformation strategy better. Using data formatting and analysis procedures recommended by Miles, Huberman & Saldana (2013), we grouped recurring references to a few specific high-level visual feature categories as follows: non-narrative (non-text features of visualization rendering the object visible), connective (visual features revealing a network structure), and adaptive (visual interface features providing ease of user interaction). We describe the resulting features in Table 2.

It is important to note that users mainly interacted with the visualizations holistically during their strategy realization practices (e.g., users did not necessarily experience either colors or a Sankey diagram alone). However, based on our research interest and analytical focus, we honed in on the sub-components of the visualizations, i.e., features, which were sufficiently fine-grained to allow us to answer our research questions. Table 2 provides in the first column a granular analytical representation of the salient features of interest to our research. These representations of features, e.g., icons, illustrate key functionalities that the visualizations are expected to provide thereby assisting an enhanced understanding of the focal object, i.e., overlap rectification strategy. The *color and size* icon represents diagrammatic representation of relative magnitudes via colored shapes. The *links and nodes* icon represents a connection between two elements. The *width and bandwidth* icon reflects a degree of intensity between two items on the screen. The *interdependence* icon shows highly interlinked objects that depend on each other. The *traceable paths* icon represents potential ways to navigate the linkages between objects. The *part-whole* icon reflects the fact that some items are contained within broader entities. The *dynamic content* icon represents how the same data source can be rendered and updated on different screens dynamically. The *reconfigurability* icon highlights how different elements on the screen can be reconfigured in ways that adapt to the user's requirements. The *animation* icon represents how digital visualizations support animating elements to make visible on-demand information items that, if displayed all the time, would cause negative cognitive overload for the user.

A similar data analysis process allowed us to derive two categories of visual capabilities that helped instructors to mobilize action toward the strategy and enact it: compliance (features that promote the fidelity of each object and its visual representation) and generativity (features that trigger exploration beyond the original intent). Table 3 provides additional illustrative context to the identified categories. Compliance elements are

represented by a funnel to illustrate the conformity among the different strategy-related objects and the convergence to a cohesive target. However, generative elements are represented by an inverted funnel to exemplify how such features can trigger an open-ended exploration of strategy-related objects beyond their initial intent.

Armed with the notion of visualization features providing a "field of affordances," whereby those affordances trigger understanding of an object and mobilize action towards it, we performed a third pass through the data. The objective at this level was to see how the visual features and associated categories were assisting the instructors in their analysis of the course overlap situation: what was the specific feature helping the instructor do regarding the curriculum change strategy? We revisited the think-aloud transcript data, the recorded videos, and the interview data to re-examine the visual features that the instructors were referring to, along with the action possibilities that the features allowed them to perform.

	Salient Visual Feature Icon	Feature Category & Description	Visual Feature Instance	Affordance of Visual Feature	
Non-Narrative Features	<<<<INSERT Table_2_Figure_a HERE>>>>	- *Color & size* draw the attention of users to specific elements in the visualization - *Links/Nodes* reflect an association between two or more entities - *Width & Bandwidth* highlight a degree of intensity in specific connections	<<<<INSERT Table_2_Figure_b HERE>>>>	*Non-Narrative Elements* - Inspiration: Gregg and Seigworth (2010); Shaviro (2007); Ahmed (2010). - Key points: the significance of affect and sensations as non-narrative phenomena. - The non-narrative features within digital maps: "affects that make us feel, think, and act." - These also provide cognitive "stickiness," which renders particular objects affective: connecting actors with the ideas and objects animating their values. - We refer to these as *affectivity* affordances.	Facilitate Strategy Understanding
Connective Features	<<<<INSERT Table_2_Figure_c HERE>>>>	- *Interdependence* shows how elements in the visualization depend on each other - *Traceable Paths* enable traversing and tracing paths on the network structure - *Part-Whole* brings transparency to the inner network components and how they fit and connect with the high-level scope	<<<<INSERT Table_2_Figure_d HERE>>>>	*Network Structure* - Inspiration: Gluga et al. (2012); Kalz et al. (2007). - Key points: the structural representation of the object as a network of elements—i.e., relationships of topics, concepts, courses, and subjects, useful in different contexts. - Instructors pointed out the advantages of this network approach concerning strategy realization within the organization. - We refer to these as *relationality* affordances.	

	Salient Visual Feature Icon	Feature Category & Description	Visual Feature Instance	Affordance of Visual Feature	
Adaptive Features	<<<<INSERT Table_2_Figure_e HERE>>>>	- *Dynamic Content* provides automated screen content updating based on the selections performed by the user - *Reconfigurability* enables users to reconfigure the screen layout through clickable visual entities and screen settings - *Animation* offers contextual information through on-demand animated transitions that complement the existing information in-focus	<<<<INSERT Table_2_Figure_f HERE>>>>	*Adaptive Interface* - Inspiration: Kostelnick (2008). - Key points: that interactive user interface/user experience (UI/UX) features offer users the capability to adapt the tools to their needs dynamically. - These features are standard for 3 reasons: (1) there are situations wherein a substantial amount of data is potentially overwhelming without a dynamic UI/UX; (2) users expect a threshold level of dynamism in UI/UX and may not use the tools otherwise; and (3) an adequately designed UI/UX can be a boon in visualization as an aid to understanding any object or an abstract representation. - We refer to these as *interactivity* affordances.	Facilitate Strategy Understanding

Table 2 - Illustrations of the Representations of Salient Visual Features and their Corresponding Affordances

Conceptual Representation	Example of Participant's Comment	Affordance of the Visual Tools	
<<<<INSERT Table_3_Figure_a HERE>>>> Compliance Elements	I agree that there is an overlap between the Finance and Accounting course to a certain extent; the first couple of chapters in finance are more of accounting topics than finance, and therefore could be given less weight or incorporated within the chapters, so they do not feel as repetition	*Compliance* - Inspiration: Lynch (1960); Ruivenkamp & Rip (2014). - Key points: how a city landscape has defining characteristics in that various pathways and buildings that are available to people motivate them to traverse the city along the intended paths while noticing the targeted elements of the landscape. - A visualizing artifact may possess a similar capability of high-fidelity representation, thus inducing users to experience "its functions or uses" as the intended ones. - In this context, the central issue of course overlap and its associated pivotal strategic role in the curriculum transformation process appeared to be captured by the visualizations in at least three ways, namely, *executability*, *fidelity*, and accentuating *authority/hierarchy*. - We refer to these as *legibility* affordances.	Facilitate Strategy Enactment
<<<<INSERT Table_3_Figure_b HERE>>>> Generative Elements	In some places, I saw clear overlap, but at other times, I saw that the apparent "overlap" was not overlap but maybe an intentional design in the curriculum, which we should probably leave it as is. However, I see the visuals as a potential way of identifying gaps in the curriculum!	*Generativity* - Inspiration: Kostelnick (2008); Pottage (2012); Yaneva (2014). - Key points: generativity of digital technology in providing a platform for users to visualize as a means of sparking the rethinking of existing problems and solutions. - It has also been pointed out that visual artifacts afford users the ability to synthesize the data in different ways, "with a rich underlayer of possibilities" waiting for the user to discover. - This generative feature of digital visualizations emerged in our data as a discernible pattern, enabling users to shift from being passively engaged with strategy to being actively involved with its potential reinterpretation and co-creation. - We uncovered patterns of engagement with the digital visualizing maps that enabled multiple and mutable understandings of the course overlap issue and the associated curriculum transformation strategy, especially regarding how to go about its implementation. The focal generative themes enabled by digital visualizations were three: namely, enabling *reinterpretation*, fostering *emergence*, and promoting *co-creation*. - We refer to these as *enunciability* affordances.	

Table 3 – Salient Visual Capabilities that Facilitate Frontline Employees in Enacting the Strategy

The patterns that emerged from the data set enabled us to highlight a set of distinctive affordances that were associated with digital visualization features. Specifically, digital *affectivity* (enabled by non-narrative visual elements), *relationality* (highlighted by network structure visibility), and *interactivity* (embodied via adaptive interface) affordances appeared to produce an enhanced understanding of the strategy, collectively and in an integrated fashion. Also, the latter three affordances as a bundle contributed to mobilizing strategy enactment either via *legibility* affordances (facilitating compliance with the strategy) or via *enunciability* affordances (aiding generativity of the strategy)[7]. The right-hand columns in Tables 2 and 3 provide further details on the affordances. Figure 2 integrates the analysis results in our adaptation of the data structure in Gioia et al. (2013).

