

COGNITIVE FLEXIBILITY HYPERTEXTS AND THE DEVELOPMENT OF CREATIVE AND CRITICAL THINKING IN BUSINESS EDUCATION: THE PANTEON PROJECT

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Abstract

In this article, we discuss how the Harvard Method of case study, Interactive Communication Technologies and Cognitive Flexibility Theory may contribute to case-based learning about business decision-making. In particular, we are interested in designing learning environments that foster critical thinking, creativity, and reasoning that entertain multiple hypotheses from multiple perspectives. One such learning environment is the Panteon Interface, a web-based system for collaborative organizational analysis. We posit a framework for implementation and evaluation based upon Jonassen's "Meaningful Learning" model and Iowa's "Integrated Thinking Model." Based upon this framework, we briefly describe the design of Panteon and the results of a study utilizing focus group interviews, observations, and questionnaires to investigate participants' evaluation of the hypertextual methodology in comparison to the Harvard Case approach. The preliminary results indicate that both students and business experts favoured Panteon for its affordances to stimulate higher order cognitive skills. The implications and limitations of this study are discussed.

Key-words: Case Study – Panteon – Learning.

Resumo

Nesse artigo, discute-se como conjuntamente o Método Harvard de estudos de casos, as Tecnologias Interativas de Comunicação e a Teoria da Flexibilidade Cognitiva podem contribuir para a aprendizagem baseada em casos para tomada de decisão em administração. Em particular, aborda a concepção de ambientes de aprendizagem que facilitem os raciocínios crítico e criativo com base em análises organizacionais em múltiplas perspectivas. Um exemplo desse tipo de ambiente é a interface Panteon, um sistema desenvolvido para a Internet que permite análises organizacionais colaborativas. Propõe-se um modelo de implementação e avaliação baseado nas categorias de "Aprendizagem Significativa" de David Jonassen, bem como no modelo de "Raciocínio Integrado" da Secretaria de Educação do Estado de Iowa. Com base nesse referencial, descrevem-se brevemente a concepção do Panteon e os resultados obtidos com o uso de entrevistas de grupos focais, observação participativa e questionários aplicados para investigar a avaliação dos participantes sobre a metodologia hipertextual do Panteon em comparação com o Método Harvard de estudos de casos. Os resultados preliminares indicam que tanto os estudantes de administração quanto os *experts* que acompanharam os experimentos favorecem o Panteon devido às suas características de estímulo às habilidades de raciocínio de ordem superior. As implicações e limitações do estudo são também discutidas.

Palavras-chave: Estudo de Caso – Panteon – Aprendizagem.

1 Introduction

Decision-making is an inherently ambiguous process. Not only are different judgments made by different people on the same situation, but the same individual will often make different decisions at different moments in time given the same information (Mantovani, 1996). The Information Society (Castells, 1996), characterized by an unprecedented amount of data available at one's fingertips, has emphasized information-searching strategies which allow decision-makers to "identify priorities amongst a rather inconsistent system of preferences and to attribute plausible meaning to an ambiguous and confusing external environment" (Mantovani, 1996, p. 32). For those who do have access to the Internet, it is clear that the lack of information is frequently a smaller problem than deciding which pieces of information among the many sources available are the most relevant for analyzing situations and choosing appropriate actions.

These issues seem particularly relevant for decision-makers in business, and by extension, to the educational preparation of business students. To what extent, then, does current educational practice prepare business students for complex decision-making and information-seeking expertise? Jonassen and Carr (2000) recently analyzed a series of tests used to evaluate the educational practices of business schools in American universities, concluding that 65% of the questions (all were multiple choice) in the course examinations assessed recall, memorization, or knowledge of what students were taught in lectures or read from the text; 25% were at the concept level; and 10% assessed higher order thinking (such as rule, principle, inference, and implication). Based on a series of examinations like these, business faculty are willing to certify (by virtue of a bachelor's degree) that graduates are competent to conduct business. Graduates' business competence, however, relies on their ability to recognize instances of the concepts that they memorized for those examinations in the real

world and to know how to apply them in real-world practice, which requires understanding that was never examined or practiced in the large lecture courses (p. 166).

In short, we find it unfortunate that evaluation systems in business schools tend to focus on the learner's conceptual memorization capacity, instead of using criteria that reflect a student's ability to establish analytical connections, to formulate hypotheses, to conceive alternatives, and to apply these skills to complex problems in real-world practice.

We use the following sections to introduce the foundation for our framework. Arguing for a complex and interdisciplinary approach to thinking about business learning processes, we introduce a convergence of three cross-disciplinary approaches: The Harvard Method of case study, the inherent properties of new Information and Communication Technologies, and the principles of Cognitive Flexibility Theory.

1.1 The Harvard Case Study Method for Business Education

The Harvard Business School has been adopting the case method as a means to stimulate critical and creative thinking amongst its students for nearly a century (Bhatti, 1985). Before 1912, the technique was most commonly used in Law and Medical Schools. One of the early adopters of the "Harvard Method," Charles Gragg (1954) defined a typical case as an organizational problem described with the surrounding facts, as well as the opinions and preconceptions of the involved personnel. In this approach, students were expected to use the information to make decisions and propose an adequate course of action. The presentation of the problem is usually made in the form of a report (Roesch, 1997), with one or few points of view concerning the available evidence (Pemberton, 1995). Traditionally, case studies include a chronology

of meaningful events during organizational development, brief statements or tables presenting cost- and profit-related numbers, information regarding competitors, the market and a few comments by key decision-making characters (Edge & Coleman, 1982).

Cases vary enormously both in size and content. The presented problem situations are often based on real events, even though frequently disguised to preserve the anonymity of persons and institutions involved. Some consist of a retrospective presentation of a flawed strategy while offering the reader the opportunity to suggest more efficient tactics. Others require students to identify a central problem in a complex situation and to suggest ways of solving it. Others will ask them to determine the possible outcomes of a series of actions. They all have in common the fact that they are a means to stimulate students to analyze data, identify problems and make decisions (May, 1984). William and Margaret Naumes (1999) define the method as follows:

Case studies provide a means by which readers can learn through the discussion of actual situations and circumstances, by following the actions and analyzing the thoughts and decision process of real people, faced with real problems, in real settings. This is true for heuristic decisions where there can be no one 'best answer', as well as for algorithmic models that are designed to provide an optimal solution. Students are often uncomfortable with cases' ambiguity, the lack of a single 'right' answer. With cases, understanding how to evaluate a situation or make a decision is often as important a student outcome as the specifics of her or his discussion. From the analyses of a series of such cases, our students can develop the ability to apply these processes and extrapolate their understanding of the underlying concepts and theories to situations they encounter in the future. (p. 11)

For these reasons, we suggest that case studies are well-suited to address the pedagogical goals of fostering critical and creative thinking in the complex informational environment of the Knowledge Society.

Furthermore, we argue that innovations in the case method are called for which make extensive use of Information and Communication Technologies in order to take advantage of the cognitive potential of its unique informational properties.

1.2 Information and Communication Technologies (ICT)

The convergence between telecommunication and computer technologies, one of the very reasons why our informational environments have grown so complex, may provide the best solutions to deal with those challenges. We do not believe, however, that the mere introduction of Information and Communication Technologies (ICT) in classrooms or in the office will solve any problems. Instead, we agree with Lemos, Palacios and Cardoso's (1999) conclusion that technology cannot provide any magic solutions in and of itself, and that simplistic, technical solutions to political, cultural, and educational problems are misguided. Nonetheless, there are some potential learning affordances of the technology worth exploring:

New technologies will not necessarily bring about a radical innovation, but force users to deal with their inherent dynamics. Without technological support, virtualization processes are entirely dependent on the competence of the professor. Thanks to ICT, however, teachers and students feel inclined to explore the hypertextual possibilities of the new medium... How may one even try to use Internet for education without inherently practicing non-linearity, interactivity, simulations and real-time processes? Hence its importance. New Technologies used in education may help reposition teachers and students in their roles as agents of virtualization (LEMOS, PALACIOS & CARDOSO, 1999, p. 69).

Because of its unique interactive potential, ICT – which may as well stand for “Interactive Communication Technologies” – may prove to be better “cognitive tools” for advanced thinking

activities than the pencil or the book (LAJOIE, 2000; LAJOIE & DERRY, 1993). Increasingly, complex informational environments require students to overcome historical limitations of paper-based reading and writing, both in the classroom and in professional business environments. Such limitations are related to traditional media's characteristics of information storage, processing and distribution. Traditional media has been proven as an effective means for storing, retrieving, and transmitting wide ranges of human knowledge, so long as it can be declaratively stated (BOLTER, 1991, 2001; MOWSHOWITZ, 2002). It relies not only on the reader's ability to make sense of the alphabetical characters in ink, but also on the underlying structure of page numbering, cross-references and tables of contents. Unlike hypertextual interfaces, however, books lack the ability to autonomously pre-process information, leaving it up to the readers the task of re-arranging the contents according to their particular informational needs. Mowshowitz (2002) has convincingly argued that books are more limited than the interactive displays of ICT from the point of view of information presentation and distribution. Unlike the digital contents of a computer network, printed pages require physical distribution systems to reach their audiences, with all the implied inconveniences of time and space. In contrast, from a single computer terminal duly connected to the Internet it is possible to have dynamic access to a virtually unlimited amount of information anywhere and at any time. In a word, ICT combine the unprecedented flexibility of multimedia with the ubiquity of computer networks to present words, sounds and animated images in a controlled environment of interaction.

In our research, we are particularly interested in how these new information storage, processing and presentation potentials of ICT may be explored to present an alternative to the traditional method of business learning through printed case studies.

1.3 Cognitive Flexibility Theory

Cognitive Flexibility Theory (CFT) suggests a series of principles to make advanced learning with hypertextual interfaces a richer experience, by taking advantage of the random, non-linear representational capabilities of computers to represent multiple perspectives of complex problems in ill-structured knowledge domains. Spiro and his colleagues (SPIRO, COLLINS, THOTA & FELTOVITCH, 2003; SPIRO, FELTOVICH, JACOBSON & COULSON, 1992a,b; SPIRO, COULSON, FELTOVICH & ANDERSON, 1988; SPIRO, VISPOEL, SCHMITZ, SAMARAPUNGAVAN & BOERGER, 1987;) call domains of knowledge "ill-structured" when they present a large degree of variation from case to case, thus not being subject to algorithmic or pre-conceived solutions, as is known to occur for instance in social study fields such as political science or business administration. CFT suggests that case-based learning through hypertextual interfaces may facilitate learning in those domains of knowledge, as well as the ability to transfer what has been learned to new situations. In ill-structured domains, it is argued, the multi-faceted nature of realistic problem-situations can only be revealed through the use of multiple schemes, concepts and analytical perspectives (JONASSEN 1996, pg. 122; SPIRO, FELTOVICH & COULSON, 1996). In this view, the ICT characteristics of information storage, processing and distribution may indeed prove to be ideal to promote Cognitive Flexibility.

Computer interfaces with those characteristics are called "Cognitive Flexibility Hypertexts" or CFH. As Spiro and his colleagues (1992b) noted, "Cognitive Flexibility Hypertexts provide *exploration environments*, organized around *building blocks for knowledge assembly*, that are useful for a process of constructivist thinking" (p. 123). In other words, CFH are constructivist learning environments that stimulate creative and critical thinking by allowing users to look at the

same problem-situations from multiple perspectives within a self-controlled, interactive environment. Previous experiments with CFH have shown that they can indeed be more effective than traditional learning methods in terms of the learner's capacity to transfer the acquired knowledge to new situations (Jonassen, 1996; Koehler, 2002). Jacobson & Spiro (1995) also found significant differences in transfer in a tightly controlled experiment with random assignment of subjects to conditions.