<<<<INSERT FIGURE 2 HERE>>>>

Figure 2 - Dimensions (Gioia Data Structure) Resulting from the Data Analysis Process

FINDINGS

We present our findings in three parts. Based on our overall findings, we found digital visualizations and their features to be consequential for strategy realization, i.e., they tended to enhance the understanding of strategy and aid the implementation of strategy. In the three parts of the findings we show how visualizations and their features influenced and shaped the process of strategy realization as engaged in by frontline employees. Part One focuses on describing how the understanding of the strategy of eliminating course overlaps was enhanced by three higher-level digital affordances of visualization elements, namely, *affectivity*, *relationality*, and *interactivity*, and their associated granular visual features. Part

[7] Our notions of legibility are inspired by Lynch (1960) and Ruivenkamp & Rip (2014), and enunciability by Pottage (2012), Kostelnick (2008), and Yaneva (2014). Our legibility/enunciability notions are digitally anchored, but are also very fine-grained and thus different from those of McDonnell (2010).

Two illustrates how the visualizing tools either guide the participation of frontline employees in taking action to implement the strategy via *legibility* affordances, or spark their creative engagement in the execution of the strategy beyond its original formulation via *enunciability* affordances. Part Three integrates the first two parts and elaborates a process framework showing how it is the affordances of *digital* visualization features that mediate frontline employees' involvement in the two distinctive strategy realization process phases, namely, understanding the strategy and enacting the strategy.

How Affordances of Digital Visualizations Enhance the Understanding of Strategy

Affectivity

The affectivity affordance reflects the presence of the non-narrative aspects of digital visualizations that have the potential to facilitate the frontline employees' improved interpretation of the strategy. Our data reveal that three digital visualization features induce affect via the following elements: Color/Size, Links/Nodes, and Line Width/Bandwidth.

Color/Size. Color and size are key visualization features in the digital maps that appeared to enable frontline employees to highlight aspects of the courses and curricula that were previously "invisible." These features appeared to have brought enhanced meaning to the rectification of course overlaps and the associated transformational change in the school's curriculum. Indeed, they seem to have affectively influenced frontline employees. For example, one instructor's perspective is very telling in this regard:

> I saw this [Treemap], it is simple but the orange grabs attention…[then] you could see the [size of] finance box is kind of smaller relative to the other things we teach [in the curriculum]. The finance people have always been going on and on about the "low" number of finance courses [in the curriculum]…Hmmm I thought for a moment… finance has 113 concepts, [while] accounting has 430! Jeez you could feel their frustration I guess. Question… should we offer more core finance courses?

In this encounter, the color contrasts appear to direct attention, and the size of the rectangle representing the finance topics is relatively smaller than the size of the rectangle

representing the accounting topics. Therefore, through the use of color contrasts and relative rectangle sizes, the Treemap visualization paved the way for inducing non-verbal affective sensemaking of the fact that despite its importance in the business curriculum, finance may be underrepresented. Such features triggered reflections on the potential for changing the number of finance courses in the curriculum. In general, this visual mode of interaction via color/size appeared to have made the instructors affectively respond to the topics associated with overlap across courses within the curriculum. The instructors' remarks point to the importance of color and size as crucial features of visualizing tools that provide affordances to enhance the understanding of the curriculum transformation strategy. They can even bring to life a previously dormant idea and turn it into a pressing issue.

Links/Nodes. Another non-narrative aspect of the visualization tools, especially using the technology of semantic web/linked data, was the presence of links and nodes that represented different networks. In this case, there was a "connection" between topics, concepts, courses, and subjects. As features of visualization tools, these links/nodes pointed to some noteworthy influences as a result of instructors having engaged with them affectively. For example, one participant mentioned the following:

> What we are asked to do, will at some point translate into revamping our courses. Changing content, sequence of courses, delivery method… But all this means what…understanding how courses connect! I see for example this dot in the core marketing course…it is SWOT analysis. But lines coming out of it…connected to 5 different courses! I did not know that…is it really needed? Should we keep it like that, the "killer" is that probably students said it's overlap—maybe it is maybe not…but now it is more visible…

In this case, the dots are "nodes" in the Forced Node visual, affording the frontline employee the ability to click on the "SWOT analysis" concept, and the lines are "links" that provide the possibility of highlighting the five courses around them that cover this topic. The presence of these affective affordances, nodes, and links brought a clearer understanding of

the notion of course overlap for the instructors, who can now better align their perceptions with the students' views.

Line Width/Bandwidth. A third non-narrative aspect of visualizations was a "linear" feature, namely, the line width/bandwidth representations within digital maps, which appeared to have played a significant role in frontline employees' improved understanding of the course overlap issue. The size of linear features such as connections among courses in the Sankey diagram renders visible a number of common concepts. However, in this type of map, the width or bandwidth of connecting lines represents the number of common concepts between courses. One instructor's comment illustrates how this helped her understanding:

> The catalog has prerequisite information on courses. I never thought about it! Now…this diagram's [Sankey] "thick" lines "moving out" of the statistics course…they go into so many others…it made an impression! More…for example these lines go into the "Statistical Inference"…"Descriptive Statistics". Then again thick lines go into "Marketing Research." This is not overlap! This is right; I guess I call it reinforcement…

In this context, the line width/bandwidth in the Sankey diagram offered clear visual cues as to the number of course connections—i.e., it was a proxy for several common concepts, and thus for course overlap. This visual feature indicated that there might be overlap. These affective affordances can potentially help sink in the notion that course concepts overlap, thereby enabling instructors to obtain an enhanced understanding.

Relationality

The network structure aspects of digital visualizations provided the relationality affordance and facilitated the instructors' improved interpretation of the relationships between the curriculum elements (subjects, courses, topics, and concepts). Our analysis shows that three digital visualization features mainly assisted relationality: Interdependence, Traceable Paths, and Part-Whole Diagrams.

Interdependence. One key feature that was employed by frontline employees was

visualization of the network affordances through digital maps to highlight the interdependence among courses and subjects. Frontline employees seemed to rely on this feature to bring greater visibility to an abstract notion of relationships among various aspects of the curriculum. Some participants said that reducing overlap could only be achieved if they had a view of the curriculum that made this very opaque and nebulous notion understandable. In other words, "instituting changes in courses, based on overlap information, without validating these via examination of existing connectedness among them would be like driving blind," an instructor explained. Another instructor stressed:

> Look my overlap is your prerequisite or vice-verse. I see in this map [Sankey] how concepts of courses depend on others…even there is a two-sided effect, information systems and strategy and marketing "snake" into each other! I want to take this [Sankey] and do a presentation to students. We can't just willy-nilly change the concepts in one course, it will impact the way we deliver other courses. Seeing it like this, I am beginning to think are we [us and students] talking about the same thing, or is it something else [not overlap].

The expressed view of this instructor also appeared among other colleagues. They asserted that visualizing features provided an explicit means for frontline employees to understand the potential for overlap differently. They had a sense that the visualizing features revealed the interdependency of concepts among courses as a network. This potential view of overlap was a new understanding afforded by the visualizing tools. The tools' relational affordances made the interdependence among courses transparent and provided a holistic understanding of curriculum transformation strategy.

Traceable Paths. Another feature of the digital maps was that they provided the ability for frontline employees to render the specific connections among courses and concepts traceable as visible paths. When the structural relations among curriculum elements are present, they can be made concrete, say by pointing to a concept and seeing the path it traces. This notion of traceability is related to managing the transparency of the curriculum, which is "unthinkable and invisible" (not concrete). Of course, a multitude of ways existed to

highlight the paths. Many participants often indicated they valued different features that provided them with this affordance. For example, this participant pointed to the hovering feature to pinpoint a potential source of concepts that overlap:

> With the [Mapping Table] you can hover on concepts' rectangles [cells] to analyze the relations of topics and courses. The X shows where a concept is covered in a course…but we need more. I really liked when I saw concepts were coming from the organizational behavior course into the ethics course…listing the concepts in a table is good. But, scrolling up and down seeing the sources of the concept was the "great" thing [emphasis]. Especially with mouse hovering…Gesture [putting the mouse on the red cell next to "Regression Analysis" in the table], now tracing back I see "Regression Analysis" is covered via four topics of four different courses.

Our analysis of the data included a considerable number of instances in which the instructors regarded as important the ability to trace the network of concepts and courses in order to discern the origins of potential overlap. This feature showed that the instructors valued the capability to navigate the paths to trace the source of course topics and concepts, as made visible by the tools. This affordance appeared to have clarified their understanding of the overlap issue.

Part-Whole Diagrams. Another digital feature that the instructors valued was the ability to zoom in/out of the network of concepts, courses, and subjects in the curriculum. In the context of the strategy of curriculum transformation, subjects often require different levels of detail depending on the stage and material they are dealing with. This requirement is usually enabled by features that allow the user to focus and de-focus on micro aspects, i.e., identify whether a coarse or granular level of information is needed. One instructor said:

> Treemap is simple and powerful. It is a bird's eye view, but it is also a detailed view… you can drill down to topics. Very cool… impossible to do without the connections! Nice to see we go from committee meetings high-level issues to course delivery details. I saw the whole thing without the details and then with the details, so it is not just hand waving in the air.