Broadly speaking, our work has focused on developing an approach to business education that uses ICT, consistent with cognitive flexibility theory, to breathe new life into the Harvard Approach to better prepare students for the complex, multi-dimensional reasoning and critical thinking that is being asked of them. We use the next section to outline some of the constructivist principles that guided the implementation of Panteon.

2 Framework for Implementation and Evaluation

The weaving together of Case Methods, Informational Communication Technologies, and Cognitive Flexibility Theory form the rough framework guiding our development of a novel learning environment for business education. Although this convergence suggests general principles for instructional design (e.g., criss-cross the conceptual domain), we found it necessary to align these general principles to specific skills, reasoning, and experiences necessary for complex, interdisciplinary thinking in business. Naumes & Naumes (1999) have provided an excellent account of the relevant mental processes that take place during business case study analyses: a) focusing skills (defining problems and setting goals); b) information gathering skills (observing and formulating suggestions); c) remembering skills (encoding and recalling information); d) organizing skills

(comparing, classifying, ordering, and representing); e) analyzing skills (identifying attributes and components, identifying relationships and patterns, identifying main ideas, and identifying errors); f) generating skills (inferring, predicting, and elaborating); g) integrating skills (summarizing and restructuring); h) evaluating skills (establishing criteria and verifying).

Our goal, then, was to design the Panteon system so that the above skills were embedded into the instructional model, scaffolded by the interface and fostered by appropriate learning experiences. In essence, we were left with the challenge of designing the pedagogy that would appropriately support the development of these core skills. Instantiating the general principles into specific features of the system was not straightforward. Fortunately, two models of pedagogy in technology-rich environments closely fit our overall framework for learning in business education, and provided detailed advice to aid in the development of our project. These two models, Jonassen's (1999) "Meaningful Learning" model and Iowa's (1989) "Integrated Thinking Model," were used to design the learning environment (Panteon) and formed the basis of the evaluation of its effectiveness.

Jonassen (1999) introduces his "Meaningful Learning" model as a framework for thinking about how technology may be used to render constructivist-learning environments (a close match to the tenants of the framework we have proposed). In producing his synthesis of "technological constructivism," Jonassen assumes that: a) knowledge is constructed, which means it cannot be directly transferred; b) knowledge construction results largely from action and symbolic manipulation, hence learning is closely associated with active participation; c) knowledge is deeply related with the context in which the action takes place; d) meaning is intrinsic to the mind of the knower. We found his arguments about the corollary of these

assumptions particularly poignant: a) there are multiple perspectives of the objective world; b) learning is enhanced by problem-situations with high levels of relevance for the learner; c) knowing requires the capacity to articulate, express and represent what has been learned; d) meaning must be shared and socially negotiated; e) technological tools may help improve the experience of learning. Jonassen's model can thus be summarized as a constructivist environment in which *interaction*, *reflection* and *collaboration* in an *authentic context* play a significant role in learning with technology. We called this set of four Meaningful Learning characteristics "Collaborative Interactivity".

In considering the specific skills that we needed to emphasize, we also found guidance in a cognitive model created by the Department of Education of Iowa called "Integrated Thinking". According to that model, the ability to conceive new ideas, solve problems and make decisions is related to the capacity to reorganize knowledge (through *critical thinking*, based on the ability to analyze, evaluate and establish connections between several pieces of information) and to generate knowledge (through *creative thinking*, based on the ability to synthesize, elaborate and imagine possible relationships among pieces of information). For the purposes of our design (and evaluation), we focused on the following eight key aspects of the model: designing, problem-solving, decision-making, analyzing, evaluating, establishing connections, synthesizing and elaborating / imagining (each of these are defined in the next section, Table 2).

Finally, it is necessary to briefly characterize the learning environment we have conceived based on the above framework. Panteon is a Portuguese acronym for "Applied Project of New Technologies for On-Line Case Studies," but it also suggests the interdisciplinary aspirations of its Greek roots *Pan* + *Theos*, a shrine where "all gods" have their place. The acronym reinforces the Cognitive Flexibility principles underlying the project design, whereby different persons may

simultaneously explore the same social phenomena through different perspectives by taking advantage of the non-linear features of hypertextual interfaces. Initially, the project consisted of an attempt to create a single multimedia case study on a CD-ROM using video, still images with voice dubbing and computer animations. Such ideas later evolved towards the concept of a web-based databank allowing business students to create and diagnose hypertextual case studies about complex organizational environments. Panteon is currently delivered via the web using dynamic (i.e., using "Active Server Pages" or "asp") technology. New data may be easily added to cases and be automatically incorporated and accessible to learners, without the need to create new pages, print revised versions of cases, or manually distribute revisions. After selecting a case for diagnosis, students are presented with a brief description of the organization and its main dilemmas, as well as a description of the organizational actors involved and how each one of them perceives each problem situation according to the several categories in a specific model of analysis. These perceptions may be investigated using search criteria such as hierarchical, position, category of analysis and problem-situations. Students may "click-capture" the perceptions they find most relevant and produce an individual diagnosis based on their non-linear explorations of this cognitively flexible environment. Such individual diagnoses and plans of action may then be intersubjectively negotiated with other students, producing a collective synthesis.

Having thoroughly described the interface elsewhere (LIMA, 2002; LIMA, KOEHLER and SPIRO, 2002; LIMA, 2003), we will refrain from presenting its detailed methodology and technology in this article. Instead, we will focus on the analysis of the results obtained during the latest experiments with Panteon in a business learning environment in Brazil, in search of evidence that these processes indeed stimulate Integrated Thinking skills within a collaboratively interactive setting. The very description of the

qualitative results obtained during our study, as detailed below, shall give a fairly clear idea about the main characteristics of the Panteon methodology and its technical features. That notwithstanding, those readers wishing to have a deeper understanding about the design of the Panteon prototype may access an online tutorial about its main features (see LIMA, 2004).