Macro and micro views enable users to achieve a higher degree of control over the transparency of the network of concepts in the curriculum. At a high level, instructors can process relations to study the connections and differences at the course level. But at the same

time, instructors could zoom in at the conceptual level to uncover a more detailed relationship view. This visual feature is one of the major features provided by the digital visualizing tools that allow on-demand exploration of large datasets, such as a school-wide curriculum.

Interactivity

Interactivity highlights the adaptive features provided by the digital visualizations that afford frontline employees the ability to dynamically shape the interface to their needs and requirements, and indirectly support an improved interpretation of strategy. Our data disclose that three main digital visualization features enabled interactivity: Dynamic Content Display, Reconfigurability, and Animation.

Dynamic Content Display. Examining the use of digital visualizations, we noticed a functionality that was highly favored by instructors—the tools that would allow them to access and dynamically integrate new and updated data on the fly. This feature enables users to access and explore the data without the need for redesigning the visuals from scratch whenever the data changes. Hence, once the visual models were defined, instructors could continuously focus on the outcomes when new data became available. One instructor said:

> I have been part of the curriculum review committee for a while, and I know the struggle that my colleagues go through when creating the reports before every meeting. Even when using spreadsheets, the data was regularly updated manually. When I learned that these new visualizations automatically adapt when new data is added to the platform, I saw how they can make the process easier for everyone involved! Imagine having the ability to dynamically see the impact of a change performed on the number of Xs in certain topics in the Mapping Table; or automatically see how the number of concepts and size of a node change in the Treemap when topics are modified. It's like a car dashboard that gives you constant and live feedback on the status of the different components in your car.

This capability may be fairly mundane in most commercial visualizing software contexts, e.g., Tableau. Nevertheless, the help instructors received through this functionality was perceived to be very salient in better understanding the strategy of rectifying course overlaps.

Reconfigurability. Still another feature of digital visualizations enabled users to (re)configure the interface in multiple ways that they deemed appropriate to their tasks and objectives. Digital interfaces have the potential to allow seamless computer screen-based actions that reduce users' burden in exploring and displaying information. An instructor had this to say, in describing her first encounter with the digital curriculum visualization maps:

> I have to admit clichés like 'picture is worth thousand words' are empty slogans until you see them 'at work'. I was really struck by how we were able to see, these curriculum maps which were a simple assembly of courses, concepts, and topics in just a table…for God's sake how much simpler can you get…(hand gesture). Then, I looked and went deeper, the next step was kind of looking back and forth. But again none of this was clear to me before I did it, I mean these geeks had told us you can 'directly and visually see and then investigate overlaps'….What I mean you are called to a meeting by the associate dean to discuss overlap issues. But you 'know' in the back of our head kind of abstractly there are common concepts—like 4 P's of marketing. But is that overlap? Who would have wanted to plow through all these syllabi and textbooks to find this out?

That is, the reconfiguration of the screen allowed the instructors to pop up information to see it by clicking or hovering, then drilling down for a micro view or drilling up for a macro view, and also by moving around to go to other parts of the data, even if located beyond the present screen. The integration and use of the features of screen pop-ups, drilling, and moving around allowed the instructor to ascribe a meaning to the course overlap problem. Stated differently, it was not the popping up of information, drilling, or moving around but their seamless integration that afforded the user a kind of "uber"-interactivity affordance. She was able to adapt the map and manipulate it (i.e., going deeper and then back and forth) to meet her needs and better understand the strategy task.

Animation. A further feature of digital visualizations highlighted by frontline employees was the animation feature. That is, users had picked up on the fact that certain features allowed for temporary redirection of user attention via, say, a popup box based on the dynamic movement of the mouse around the screen, and various parts of a visualization tool. One instructor highlighted this point as follows:

> To me, the Forced Node map at first looked too much like an opaque jellyfish, but when you zoom in and click, it becomes transparent. Initially, I was overwhelmed when all the nodes loaded and started jumping around. I felt I was immersed in these hundreds of nodes that were moving up to a point where they stabilized. When you start controlling it, it becomes a valuable tool to understand the relations in the curriculum. I started making my way around the nodes by gradually clicking on course nodes to expand their concepts, then back to close them. I saw and clicked on this concept that seemed relatively larger, and I had all these related courses floating close to it. I like this graph. I think it can help us with overlap detection.

The fact that things pop up as the user engages with the tool is a means of directing her attention to that item as well as associated information. This animation feature, which affords selective allocation of attention to elements within the visualization object, e.g., curriculum concepts, while displaying a less crowded and sparser screen elsewhere, was pointed out as a feature of UI/UX that aided the exploration of hundreds of concepts on one screen. The animation affordances helped the user to be selective by interactively directing her attention, and also aided in the understanding of the target object, i.e., aspects of the curriculum transformation strategy.

How Affordances of Digital Visualizations Aid the Enactment of Strategy

Legibility

The legibility affordance reflects the capability of visual artifacts to represent objects (e.g., the strategy) that have high fidelity with their intended meaning to an audience, and thus aid the participation of employees in strategy enactment. Our data show that legibility was guiding strategy enactment in three ways: Executability, Fidelity, and Accentuating Authority/Hierarchy.

Enhancing Executability. A further emergent theme that instructors appeared to note was the role that digital visualizing maps played in encouraging them to act on the "eliminate course overlap" issue. That is, the visualizing tools motivated instructors to move towards eliminating overlap among courses. Instructors now began expressing things like, "I probably

do not need to include SWOT here, since it is covered there," or "Yeah, they are learning Net Present Value in introductory finance, but they do not really use it until the strategic management course." One instructor pointed to the Gestalt power of these digital visual maps as follows:

> I think seeing the curriculum in one place and deciding where a topic should be covered and to what depth is all owed to seeing it via the digital curriculum maps. But that still begs the question, the gestalt nature of the power of such tools. Once we see something it triggers additional actions which would have not been fathomable. That is, we could look at traditional syllabi and textbooks with a 'naked eye' until we are blue in the face but that would not help in finding if there is overlap. Even more to the point, the path towards eliminating it would be kind of fuzzy and murky. By 'revealing' overlaps that were kind of hidden in plain sight they simultaneously compelled us to adjust the syllabi and to eliminate the overlap or reinforcing concepts in a different way.

Other instructors expressed a similar perspective. The alignment of the visual inscriptions in the digital tools with the strategy articulated by the management appeared to be aiding strategy execution.

Encourage Fidelity. This theme highlighted the replication of the focal strategic maxim as-is. In other words, most frontline employees acknowledged the need for eliminating course overlap and highlighted how specific tools aided in this by encouraging fidelity. One instructor said:

> It is clear from the administration and students' feedback that overlap is a key priority. What is more surprising is that we see this thing called curriculum in one place, and for sure, I see a lot of concepts in the Sankey and Forced Node maps with lots of connections. It does not take a genius to kind of see "where there is smoke there is a fire"!

Numerous references like this existed in our data, where there is evidence of the fidelity of the tools with the intended strategic action, namely, "motivating" instructors to eliminate course overlap and change the curriculum accordingly. Furthermore, these frontline employees are also conveying the message to us that the curriculum mapping initiative, and especially the digital visualization artifacts, are driving the instructors towards acting on the

idea of overlap elimination by producing a kind of shared reality through high fidelity to the students' expectations for action.

Accentuating Authority/Hierarchy. A distinctive theme reflected in the responses of the instructors to the use of visual tools was that a precise accentuation of authority/hierarchy was an overwhelmingly important factor in their taking action towards eliminating course overlap. In such instances, the engagement of the instructors reinforced the authority/hierarchical structure of the directive to "eliminate overlap" as a given management charge—although this had unique nuances. For example, one instructor said:

> It seems to me that, somehow the management wants to prove to us that there is overlap among courses by asking us to go through these maps. Yes, of course, the Mapping Table shows it, the Treemap too. I really do not need to rediscover these myself. Telling us they exist is good enough for me. I guess I can be sure that I don't start from zero and create overlap in new courses. But in existing courses, I am happy for my department chair to say it is so.

We heard similar comments from others. That is, digital visual tools appear to be overkill to some frontline employees since they were satisfied to be told that overlap exists, and they should make sure to cut it out. This type of response did seem consistent with some of the literature on the topic of strategy implementation, and we felt obligated to record it and present it as a theme. Perhaps digital tools did accentuate the notion of overlap for some frontline employees—as a directive from upper management. In other words, digital tools sometimes emphasize the existing authority/hierarchical view of taking strategic action.