3 Study of the Effectiveness of Panteon

Panteon was designed with the hope of fostering the development of critical, creative and complex thinking. Accordingly, the goal of this study was to determine the extent to which the Panteon interface accomplishes these goals in comparison to the current best practice: The Harvard Method. We used an opportunity provided by ongoing field experiments with Panteon to study the interface as it was being used in the context of an undergraduate business course. We used a combination of participant observation, focus group methodology, and survey data to inform our analyses. In particular, we wished to find out if, when compared to the Harvard Method, both students and practicing business experts would find Panteon better-suited in terms of the dimensions of participation suggested by the “Meaningful Learning” model and the dimensions of reasoning indicated by the “Integrated Thinking Model.”

3.1 Participants

Twenty-nine business students (19 men and 10 women, mean age = 23.6) were selected for this study from two senior classes (4th year students) from a school of Business Administration in Salvador, Brazil. The experiment was conducted in a computer laboratory with one machine per student, as an extension to their “Strategic Planning” class activities; even though participation was voluntary, participants who attended at least three of the four Saturday all-

morning sessions were credited with an extra point in the final examination. All 29 students used in the sample fulfilled this requirement. The semester ended after the last computer laboratory session; we offered fifteen dollars per person to two groups willing to come to the university an extra Saturday morning and take part in the focus group discussions of the experiments. Eight participants of two groups accepted the offer.

Additionally, four business and education experts (mean age = 35.75) participated in this study as observers. This expert group was comprised of one instructor of the student participants, plus two other business teachers who had observed Panteon in practice at a local small business, Conduit Technology (a pseudonym), as well as the owner of Conduit Technology (who was also a 4th year business student). These four experts participated in a focus group session of their own. Note that the Panteon case materials used in this study were developed using Conduit Technologies as its source material.

3.2 Materials

The case study presented to the students consisted of the nine Conduit employees’ perceptions about the three most urgent problems faced by their firm: a) internal and external communication problems; b) uneven cash-flow; c) lack of commitment. These problems were looked at from the perspective of a five-category model of analysis that prompted employees to reflect upon the following organizational dimensions involved: production (tasks), structure (hierarchical relations), strategy (market- and environment-related), technology (including available infrastructure), and culture (human resource motivational policies, leadership). As a result of an interview with the employees, 256 perceptions (with an average 63.67 words each) were transcribed and inputted in the Panteon interface under the category of analysis they were most closely related to.

Near the end of the study, participants filled out a questionnaire to assess their age, level of Internet experience, the ease of using the Panteon interface, and the participants' rating of their knowledge and experience with the Harvard Method. They also wrote answers to open questions about what they thought were Panteon's advantages and disadvantages as compared to the Harvard method, as well as what pleased and displeased them most in Panteon. An additional form asked participants to use a 4-point Likert scale (1 = "very low"; 2 = "low"; 3 = "high"; 4 = "very high") to rate the extent to which the Harvard Method and the Panteon approach fostered: *Interactivity*, *Authenticity*, *Reflectivity*, and *Collaboration* (the four dimensions of the "Meaningful Learning" model dubbed as "Collaborative Interactivity"). Participants used the same scale to rate both Panteon and the Harvard Method on eight dimensions of the "Integrated Thinking Model" (i.e., *Establishing Connections*; *Analyzing*; *Designing*; *Evaluating*; *Problem-solving*; *Synthesizing*; *Decision-making*; and *Imagining / Elaborating*).

During the two focus group sessions (one with the 8 students and another with the 4 experts), the moderator used the filled out forms as a guideline to prompt questions to the participants about pros and cons of the Panteon Method, as well as individual aspects of both the "Collaborative Interactivity" and "Integrated Thinking" models. Both focus group sessions were videotaped. Participants were encouraged to express their agreement or disagreement with each other's views, but not necessarily to reach a consensus.

3.3 Design and Procedure

Participants developed their case analyses during 12 hours, between October and November as part of a 4th year class on Strategic Planning (actual diagnosis took place over three 4-hour sessions

on Saturday mornings). The 29 participants were each assigned a role in their groups, either as a "Generalist," a "Marketing Specialist," a "Human Resources Specialist," or an "Organizational Systems Specialist." Roles were freely negotiated among group members according to their own professional aspirations. Marketing specialists were told to focus their investigative strategies on the "uneven cash-flow" problem, while Human Resources and Organizational Systems specialists were respectively asked to focus on the "lack of commitment" and "internal and external communication" problems. Generalists were asked to dedicate equal attention to the three problems simultaneously and to coordinate group discussions. Students were confronted with those three real-life problem-situations of Conduit Technology as perceived by its nine employees. Two business teachers were invited to observe student behavior during diagnosis. Observations were unstructured, and there was no protocol used for these observations.

Following individual case diagnosis (two 4-hour Saturday morning sessions), collaborative discussion took place within each group involving three specialists and a generalist (during one 4-hour session in which students were asked to produce a final, collective diagnosis and plan of action). Students then completed the evaluation survey (described in "Materials," above). After the participant observation stage, two focus groups were formed. The Student Focus Group was comprised of eight volunteers among the student participants, and was convened one week after the last diagnosis session. This one focus group session lasted two hours. The other group was comprised of the four business experts; it convened almost two months after the first focus group (due to scheduling difficulties) and lasted about two hours and a half. Following the convening of the focus groups, the four experts also completed the evaluation survey.

3.4 Analyses

Responses from the evaluation survey for student and expert participants were used to quantitatively compare participants' beliefs about the learning afforded by Panteon in comparison to the Harvard Method on the four dimensions of "Collaborative Learning" and the eight dimensions of "Integrated Thinking." These comparisons are reported as matched-pair *t*-tests: effect sizes and *p*-values are reported for the purposes of evaluating practical and statistical significance respectively. Comparisons between expert and student rankings were not practical given the small sample size for expert ratings (n=4).