Enunciability

The enunciability affordance highlights the generativity features of digital visualizations that can spark the redesign of the strategy by frontline employees beyond its original formulation. Our analysis shows that enunciability was generated via Sparking Re-interpretation, Fostering Emergence, and Promoting Co-Creation.

Sparking Re-interpretation. A theme that emerged from the data was how the digital maps prompted frontline employees to go beyond the original course overlap issue. One instructor commented as follows:

> My encounters with a holistic view of the curriculum were very eye-opening, indeed. I am sure people (other than myself) did not expect to see the complexity and multisided nature of the curriculum. There are more than 180 courses taught each semester and 30-40 unique ones. Most of us worry about our little corner with little interest in the whole picture. But it is the whole picture that students see more than us. It was for me very unexpected to be able to wrap my head around the whole curriculum thing and think that there is overlap here, there, and so on. What was even more unexpected for me and I think a few other colleagues, is that we started exploring things beyond overlap elimination. "Yeah this is overlap…but look how come we do not offer spreadsheet modeling and simulation instead of generic computer programming".

This type of comment was heard frequently in our sessions, and it highlights how digital curriculum maps shaped instructors' engagement orientation or line of action, prompting them to go beyond immediate compliance with the organization's strategic intent and mandate. This view, in turn, transformed the issue from a relatively pedestrian focus on course overlap alone to thoughts of redesigning the curriculum. And such a strategic transformational redesign can now be more easily imagined and planned with digital visualization tools.

Fostering Emergence. Another theme that emerged in connection with digital visual maps was that they enabled the exploration of new ideas without necessarily being bound to a concrete goal. In other words, the outcome would emerge through exploration and in an unpredictable manner. The data provided evidence of new tasks that became pertinent to the frontline employees' everyday duties. For example, one instructor said the following:

> My own journey of course overlap resembled this. At first, you start your search looking things up. But after seeing these, you kind of start exploring and thinking and doing "What-if?" So for me, I went hunting for overlap but discovered we have the opportunity to go beyond the overlap: things like what is missing in the curriculum and what is redundant in the curriculum—business model innovation was not covered anywhere in the curriculum formally. I have to say, that was the trigger for me. These were merely computer map visuals animating the curriculum to detect and eliminate overlap. But what followed and kind of emerged serendipitously is why stop there. Of

> course, I am not sure if the curriculum committee of the school is happy to be receiving and processing these changes!

By capitalizing on distinctive digital visualization artifacts through the use of curriculum maps, we came to see that the associated features can also play an essential but serendipitous role in the process of enacting the strategy. In other words, the flexibility of digital tools allows for the creative and imaginative enunciation of an abstract strategy, which inevitably provides further impetus for its rethinking—albeit in an unpredictable and emergent manner.

Promoting Co-Creation. A final theme that emerged from our analysis was how frontline employees used digital visualizations to facilitate strategy co-creation. Visual artifacts acted as boundary objects that enabled frontline employees to be inspired to participate in strategy redesign (more or less "re-making strategy"). One instructor explained his experience working with the digital maps as follows:

> I have been an instructor in the school for more than 15 years. This is not my first time going through curriculum reviews. What used to happen before, we used to get certain objectives that we need to fulfill. For example, introduce a new course, or revamp a course based on a change in the learning objectives. We used to follow directions. Today we're talking about overlap reduction. That's fine with me. But I think today it's somehow different. I have a feeling that I am well equipped to take this picture to the associate dean if he pushes for removing the repeated concepts across courses, and discuss the overlap issue in my course. I might have misunderstood, but check this out, it doesn't look like overlap to me, does it? I think, as a school, we should focus on other more pressing issues, like identifying gaps in our curriculum. Those visuals can be used for this.

The engagements with the digital visualizations show that the effort to establish a live connection with complex phenomena such as the course overlap issue as a pivot for curriculum transformation strategy can benefit from the affordances of digital visualization features. Therefore, the affordances of digital visualization features appeared to extend the horizon of instructors' efforts in co-creating strategy and thus support their strategy implementation actions beyond the intended one.

How Affordances of Digital Visualizations Mediate Strategy Realization Process

So far, our analytical interest has focused on teasing out the distinctive influence of different visualization features. As an analytical tactic, we focused on separating out how the affordances of the visualizations' features influenced the strategy implementation process. However, it is important to stress that users tend to experience the holistic impact of affordances effectively operating as an ensemble that induces them to engage in strategy realization. We now attempt to integrate the earlier fine-grained findings in terms of their overall influence on the strategy realization process. The aim is to propose a process framework that points to a discernible effect of the *digital* visualization environment on strategy realization.

Strategy Understanding. Let us return to how digital visualizations enhanced the understanding of strategy among instructors, using a different focus. For example, when questioned, one of the instructors at first said, "Look, an intuitive grasp of abstract notions such as 'Overlap' with a capital O or 'Curriculum' with a capital C is not easy." But then she went on to describe her journey in engaging with the computer-based visual tools. She reported that she appreciated the visual aspects of most of the digital curriculum maps upon seeing them for the first time and that she was impressed by what was "achieved." The visual tools piqued her curiosity, as she recounted on a visit to one of the authors, shortly after the demo part but before her formal session. Sitting in front of the computer, one of the paper's authors explained to the instructor how to manipulate the curriculum maps on the screen using the mouse and keyboard controls. The author then stood up and let the instructor take control of the curriculum maps on the screen. The instructor recalled:

> I started pointing to a course (Fundamentals of Management) and then a concept, hovering on its associated topics, on the Sankey map, moving around, jumping to other courses, other topics, and then to another course. Suddenly I could *feel* it! I am not a gadget person and not easily impressed by technology. But the "Sankey" map had leaped into [palpable] reality, as I started to manipulate it, navigate it, there was a

> feeling I had at my fingertips something very abstract and fuzzy, like the whole curriculum, was clearer; I could see it now.

This instructor's exclamation "I could *feel* it!" and her assertion that the curriculum map (Sankey) "leaped into [palpable] reality" show the cognitive transformative power of visual maps to serve as a scaffolding for enhanced understanding of the strategy of overlap elimination. As this instructor put it, it became a means of attaining a "live rapport" for rectifying course overlap.

It may be fair to assert that the non-narrative elements and the associated affordances based on the exploitation of the color/size, link/nodes, and line width features triggered affective responses by this instructor and other users, thereby enhancing their understanding of the organization's strategy. However, these affective affordances were not acting alone or in isolation. Instead, our visualization tools seamlessly combined these affective elements with the network representation capabilities as well as the interactivity features. Together, all these features operated as an ensemble that was made distinctively possible through our digital visualizing infrastructure. In other words, the same non-narrative elements could have been used on paper, but then they'd be unlikely to generate a similar response among users. Therefore, we conjecture that as an ensemble, it is the digital interactivity affordances working hand-in-hand with the relationality and non-narrative affectivity affordances that give rise to enhanced user understanding of strategy.

Strategy Enactment. Here our emphasis shifts to highlighting how the use of visualizing tools shapes the enactment phase of the strategy realization process. An instructor related a colorful analogy that reinforces this point:

> I think we can safely say, the school can no longer ignore "course overlap." But so what? When you think about it, the curriculum maps pointed the way towards taking some action. You could see, wow, we are covering "Porter's 5 forces of strategy" in 4 courses. So it means now that we have this information, we can move to rectify it. So let's cover it only here but refer to it in other places. I like to think of the curriculum

> maps as the instructional equivalents of 'night vision goggles' in what they afford to the military Special Forces. They help us pinpoint where we need to take action and how.

This informant's intuitive metaphor for visualizing computer maps is the strategy equivalent of using night goggles in combat—being able to align the strategy to a target you aim at via a scope or goggles resonates with legibility affordances.

Another instructor relayed a different anecdote:

> There is no doubt about it, now, we see there is overlap among courses. The perspective has changed from "Is there overlap?" to "How much overlap should be?" This is such a subtle shift, yet it is so powerful. In fact, I heard several hallway conversations where people were asking, and I am not exaggerating 'these visuals are not that advanced, but why did we not see and do this before?'

In other words, the visualizing tools have transformed the strategy execution maxim beyond eliminating overlap to a more generative and interpretive stance, which can be paraphrased as, "It is not a question of if, but how much overlap should there be?" What is clear from these informants and others is that map-based digital visualization allowed the users to go beyond the strategy-as-is to a strategy-to-be mode of influence via enunciability affordances.

It is probably uncontroversial to state that beyond boosting users' understanding of strategy, our visual tools aided users to move towards taking action to enact strategy. Here again, it is our contention, backed by the evidence, that it is the visualizations' digital mediation of strategy enactment that is unique. The uniqueness stems from digital visual tools being able to provide simultaneous support for either strategy-as-is orientation via legibility affordances or strategy-to-be orientation via enunciability affordances. It is precisely this duality that is a unique property of digital visualizations. We conjecture that it would be highly inconceivable for the same "paper visuals" to provide the generative properties exhibited by the digital visualization features (say, exploring overlap by zooming in and zooming out), thereby provoking the question, "How much overlap should we have?"

Digital Visual Mediation of Strategy Realization Process. To recap, the starting point is that digital visual tools engendered the so-called "a picture speaks more than a thousand words" effect—the collective influence of visual features consisting of non-narrative, connective, and interactive elements. However, the effect was not limited to the latter. On the one hand, the digital visualizations provided subsequent guidance for taking strategy execution action consistent with the "letter of strategy." On the other hand, they motivated the frontline employees to engage in exploratory activities to re-interpret the strategy beyond its original focus. We assemble these components into an overall process framework that attempts to capture how digital visualizations mediate the strategy realization work of frontline employees via an ensemble that incorporates the five high-level affordances. Figure 3 illustrates the proposed process framework.

The left part of Figure 3 highlights how the digitality of three distinctive visual features, viz., non-narrativity, network representation, and interactivity, gives rise to their mutual and reciprocal reinforcement when users engage with the tools, contributing to an enhanced understanding of strategy among frontliners. The non-narrative digital effects notably take hold in combination with network representation and interactivity features. It would be fair to say that there may be little or no impact if digital integration of the three were absent (e.g., if the affective elements existed without the user capability to click-highlight a path among the nodes and zoom in and out). In terms of the right part of Figure 3, in the strategy enactment phase, these features can collectively produce either a guiding effect that helps influence the frontline employees to work on implementing the strategy mostly as-is and consistent with

<<<<INSERT FIGURE 3 HERE>>>>

Figure 3 - How Digital Visualizations Shape Process of Strategy Realization and Frontline Employees' Work

its original formulation; or for a generative effect whereby the frontline employees appear to engage in exploring strategic actions beyond the intent articulated initially. The guiding influence may be hypothetically possible in a non-digital environment—encouraging compliance is the purpose for which top management has used traditional strategy visuals in analog form for the past few decades, if not longer. However, it is difficult to contemplate the simultaneous existence of compliance effects along with generative effects in the absence of a digital visualization environment, which allows for both affordances to exist simultaneously.

DISCUSSION

We began by asking how digital visualizations both as a whole and especially at the level of specific features (e.g., color/size/shape of map elements) can influence strategy work, and in particular, the strategy realization work of frontline employees. Our study showed at a *granular* level *how* specific features of digital visualization tools are consequential for the strategy realization work of frontline employees. First, we showed that digital visualization features facilitate frontline employees' *understanding* of strategy via three distinct affordances—*affectivity*, *relationality*, and *interactivity*. Second, we illustrated that strategy *enactment* was supported by the latter visualization affordances. In particular, two additional key affordances—*legibility* aiding compliance with strategy and *enunciability* sparking re-interpretation—influenced the mode of participation of frontline employees.

Generalizability of Findings. First, an important issue that emerges from our findings is whether any digital visualization could potentially influence strategy work via the three understanding-related and the two enactment-related affordances we identified. Our analysis suggests a conditional "yes" to this question. It indicates that any digital visualization that incorporates the associated features could hypothetically influence strategy work via the affordances we have identified. Let us consider the potential for digital visualization features

(colors/sizes, interdependence, and animation) in the form of a Forced Node diagram. Based on our findings, Forced Node performed a facilitative role in strategy understanding (overlap detection) and further aided strategy enactment (the elimination of overlap), thereby affecting the strategic transformation of the curriculum. Then the issue becomes whether similar affordances will be at play in the process of understanding and enactment of strategy when, for example, frontline employees use a Forced Node paper poster that displays course connections in color. It is important to note that we explicitly did not focus on that, nor did we have the appropriate kind of data available to us to explore these types of variance dynamics (we suggest finding such data in further research). Instead, we focused on the process or the "how" question via digital tools and features. However, we may be able to shed some light on the matter implicitly. We might expect that the process of employing digital visualization tools embodying a set of functions/features, such as our visualizations had, would contribute to strategy understanding and enactment in ways that using a paper poster visualization may not. A paper poster may indeed contain non-narrative elements (color) and limited connectedness (a set of linked courses). However, it is reasonable to postulate (as is argued below) that the digital interactive elements and network representation features, working together with affective aspects, reciprocally reinforce each other and produce a complementary bundle of affordances underpinning strategy work emanating from their digital properties. In other words, a "paper poster" of similar affective features would likely produce a much less pronounced effect, if any—mainly because of missing digital connective and interactive affordances. Also, the simultaneous presence of compliance and generative affordances of digital visualization tools would be expected to be more or less absent from the paper poster case.

Second, an empirical question can also be raised: namely, does our study of eliminating course overlap as a pivot for curriculum transformation (which involves an

organizational strategic turnaround focusing on better customer engagement, and reversing product quality drift and falling revenue) constitute a template for organizational strategic changes with results that are transferable to other corporate contexts? Again, our answer is a qualified "yes." These issues are generically of strategic significance regardless of the organizational type or industry. In general, academic organizations are increasingly forced to engage in strategic changes that alter their taken-for-granted ways of approaching their educational mission. For example, professors are asked to behave in more businesslike fashion and coordinate their work due to the university being exposed to the market dynamics of competing for funds and rankings (Gioia & Thomas, 1996). Furthermore, other authors have frequently used such pluralistic contexts to study issues that have broader implications and generalizability (e.g., the study by Knight et al. (2018) of government budgeting change; Jarzabkowski's (2004) study of strategic planning by top management of a university; and the study by Gioia et al. (1994) of strategic sensemaking in a public university). The other empirical issue is about the choice of (curriculum) maps as visualization tools and their underlying features as the primary digital environment to study "how" they influence the strategy realization process. It is important to note that the underlying digital mapping technologies (semantic web and JavaScript-based visualization approaches and techniques) offer very generic yet extremely powerful visualization features and capabilities such as network representation, shape/color/size, flow, drill-down/up and animation, which indeed are characteristics of a wide range of digital visualization tools.

The implications of the above points can be theoretically and empirically significant. They suggest that our analysis does not appear to be idiosyncratic to the particular digital visualizations and our specific case of a school engaging in transformational strategic turnaround. Thus, it is a strong possibility that our digital visualizations and associated features actually can be facilitating strategy understanding and aiding enactment via non-

narrative elements, connectedness, and interactivity, along with legibility and enunciability. However, we must remain cognizant of the caveats associated with studying revelatory cases.

Contributions to Theory and Practice. First, visual artifacts, e.g., Porter's five forces diagram (Porter, 1985) and Boston Consulting Group's 2x2 growth matrix (Henderson, 1979) have been staples of strategy theories and strategy practitioners' tool kits for more than four decades. However, scholarly research on the significance of visuality for Open Strategy and strategy process is fairly recent (e.g., Eppler & Platts, 2009; Hautz et al 2017). One interesting piece of research has focused on the relevance and impact of visualization artifacts within strategy meetings, alongside specific software visualizing functions such as PowerPoint (Knight et al., 2018). In parallel, Open Strategy researchers have provided evidence of how specific social media technologies were important for increasing transparency and inclusion of non-management input into strategy making (e.g., Baptista et al 2017). Still, there are calls to make strategy visualizations' specific granular features as well as technology's salience for Open Strategy a center of scholarly attention (Knight & Paroutis, 2019; Hautz et al 2017). Our research is among the few to focus on the specific visualization *features'* role within the strategy process. We showed how granular features that are non-narrative[8] (e.g., color/size, link/node, and line width), along with network representation features (e.g., interdependence, traceable paths, part-whole diagrams), as well as interactivity features (e.g., dynamic content display, reconfigurability, and animation) facilitate the frontline employees' enhanced understanding of a strategy (in our case, reduction of course overlap as part of curriculum transformation). A critical aspect of the course overlap "reduction" strategic initiative was reflected in the design of the visualizations, i.e., certain features exemplified the focus on relationships among subjects, courses, concepts, and topics

[8] We note that these have traditionally been available in most visualizations, paper or digital.

as network structures. For example, we may wish to find out in which courses SWOT occurred in relation to certain other items. This kind of relationship-finding is common to the strategy process theme in organizations. (For example, the question, "Which touchpoints does this movie encompass as we implement our video streaming service?" is a hot strategic transformation issue for traditional movie studios going online!) In this context, the SWOT concept has a "part-whole" relationship to the "strategy development" topic. To enable the incorporation and use of this feature, the visualizations employed semantic web-based functionalities (of resource descriptions and their corresponding relations). This network representation feature, along with non-narrative and interactivity features (e.g., zooming in and out) are uniquely available and deployable as a result of their digital integration into our visualization environment. Therefore, we conjecture that the features deployed within the visualization tools work as a bundle, with digitality performing a glue-like functionality that enables a field of affordances —*affectivity*, *relationality*, and *interactivity*—to work together. This in turn leads to enhanced understanding of the strategy by frontline employees thereby boosting transparency of the strategy process (Hautz et al 2017; Baptista et al 2017). As a result, our work has extended the literature by answering calls for finding out the role of granular visualization features, especially those that are distinctively digital, and demonstrating the mechanisms of their influence on Open Strategy process and the strategy work of frontliners.