Qualitative data from the focus groups are used to illuminate and explain participants' ratings, as well as highlight particular features of Panteon's design that were relevant to participants (both positively and negatively). In short, the focus group is used to examine the qualities that lead to the described quantitative differences evidenced in the evaluation surveys.

3.5 Results and Discussion

Responses from the evaluation survey for student and expert participants were used to quantitatively compare participants' beliefs about the learning afforded by Panteon in comparison to the Harvard Method. Survey questions addressing the dimensions of "Collaborative Interactivity" and the "Integrated Thinking Model" helped investigate participants' beliefs about Panteon and the Harvard Method.

3.5.1 Collaborative Interactivity

Table 1 displays the results from the survey for the 29 student participants who rated Panteon and the Harvard method on the dimensions of Collaborative Interactivity, after 12 hours of group work with Panteon. Table 1 also displays statistical (*p*-values) and descriptive (effect size *r* and Cohen's *d*) measures of the difference in mean ratings of the Panteon interface and the Harvard Method.

Table 1 - Mean of student ratings on Collaborative Interactivity for Panteon and the Harvard Method

Dimension of Collaborative Interactivity	Student Respondents (n=29)			
	Harvard	Panteon	H vs. P p-value	Effect Size H vs. P (d / r)
1. Interactivity (how easy it is to manipulate available pieces of information)	2.21 (0.86)	3.62 (0.49)	< .001	2.05 0.72
2. Reflectivity (degree of stimulation to creative and critical thinking)	2.66 (0.77)	3.55 (0.51)	< .001	1.40 0.57
3. Authenticity (degree of realism and relevance of the presented problems)	2.59 (0.91)	3.39 (0.57)	< .001	1.34 0.56
4. Collaboration (degree of stimulation to conversation and negotiation among team members)	2.69 (0.97)	3.07 (0.96)	.203	0.40 0.20

Note that on every dimension of Collaborative Interactivity, the mean rating for Panteon is higher than for the Harvard Method. This difference is statistically significant for Interactivity, Authenticity, and Reflectivity but not for Collaboration. An inspection of the effect sizes points to a very large preference for the Panteon approach (when Cohen's *d* exceeds .80, effects are considered "large").

One might consider that students have very little experience of the Harvard Method, undermining their ability to effectively rate the difference between the two approaches. However, this group of students reported fairly extensive experience with Harvard-like case studies (an average rating of 3.79 on a four-point scale). Furthermore, correlating case experience with the observed differences in favor of Panteon suggests either no relationship between case experience and the observed favor with Panteon (in a hypothesis testing framework), or perhaps even a modest preponderance to rate Panteon even more favorably among students with more Harvard-like case studies (using a descriptive framework). It is also worth noting that other factors (e.g., age, computer experience, gender, etc.) did not correlate with any of the observed differences.

Not surprisingly, interactivity ranked as the Panteon characteristic that most contrasts with the traditional Harvard method (a difference of 1.41). Indeed, the ability to "interact" with characters and their perceptions seems to be a powerful idea for learners. For example, one participant noted: "it is very handy: you see a character's photo on the screen, on the same spot you capture his or her perception on a given problem situation ... This is a very involving experience, all of the elements are easily manipulatable." Another noted, "this involvement occurred basically because of the possibility of writing your commentaries while capturing perceptions; this breaks the monotony of reading only; as you write your partial insights on the screen you end up interacting more." Yet another points out that seeing the pictures of characters beside every perception, along with one's own annotations helps to bring the context

to life, "as if you were talking to those people" or "as if you were inside the organization."

The degree of reflectivity in Panteon received a score 0.89 higher than Harvard's. It looks as if the possibility to annotate every captured perception somehow forces the users to think about every single aspect of the problem before they move on with their reading. In one student's view, this active role makes some difference in the degree of reflectivity, for "it is not an academic text which you are supposed to read in its entirety before you start analyzing." The degree to which students engage in this reflective thought can be surprising, as one student noted: "I usually hate to be passively stuck in front of a web browser, [but while using Panteon] I did not feel like that. ... I captured over 67 perceptions, selecting only the fragments of information I felt I needed." Another indicator of how much reflection, analysis, evaluation, and critical thinking are involved is the amount of attention given to the activities in the research room. For example, the word "filter" was mentioned 14 times in focus group transcripts and questionnaires. Almost always, this word was used in a context related with the ease of manipulating information with the interface.

Also unsurprising was the 0.80 difference attributed to "Authenticity." Here, Panteon being perceived as superior is probably based in part on the authentic context provided by the Panteon design, but also due to the fact that business students in Brazil seldom have an opportunity to diagnose case studies about local Brazilian businesses – the vast majority of materials they use are developed abroad, and often out of date. One of the students, for instance, thought that "[the Panteon case] is much closer to our reality... it's not like those foreign multinational cases; the fact that it is a small size, local organization helped a lot." That aspect notwithstanding, the digital medium may indeed have played a role in the overall perceived authenticity of the Panteon case due to its inherent capability of reorganizing hundreds of informational fragments according to user-determined searching and filtering criteria. It

would be arguably very difficult to deal with as many first-person perspectives using traditional paper-based media and narrative structures. The possibility to investigate hundreds of transcribed speeches using search criteria such as problem-situation, category of analysis or self-determined keywords seems to have been quite appreciated by the participants. The following statements, written down on the student questionnaires, seem to validate this assertion: “through Panteon it is possible to have a broader and more truthful perspective of the organization. You can perceive small details in how the employees express their frustrations and motivations, as though you were interviewing them,” and, “those are very real opinions, which appear coherent with reality, which motivates us to use [the interface].”

Understandably, the degree of collaboration was the least distinguished feature of the Panteon approach to case studies, perceived as only 0.38 points above Harvard. We had actually expected Harvard to have a higher score in this regard, as this is the main emphasis of the method, oftentimes taking up more than a two-hour class to collaboratively discuss a case. In our experiment, most of the twelve hours of computer laboratory time was spent by users in their own individual diagnosis, with hardly any interaction with their fellow participants. So much so, that one of the recurrent criticisms of the Panteon method that appeared in the questionnaires was that it “does not allow much room for group discussion of the case study, because we interact more with the computer than with one another” or that there is “a lack of interactivity among the students during the process, as each of us faced our workstations the whole time, isolated from each other.” The scant four hours actually devoted to collaborative diagnosis were hardly sufficient to achieve a consensual final output, but we had run out of time as the semester was over. In spite of the limited exposure to the collaborative dynamics of the proposed method, quite a few students seem to have understood the potential for extended collaborative work after the stage of individual

diagnosis with Panteon. One student noted: “I loved the fact that one can concentrate on one’s specialty during diagnosis, working only with a few related perceptions; the resulting insights may be perfected later on while sharing these specialized findings with the generalist or with the other specialists in the group.” Similarly, another student states that “one may deepen one aspect of the analysis while another focuses on a different part of the problem; when we get together, the assembled picture ends up being more complete.”

The four experts in the study also rated Panteon higher than the Harvard method on measures of Collaborative Interactivity. Even though statistical analyses with $n=4$ participants are problematic (e.g., very low statistical power to detect differences), experts rated Panteon significantly higher on Interactivity and Collaboration. One of the expert observers highlighted, during the focus group, the virtuous relationship that appears to exist between the interactive aspects of the tool and the collaborative aspects of the method: “Panteon, taken as both a methodology and a technology, seems to stimulate the free manipulation of subjective perceptions while requiring analysis and interaction with peers, which definitely seems to facilitate learning and the development of critical and creative skills.”

3.5.2 Integrated Thinking

Table 2 displays the results from the survey for the 29 student participants who rated Panteon and the Harvard method on the dimensions of Integrated Thinking. Table 2 also displays statistical (p -values) and descriptive (effect size r and Cohen’s d) measures of the difference in mean ratings of the Panteon interface and the Harvard Method. Results indicate large practical, descriptive, and statistical differences in favor of Panteon on each dimension of the Integrated Thinking model for the 29 student participants. As before, experience of the case method does not predict the size of the observed differences between the two approaches.

Table 2 - Mean and standard deviation of student ratings on Integrated Thinking measures for Panteon and the Harvard Method

Dimension of Integrated Thinking	Student Respondents (n=29)			
	Harvard	Panteon	H vs. P p-value	Effect Size H vs. P (d / r)
1. Establishing Connections (comparing, contrasting, logical thinking, inferring, identifying causal relationships)	2.24 (0.91)	3.69 (0.54)	< .001	1.96 0.70
2. Designing (imagining a goal, formulating a goal)	2.52 (0.51)	3.69 (0.47)	< .001	2.43 0.77
3. Analyzing (recognizing patterns, classifying, identifying assumptions, identifying main ideas, finding sequences)	2.31 (0.71)	3.45 (0.57)	< .001	1.79 0.67
4. Evaluating (assessing information, determining criteria, prioritizing, recognizing fallacies, verifying)	2.48 (0.87)	3.55 (0.51)	< .001	1.53 0.61
5. Synthesizing (analogical thinking, summarizing, hypothesizing)	2.45 (0.69)	3.45 (0.63)	< .001	1.54 0.61
6. Problem-solving (sensing the problem, researching and formulating the problem, finding alternatives, choosing the solution, building acceptance)	2.41 (0.73)	3.38 (0.62)	< .001	1.44 0.58
7. Decision-Making (identifying an issue, generating the alternatives, assessing the consequences, evaluating the choices)	2.55 (0.57)	3.48 (0.57)	< .001	1.65 0.64
8. Imagining / Elaborating (forecasting scenarios, extending projections, concretely expressing abstract ideas)	2.62 (0.82)	3.24 (0.83)	.012	0.77 0.36

“Establishing Connections” was the feature of Integrated Thinking perceived to be the most distinguished aspect of the Panteon approach to case studies, an average 1.45 points higher than Harvard. Transcriptions from the student focus group helped us better understand how this aspect of the model was perceived by users: according to one statement, “the ability to easily manipulate pieces of information helped us compare and contrast opinions;” this seems to have allowed participants to “compare how the lower levels of the organization see the problems with the perceptions of the upper levels.” Another participant feels that again a crucial aspect of a

non-linear case study is the possibility of dividing investigating students into specialized consultants, using specific navigational strategies to concentrate on certain aspects of the problem. He states that “the interconnections between Marketing and Organizational Systems [OS] or between OS and Human Resources emerge when a specialist who collected information about his area interacts with a specialist from a different field ... as it happens in an actual organization in a competitive market, different department specialists get to interact with each other. I find that having the opportunity to emulate that interaction within a class is one of the greatest aspects of the [digital] approach.”

“Designing a plan or strategy” was the next highest distinguishing characteristic of Panteon (1.17 point difference to Harvard). Once more, the possibility of annotating captured perceptions was seen as a facilitating device. The fact that the interface allows users to categorize their captured perceptions along with their own comments during diagnosis seems to enrich the process of suggesting a course of action in the final stage of the procedures. This is confirmed by participants who stated that “I had a chance to write my thoughts about everything I read, [in the end] these annotations helped me think the entire case over” and that “when you annotate [your thoughts about a perception], you are creating the very fundamentals of your plan of action.”

Students were also attracted to the Analyzing feature of Panteon. A few students mentioned this feature as one of the most distinguishing aspects of the hypertextual method in the questionnaires, for example one student’s comments suggest that the graphical displays of the interface allowed her to “clearer visualize the characters and their statements, facilitating the analysis of organizational problems.” Besides, the transcription of the direct speeches of actual decision-makers into a searchable database structure seems to have contributed to a more authentic analytical environment. According to a participant, “in a conventional analysis it is very hard to get in contact with certain subtleties of the process, such as the way the leader is actually perceived by his/her followers, what the organizational context feels like, what are the underlying human aspects of the problem.” The use of search engines and filters to customize one’s problem-solving approach was also mentioned as a unique feature of hypertextual cases that facilitated analysis.