Second, prior research has called for foregrounding the role that frontline employees play in the strategy work of the organization, specifically in the execution phase of the strategy realization process, as well as how an Open Strategy process can be put into effect (Arnaud et al., 2016; Balogun et al., 2015; Birkinshaw, 2017; Hautz et al., 2017). On the one hand, the research that addresses the work of frontline employees is often silent on the issue of how they engage in the strategy execution process: the modality of their participation and

the logic of their action is often presumed at least implicitly to be that of mere "executants" of strategy realization (for arguments to the contrary see Demir, 2015; Martin, 2010). On the other hand, while Open Strategy research currently focuses mainly on the role of employees in strategy making and how they can contribute their ideas through digital technologies (Baptista et al., 2017; Birkinshaw, 2017; Hautz et al., 2017), it puts less emphasis on their role in the strategy enactment phase, especially via engagement with digital visualizations.

Our data, findings, and emphasis on the role of digital visualization features helped us highlight the distinctive role played by digital visualization features in enabling a compliant and consistent enactment of strategy in line with its original intent. In particular, greater transparency was afforded to the organizational strategy, viz., overlap rectification and curriculum transformation, via the digital visualizations' collective features. This enhanced observability appeared to have aided the strategy enactment via the *legibility* affordances—facilitating the strategy's executability, having fidelity with its original intent, and channeling via a top-down hierarchy. In the same way that electronic prescribing enhances the legibility of a doctor's handwriting on a prescription, our data showed a digital equivalent of "no more illegible scripts at the pharmacy" via the visualizations' features.

But the role of digital visualizations in the mobilization of frontline employees to engage in the enactment of strategy went beyond legibility. There was evidence of a distinctively generative pattern of action. That is, employees appeared to be responding to visualizations by re-interpreting the strategy, giving rise to a sense of emergence, serendipity, and engagement in co-creation during the enactment phase. As employees grappled with rectifying the course overlap, they more or less started asking, "Why stop there?" For example, the visualizing features, through a combination of digitally connected course contents and their affective digital and interactive display, triggered the employees to ask "why business model innovation was not formally covered anywhere in the curriculum." In

the latter context, we term the process of allowing for re-interpretation, emergence, and co-creation, which makes the mode of participation of frontline employees more agentic in the strategy enactment phase, *enunciability* affordances. Our findings extend the literature on the participation and inclusion of frontline employees during the strategy execution and Open Strategy processes (Hautz, et al 2017) by showing that digital visualization features simultaneously, and perhaps unexpectedly, provide for two largely opposite mechanisms in strategy enactment. This takes place by means of the legibility and enunciability affordances, depending on the orientation of the actor towards the process of strategy enactment.

There are practical lessons based on our focus on the role of visualization tools at the nexus of frontline employee engagement in strategy realization, as well as in the practice of Open Strategy. First and foremost, the recent Open Strategy research has provided evidence that digital technology in the form of social media (Baptista et al., 2017), for example, can be a boon for engagement of internal stakeholders by providing a means of expanding transparency and the inclusion of strategy process. But practical advice on how to do this, as well as steps to take to deploy digital technology, is somewhat rare. The affective appeal of visualizing elements in depicting connections across courses and the animating aspects of transformation strategy appeared to translate the potentially vague notion of course overlap reduction strategy into one with a clear message. These visualizations engendered an enhanced understanding of the significance of the turnaround strategy (i.e., curriculum transformation) by the frontline employees. Second, our findings provide clues to practicing managers and others that the understanding of a strategy is open to influence and is likely to be enhanced through digital visualization tools, thus increasing the probability of strategy executability in line with its original intent. Third, Open Strategy practitioners interested in promoting co-creation of strategy can take heart in our results: frontline employees can engage in re-design and re-interpretation based on the generative mechanisms that are

collectively promoted by the features of digital visualization tools that trigger an exploration of the strategy beyond its original intent.

Our study has limitations that can be addressed in further research. First, we focused on a pluralistic organizational context, namely, a university. Choosing a more hierarchical organization can bring additional insights into the role of digital visualization features in strategy realization. Second, there is an opportunity to expand the categories of digital visualization features and open the door to exploring their role and, more importantly, the repertoire of affordances that arise from these features. Third, different modes of data collection and analysis can help to delineate with more precision the potential role of specific features in enabling the legibility and enunciability affordances. Fourth, comparative analysis of digital and analog visualizations can be an additional dimension for exploration.

CONCLUSION

On the one hand, Open Strategy researchers have opened the door to inclusion and transparency as key dimensions of strategy process worthy of scholarly focus. On the other hand, we can assume that "diagrams speak louder than words" and that they have a consequential role in the strategy process informed by the work of strategy visualization scholars. The fundamental question is increasingly, "How can they do so and through which features"? Our research, which focuses on the role of digital visualization features at a granular level and zeroes in on the frontline employees' engagement with these visualizing features (especially in the context of the Open Strategy process), has made some headway in this regard. We have suggested that the digital environment can bring to life non-narrative, connective, and adaptive elements as a holistic visualization ensemble, and thus can play the role of facilitator in enhancing strategy understanding via affective, relational, and interactive affordances. Also, the same digital visualization features enable legibility affordances, which

guide the realized strategy to be faithful to the original intent. In contrast, digital visualization features provide enunciability affordances, which can collectively spark the re-interpretation and co-creation of strategy.

Our study complements an expanding body of research on strategy visualization and Open Strategy, since we consider strategy process and practice to be highly intertwined with artifactual elements, particularly their visuality. Specifically, this work paves the way for a more differentiated and nuanced view of how digital visualizations can make a difference to Open Strategy processes and outcomes. In particular, it provides granular-level and concrete details of how visualization features, primarily enabled by distinctive digital capabilities, can potentially offer inclusion and transparency in a strategy realization process.

Acknowledgments

We would like to thank the editors and anonymous reviewers for their time and invaluable constructive feedback on the earlier versions of this paper. This work was partially supported by the University Research Board of the American University of Beirut.

References

Ahmed, S. (2010). Happy Objects. In *The Affect Theory Reader*. Duke University Press.

Archambault, S. G., & Masunaga, J. (2015). Curriculum mapping as a strategic planning tool. *Journal of Library Administration*, *55*(6), 503–519.

Arnaud, N., Mills, C. E., Legrand, C., & Maton, E. (2016). Materializing strategy in mundane tools: The key to coupling global strategy and local strategy practice? *British Journal of Management*, *27*(1), 38–57.

Balogun, J., Best, K., & Lê, J. (2015). Selling the object of strategy: How frontline workers realize strategy through their daily Work. *Organization Studies*, *36*(10), 1285–1313.

Baptista, J., Wilson, A. D., Galliers, R. D., & Bynghall, S. (2017). Social media and the emergence of reflexiveness as a new capability for open strategy. *Long Range Planning*, *50*(3), 322–336.

Birkinshaw, J. (2017). Reflections on open strategy. *Long Range Planning*, *50*(3), 423–426.

Bjelland, O. M., & Wood, R. C. (2008). An inside view of IBM's' Innovation Jam'. *MIT Sloan Management Review*, *50*(1), 32.

Blumer, H. (1986). *Symbolic interactionism: Perspective and method*. Univ of California Press.

Blumer, H. (2004). *George Herbert Mead and human conduct*. Rowman Altamira.

Burgelman, R. A. (1983). A model of the interaction of strategic behavior, corporate context, and the concept of strategy. *Academy of Management Review*, *8*(1), 61–70.

Casadesus-Masanell, R., & Ricart, J. E. (2010). From Strategy to Business Models and onto Tactics. *Long Range Planning*, *43*(2), 195–215. https://doi.org/10.1016/j.lrp.2010.01.004

Charon, J. M. (2001). *Symbolic interactionism: An introduction, an interpretation, an integration*. Pearson College Division.

Cunha, M. P. e, Rego, A., & Clegg, S. (2011). Beyond addiction: Hierarchy and other ways of getting strategy done. *European Management Journal*, *29*(6), 491–503.