On the measure of “Evaluating,” the possibility of looking at the same fact from multiple points of view was perceived as the most distinguishing characteristic of the hypertextual case. Panteon seems to make it easier to identify “character comments that often have nothing to do with the

actual problem.” This same participant went on to say that the search engines help separate useful statements from misleading ones; by refusing to capture superfluous or misleading comments into the Pantpad, “you avoid taking into account perceptions that won’t help you diagnose the problem” and suggest an adequate plan of action. Another participant feels that after investigating a few of the perceptions related to the same problem it becomes easier to realize when characters are talking about a relevant issue or when they are merely “making a personal point about their particular empathies and antipathies.”

“Synthesizing” is seen as one of the main advantages of Panteon by a student who believed that it may help “deal with larger quantities of information than you find in a traditional case, while allowing you to summarize the essential bits.” In the context of the diagnosing process, this competence seems to be associated with the possibility of establishing hypotheses with every annotation of captured perceptions, which may be later retrieved under specific categories to produce a final diagnosis and a plan of action. The very built-in functionality of sorting the transcribed statements by character, keyword, hierarchical position or category of analysis may facilitate synthesizing. Another user felt that the sorting devices allow users to categorize the dozens of character perceptions into “variations over a few themes, which facilitates summarizing.” The division of diagnosing tasks among specialists and the later reunion of those to talk about complementary or contradictory aspects of their findings were also pointed out as an aspect that contributes to develop synthesizing skills.

“Problem-solving” is an inherent part of interacting, reflecting and collaborating during the three stages of diagnosis with Panteon. During the first stage, the individual diagnosis, students have to deal with dozens of perceptions, capturing and commenting those they find most relevant. This is a more interactive and reflective stage by definition. During the other two stages,

partial synthesis within each group and the final collective synthesis among groups, collaboration is the foremost element in problem-solving, as students confront their individual results with their peers'. As explained by a participant, "the tool has proven to be very useful when it comes to capturing, analyzing and commenting multiple character perceptions, producing a synthesis and then exchanging your findings with your colleagues." The fact that, contrary to most Harvard-style cases, Panteon explicitly presents the problem situations upfront was not necessarily perceived as making it less challenging, for "even though the issues are pre-identified, one can always find during the investigation that undeclared, subtle problems may lurk beneath the presented situations."

"Decision-Making" is a crucial skill to be developed by any businessperson. In Panteon, users have to make decisions not only about the final courses of action an organization should take, but also about which "versions of the truth" to rely on. In this respect, it tries to emulate the complex decision-making environments of actual organizations, which are based not only on objective data but also on how fellow managers perceive the problem. As put forward by one of the written answers to the question about the main virtues of the interface, "Panteon allows us to collect and to cross larger quantities of data, involving several levels of organizational decision-making, before actually deciding on an appropriate course of action. Besides, because opinions may be captured from characters occupying different positions, with different perspectives, it is easier to analyze which organizational issues seem to be the most urgent."

Finally, the least distinguishing aspect of the Panteon method seems to be "Imagining / Elaborating" – a construct of some dispute amongst the two focus groups. Apparently, it did not become clear to the participants just what was meant by "forecasting scenarios, extending

projections, concretely expressing abstract ideas." In one of the participant's point of view, "a traditional case study allows for more imagination and elaboration than does a Panteon case, because amidst as many Panteon perceptions one is left with little room for personal extrapolation." Likewise, another one states that "in a traditional case we have to guess and speculate ... as in Panteon the problem situations are previously defined, one's own imagination is less demanded." These views, however, are not in accordance with student views contending that "in Panteon it is actually easier to visualize organizational situations because you are looking at them from multiple perspectives" and "elaborating scenarios is much easier with Panteon than with paper, because [traditional cases studies] hardly ever present enough arguments, you don't get as many different points of view." The majority of participants seem to agree with these two, as indicated by the significant difference in the ratings of the two approaches.

Due to a small sampling of experts (n=4), only one of the observed differences is statistically significant (e.g. Analyzing, $p=.014$). However, an inspection of the observed effect sizes indicates a similar pattern to those obtained by the student participants. The overall impression of the experts was that Panteon can be an effective way of stimulating Integrated Thinking, as can be seen by these two sample quotations from the expert focus group: "[the interface] provides a very complex organizational landscape and allows users to roam freely before meeting to discuss their findings, comparing partial results and producing a collective synthesis"; "the ability to simultaneously analyze a great variety of perceptions according to different criteria allows students to deal with the great complexity of contemporary organizations in a controlled environment, forcing them to deal with contradictory and complementary evidence about various aspects of the problems at hand."

3.6 Qualitative Evaluation of the Panteon Interface

The exit survey and focus group discussion allowed us to focus on the qualities of the Panteon interface in terms of its affordances, as well as its constraints. Although we have included some of these responses in support of the previous quantitative analyses, we use this section to categorize some of the most popular responses, and highlight some shortcomings in the interface, in addition to some of its strengths.

Most of the limitations of the interface and suggestions for improvement were written in response to two open-ended survey questions: “What aspects of the Harvard method do you think are superior to Panteon?” and “What do you think could be improved in the interface?” The most common criticism to Panteon related to its complexity – many participants noted that Panteon depended on an overly complex infrastructure (24% of student answers to this item fell into this category, even though none of the experts mentioned this as a problem). The first criticism is particularly understandable because at the time of the study, Panteon was only available on the local computer lab. Therefore, students could not use their extra time at home or at work to further their individual diagnosis. It is also possible that a certain amount of complexity in implementation is required, as one of the main goals of the design was to foster thinking about complexity, and avoiding the tendencies to rush towards prototypical (and overly linear) solution paths. However, we take seriously the notion that the interface may be redesigned so that presentation to users is as simple as possible, enabling learners to focus on the complexity of the underlying decision-making portrayed in the business cases.