Dadzie, A., & Pietriga, E. (2017). Visualisation of Linked Data – Reprise. *Semantic Web*, *8*(1), 1–21.

de Haan, S., Rietveld, E., Stokhof, M., & Denys, D. (2013). The phenomenology of deep brain stimulation-induced changes in OCD: An enactive affordance-based model. *Frontiers in Human Neuroscience*, *7*.

De Souza, C. S. (2005). *The semiotic engineering of human-computer interaction*. MIT press.

Demir, R. (2015). Strategic activity as bundled affordances. *British Journal of Management*, *26*, S125–S141.

Denis, J.-L., Langley, A., & Rouleau, L. (2007). Strategizing in pluralistic contexts: Rethinking theoretical frames. *Human Relations*, *60*(1), 179–215.

Dyjur, P., & Lock, J. (2016). Three strategies for moving curriculum mapping online. *Educational Developments*, *17*(2), 15–19.

Eppler, M. J., & Platts, K. W. (2009). Visual strategizing: The systematic use of visualization in the strategic-planning process. *Long Range Planning*, *42*(1), 42–74.

Ervin, L., Carter, B., & Robinson, P. (2013). Curriculum mapping: Not as straightforward as it sounds. *Journal of Vocational Education & Training*, *65*(3), 309–318.

Faraj, S., & Azad, B. (2012). The Materiality of Technology: An Affordance Perspective. In P. M. Leonardi, B. A. Nardi, & J. Kallinikos (Eds.), *Materiality and Organizing* (pp. 237–258). Oxford University Press.

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Houghton, Mifflin and Company.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15–31.

Gioia, D. A., & Thomas, J. B. (1996). Identity, image, and issue interpretation: Sensemaking during strategic change in academia. *Administrative Science Quarterly*, 370–403.

Gioia, D. A., Thomas, J. B., Clark, S. M., & Chittipeddi, K. (1994). Symbolism and strategic change in academia: The dynamics of sensemaking and influence. *Organization Science*, *5*(3), 363–383.

Gluga, R., Kay, J., & Lever, T. (2012). Foundations for modeling university curricula in terms of multiple learning goal sets. *IEEE Transactions on Learning Technologies*, *6*(1), 25–37.

Gregg, M., & Seigworth, G. J. (2010). *The affect theory reader*. Duke University Press.

Hautz, J., Seidl, D., & Whittington, R. (2017). Open strategy: Dimensions, dilemmas, dynamics. *Long Range Planning*, *50*(3), 298–309.

Henderson, B. D. (1979). The product portfolio: Growth share matrix of the Boston Consulting Group. *The Strategy Process: Concepts, Contexts, Cases*, 678–680.

Hrebiniak, L. G. (2006). Obstacles to effective strategy implementation. *Organizational Dynamics*.

Jarzabkowski, P. (2004). Strategy as practice: Recursiveness, adaptation, and practices-in-use. *Organization Studies*, *25*(4), 529–560.

Jarzabkowski, P., & Seidl, D. (2008). The role of meetings in the social practice of strategy. *Organization Studies*, *29*(11), 1391–1426.

Kalz, M., Van Bruggen, J., Rusman, E., Giesbers, B., & Koper, R. (2007). Positioning of learners in learning networks with content, metadata and ontologies. *Interactive Learning Environments*, *15*(2), 191–200.

Kaplan, R. S., & Norton, D. P. (2001). *The strategy-focused organization: How balanced scorecard companies thrive in the new business environment*. Harvard Business Press.

Kaplan, S. (2011). Strategy and PowerPoint: An inquiry into the epistemic culture and machinery of strategy making. *Organization Science*, *22*(2), 320–346.

Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 67–93.

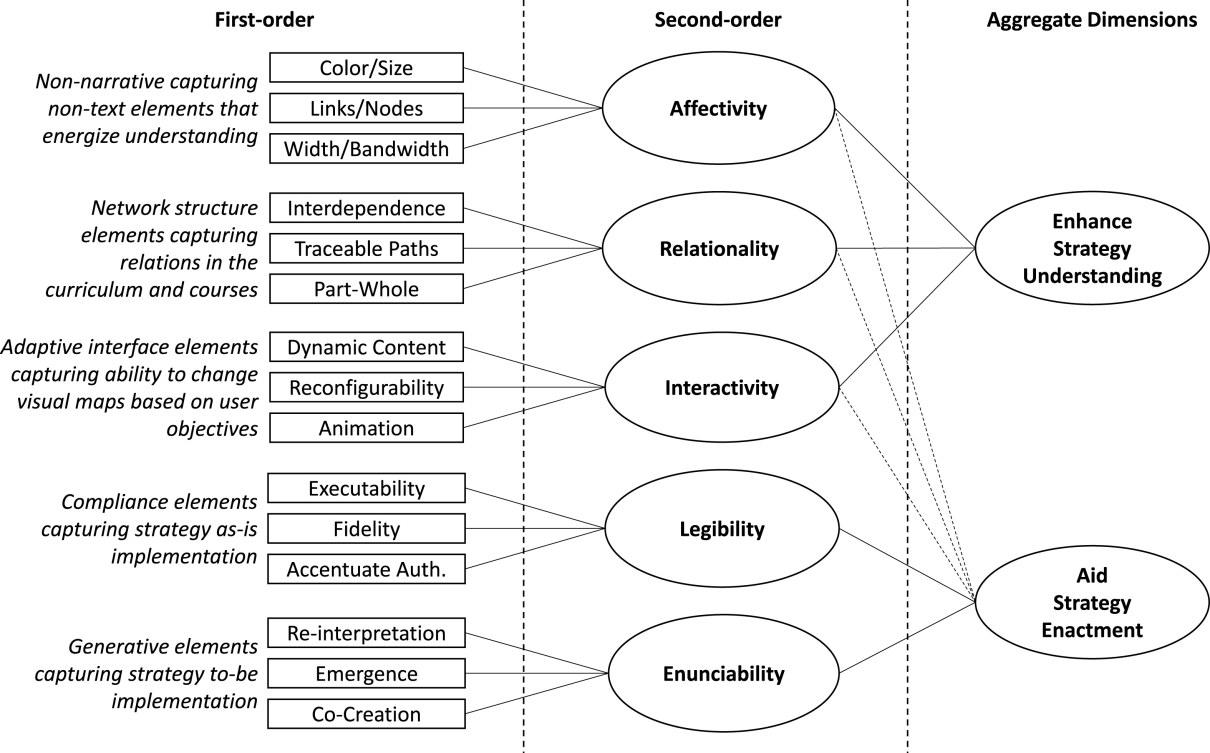
Knight, E., & Paroutis, S. (2019). How Visual Methods Can Enhance Our Understanding of Strategy and Management. In *Standing on the Shoulders of Giants (Research Methodology in Strategy and Management)* (Vol. 11, pp. 77–90). Emerald Publishing Limited.

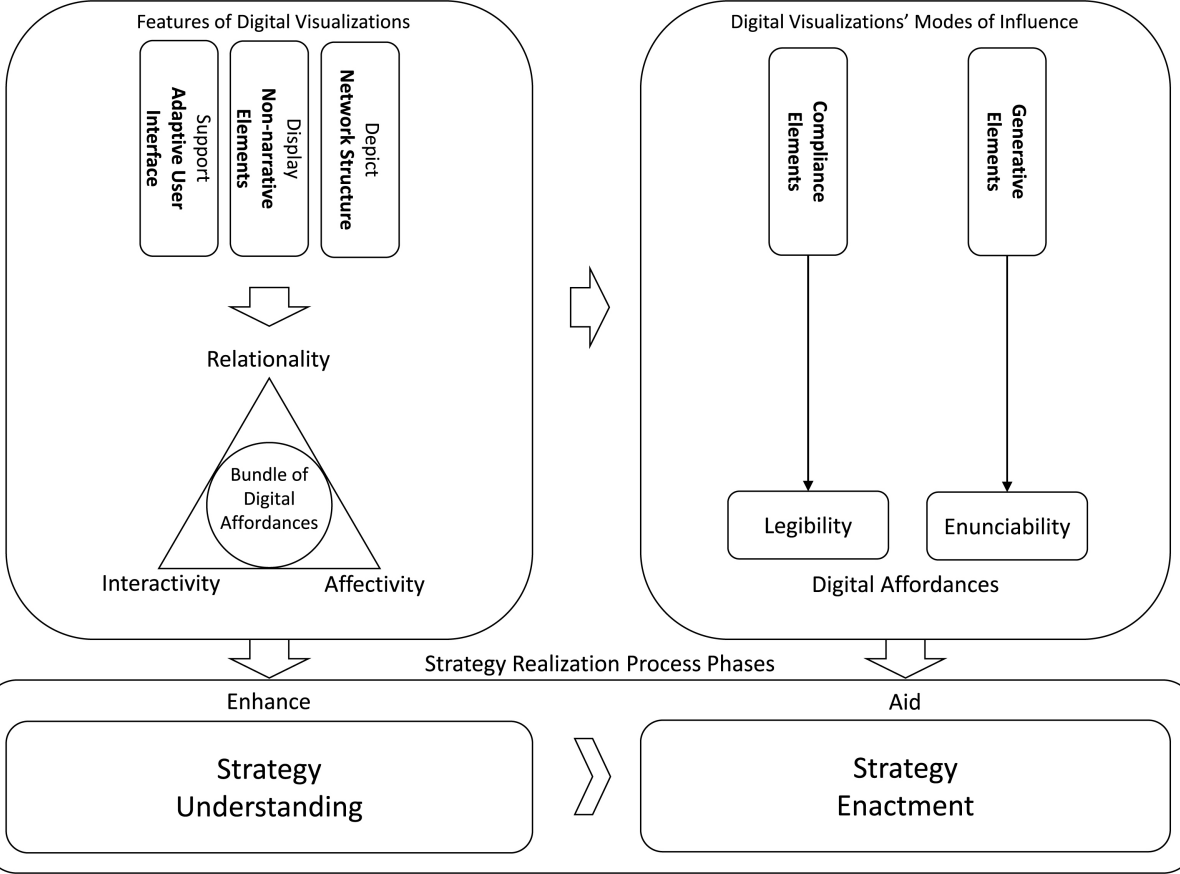
Knight, E., Paroutis, S., & Heracleous, L. (2018). The power of PowerPoint: A visual perspective on meaning making in strategy. *Strategic Management Journal*, *39*(3), 894–921.
Kostelnick, C. (2008). The visual rhetoric of data displays: The conundrum of clarity. *IEEE Transactions on Professional Communication*, *51*(1), 116–130.
Krotzsch, M., Vrandecic, D., & Volkel, M. (2006). Semantic mediawiki. In *The Semantic Web-ISWC 2006* (pp. 935–942). Springer.
Lynch, K. (1960). *The image of the city* (Vol. 11). MIT press.
Mack, D. Z., & Szulanski, G. (2017). Opening up: How centralization affects participation and inclusion in strategy making. *Long Range Planning*, *50*(3), 385–396.
Martin, R. L. (2010, July 1). The Execution Trap. *Harvard Business Review, July–August 2010*.
McDonnell, T. E. (2010). Cultural objects as objects: Materiality, urban space, and the interpretation of AIDS campaigns in Accra, Ghana. *American Journal of Sociology*, *115*(6), 1800–1852.
McGee, J., & Thomas, H. (1986). Strategic groups: Theory, research and taxonomy. *Strategic Management Journal*, *7*(2), 141–160.
Miles, M. B., Huberman, A. M., & Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook*. SAGE Publications, Incorporated.
Mintzberg, H. (1978). Patterns in Strategy Formation. *Management Science*, *24*(9), 934–948.
Mirabeau, L., & Maguire, S. (2014). From autonomous strategic behavior to emergent strategy. *Strategic Management Journal*, *35*(8), 1202–1229.
Porter, M. E. (1985). *Competitive Advantage: Creating and sustaining superior performance*. The Free Press.
Pottage, A. (2012). The materiality of what? *Journal of Law and Society*, *39*(1), 167–183.
Prates, R. O., Barbosa, S. D., & de Souza, C. S. (2000). A case study for evaluating interface design through communicability. *Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*, 308–316.
Rawle, F., Bowen, T., Murck, B., & Hong, R. (2017). Curriculum mapping across the disciplines: Differences, approaches, and strategies. *Collected Essays on Learning and Teaching*, *10*, 75–88.
Reed, E. S. (1996). *Encountering the world: Toward an ecological psychology*. Oxford University Press.
Rietveld, E., & Kiverstein, J. (2014). A Rich Landscape of Affordances. *Ecological Psychology*, *26*(4), 325–352.
Ruivenkamp, M., & Rip, A. (2014). Nanoimages as hybrid monsters. *Representation in Scientific Practice Revisited*, 177–200.
Shaviro, S. (2007). Pulses of Emotion: Whitehead's "Critique of Pure Feeling." *The Pinocchio Theory*.
Stieger, D., Matzler, K., Chatterjee, S., & Ladstaetter-Fussenegger, F. (2012). Democratizing strategy: How crowdsourcing can be used for strategy dialogues. *California Management Review*, *54*(4), 44–68.
Treem, J. W., & Leonardi, P. M. (2012). Social media use in organizations: Exploring the affordances of visibility, editability, persistence, and association. *Communication Yearbook*, *36*, 143–189.
Vaara, E., & Whittington, R. (2012). Strategy-as-Practice: Taking Social Practices Seriously. *Academy of Management Annals*, *6*(1), 285–336.
Van de Ven, A. H. (1992). Suggestions for studying strategy process: A research note. *Strategic Management Journal*, *13*(S1), 169–188.
Werle, F., & Seidl, D. (2015). The layered materiality of strategizing: Epistemic objects and the interplay between material artefacts in the exploration of strategic topics. *British Journal of Management*, *26*(S1), S67–S89.
Wijngaards-de Meij, L., & Merx, S. (2018). Improving curriculum alignment and achieving learning goals by making the curriculum visible. *International Journal for Academic Development*, *23*(3), 219–231.
Yaneva, A. (2014). Mapping Networks: Learning From the Epistemology of the "Natives." In *Visualization in the Age of Computerization* (p. 231). Routledge.
Yin, R. (2014). *Case Study Research Design and Methods* (5th ed.). Sage.

Bijan Azad (ba20@aub.edu.lb), is Associate Professor, also Director of Darwazah Center for Innovation Management & Entrepreneurship, American University of Beirut; his recent contribution on technology affordances appeared in *Materiality and Organizing: Social Interaction in a Technological World* (2012) Oxford University Press. He earned his Ph.D. and masters degrees from Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A. His research has been published in *Journal of Strategic Information Systems*, *European Journal of Information Systems*, *Government Information Quarterly*, *Information Systems Journal*, *Journal of Global Information Management*, and *International Journal of Accounting Information Systems*, *New Technology Work and Employment*, Academy of Management *Best Paper Proceedings*, *America's Conference on Information Systems Proceedings* as well as several practitioner publications. He was the Organizational Communication and Information Systems Division's recipient of the *Best Conference Paper Award* at the Academy of Management 2008 annual meeting in Anaheim, California, USA, a first time honor for an academic from a Middle Eastern university.

Fouad Zablith (fouad.zablith@aub.edu.lb), is Assistant Professor of Business Information and Decision Systems at the Olayan School of Business at the American University of Beirut. He earned his Ph.D. from the Knowledge Media Institute in the UK, and his master's degree from the British University in Dubai and University of Edinburgh. His research has been published in *Artificial Intelligence Journal, Knowledge Engineering Review, Interactive Learning Environments, Business Process Management Journal, Academy of Management Proceedings, America's Conference on Information Systems Proceedings, World Wide Web conference companion proceedings (received best paper award), International Semantic Web Conference proceedings, Conference on Knowledge Engineering and Knowledge Management proceedings (received best student paper award),* and others. He also published several book chapters and in other outlets. He has served on the program committee of several research events and international conferences including The Web Conference, International Semantic Web conference, Association for the Advancement of Artificial Intelligence conference, International Joint Conference on Artificial Intelligence, Extended Semantic Web conference, and others.

Recording Sessions of 25 Faculty Using Visualizations
Transcribing Recordings to Text
Identifying References to Visualization Features
Classifying Affordances of Visualization Features
Identifying Mechanism of Influence on Strategy Understanding
Identifying Mechanism of Influence on Strategy Enactment


First-order
Second-order
Aggregate Dimensions
Non-narrative capturing non-text elements that energize understanding
Color/Size
Links/Nodes
Width/Bandwidth
Affectivity
Network structure elements capturing relations in the curriculum and courses
Interdependence
Traceable Paths
Part-Whole
Relationality
Enhance Strategy Understanding
Adaptive interface elements capturing ability to change visual maps based on user objectives
Dynamic Content
Reconfigurability
Animation
Interactivity
Compliance elements capturing strategy as-is implementation
Executability
Fidelity
Accentuate Auth.
Legibility
Aid Strategy Enactment
Generative elements capturing strategy to-be implementation
Re-interpretation
Emergence
Co-Creation
Enunciability


Features of Digital Visualizations
Support Adaptive User Interface
Display Non-narrative Elements
Depict Network Structure
Relationality
Bundle of Digital Affordances
Interactivity
Affectivity
Digital Visualizations' Modes of Influence
Compliance Elements
Generative Elements
Legibility
Enunciability
Digital Affordances
Strategy Realization Process Phases
Enhance
Aid
Strategy Understanding
Strategy Enactment