A related concern about complexity was raised in terms of the underlying pedagogy of Panteon. Some students mentioned that the approach was overly complex (the Harvard Method seemed more straightforward) and that Panteon presented

too much information (24% of the students mentioned either the complex methodology or the excess of information as disadvantages of Panteon; one out of four experts agreed with that criticism). We concur that the Harvard approach is a simpler, more straightforward method. Panteon does require a few hours of getting used to the interface and its tools for creating and diagnosing case studies. The issue of Panteon presenting excessive information, however, is actually part of its learning principles rather than one of its faults. Based on the constructivist premise that emulating the complexity of professional environments increases the feeling of authenticity, Panteon seeks to incorporate not only to-the-point, relevant character perceptions but also less relevant, subjective commentaries and superfluous evidence. The degree to which this complexity is represented, and is optimal for learning, remains an avenue of future research.

Participants also had specific advice on how to improve features of Panteon. The most noteworthy include: improving the navigational system (seven out of 29 students, one out of four experts), enhancing the filtering and searching capabilities (three students, one expert) and developing features that would allow students to work collaboratively across distance and time (mentioned by two students). We find all of these suggestions helpful, and revisions of the Panteon interface have sought (and will seek) to implement such improvements.

In spite of these criticisms and suggestions, overall the interface was very well evaluated by both students and experts. The novelty of using the computer as a cognitive partner was pointed out by one expert and nine students as the most pleasing aspect of the experience. The “multiple perspectives” characteristic inherent in its Cognitive Flexibility principle was seen as the most enjoyable aspect by two experts and six students. The degree of interactivity and authenticity were also directly mentioned as key aspects of the methodology.

4 Conclusion

Panteon was not developed as a substitute for the Harvard-style case study, but as a possible alternative that borrowed from the strengths of the approach. Our analyses show that students using Panteon in their studies, as well as expert educators and practitioners, believe it to offer advantages in the areas of Collaborative Interactivity (degree of Interaction, Authenticity, Reflectivity, and Collaboration) and the “Integrated Thinking Model” (Basic, Critical and Creative Thinking). In part, this is no surprise, as Panteon was developed specifically to address these issues. But, like any design project, planning to meet goals and succeeding to reach goals are two different things. In this regard, we feel that the design of Panteon was successful in providing an alternative model of pedagogy in business education that fostered higher-order, complex reasoning skills in students.

Even though this research has focused on the potential advantages of hypertextual interfaces as compared to ink and paper, we do not mean to imply that one medium is generically superior to the other, but rather that certain media may address certain cognitive needs in a better way under certain circumstances. From this perspective, we realize that the fact that Panteon average scores were consistently higher than Harvard’s does not necessarily mean that the new method is superior to the older. It may very well be that the Harvard Method, implanted with a high degree of energy and instructional fidelity might also be able to produce high ratings of complex reasoning. Alternatively, even though students and experts rated themselves as having a high-level of experience and familiarity with the case approach, their understanding of the Harvard Method may represent an oversimplified one, consisting of a superficial class discussion on an oversimplified dilemma, often presented as a two page long anecdotal account. This possibility is supported by several statements made by the students (either during the group interviews or while filling out the post test forms) about the

shallow or laconic character of “typical cases.” Contrary to that perception, however, full-blown Harvard cases may be up to 30 pages long, containing an enormous amount of details and demanding several hours of sophisticated analysis and qualitative and quantitative inferences. Such an advanced approach to case studies is very seldom seen in undergraduate level business schools in Brazil. If repeated elsewhere, the same experiment might produce drastically different results, with Harvard-style cases having the upper hand in many aspects of the adopted model. As such, an avenue of future research should focus on different demographics and/or on comparing it to actual implementations of the Harvard Method. Another limitation of this study is that it focused on participants’ perceptions of the learning affordances of the two methods. This is understandable given the introductory, exploratory nature of the above experiment, and the early stages of software design for Panteon. Future work will focus on the extent to which the Panteon approach actually fosters higher-order thinking in students, and their ability to analyze problem situations and think critically about potential solutions.

Instead of comparing the Panteon approach to the Harvard Method, however, it may be fruitful to explore the potential synergy between approaches. Harvard-style narratives may be used to present the objective elements of the case study, including the historical context, tables and charts, while the Panteon may be used to explore the subjective aspects of the problems at hand from multiple points of view. In fact, as demonstrated by other recent experiences using the interface in post-graduate courses in Salvador (one-session diagnosis with Panteon supported by Harvard-style objective evidence and historical account of a corporate dilemma), it is possible and desirable to work with the two techniques simultaneously, enjoying the best the printed and digital media can offer.

From the preliminary results obtained, we do believe that some of the unique features of hypertextual interfaces may not be easily emulated

using ink and paper. ICT's informational storage, processing and distribution characteristics are already having a deep impact on how the new generations learn. It has become clear that hypertextual environments need to be seen less as a mere repository of data, and more as a cognitive partner to help users develop their critical and creative thinking. Wider use of similar techniques may help complete the transition from the declarative knowledge acquiring mechanisms that still linger in many institutions of higher education to the diffusion of procedural knowledge instruments such as the one we have proposed. It was a gratifying experience to witness how most students participating in the experiment became involved with Panteon, to the point of being fully immersed in the organizational environment of Conduit Technology. As many of the statements from the focus groups show, these students found themselves in a "web-chat-like environment" they are very familiar with, taking full advantage of the same two-fingered skills they are used to employing on their everyday Internet surfing to analyze and diagnose complex organizational problems. In an era in which hypertextual interfaces are used not only at school or at work, but also for daily leisure activities, it is necessary to find out more about how the non-linear rationale of the web may help us cope with the increasingly complex challenges of the Information Age.

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