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Mapping the Complexities of Online Dialogue: An Analytical Modeling Technique

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Abstract: The e-Dialogue platform was developed in 2001 to explore the potential of using the Internet for engaging diverse groups of people and multiple perspectives in substantive dialogue on sustainability. The system is online, text-based, and serves as a transdisciplinary space for bringing together researchers, practitioners, policy-makers and community leaders. The Newell-Dale Conversation Modeling Technique (NDCMT) was designed for in-depth analysis of e-Dialogue conversations and uses empirical methodology to minimize observer bias during analysis of a conversation transcript. NDCMT elucidates emergent ideas, identifies connections between ideas and themes, and provides a coherent synthesis and deeper understanding of the underlying patterns of online conversations. Continual application and improvement of NDCMT can lead to powerful methodologies for empirically analyzing digital discourse and better capture of innovations produced through such discourse.

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1. Introduction

Sustainable development presents considerable challenges to both practitioners and educators (DALE, 2001; ROBINSON & TINKER, 1997). What is key to community practitioners is how to build on best practices and leading-edge technologies while at the same time minimizing risk in the face of learning. Educators equally are concerned with research dissemination and knowledge diffusion about leading-edge implementation and best practices for achieving sustainable community development. Since sustainable development research

and learning involves the production of useful knowledge, it is highly normative, inherently interdisciplinary and demands an unprecedented interface between the natural and social sciences; it necessitates inter- and trans-disciplinary space for dialogue and knowledge transfer. Both learning and practice require novel ways of knowledge diffusion, particularly since any solutions are beyond the jurisdiction and expertise of any one sector or government to implement. There is often no single right answer; rather, there are multiple solutions and multiple pathways for implementation. [1]

Many communities are attempting to embrace the challenge of sustainable development at present, but their efforts are often reactive, occur on a one-time basis, and are not properly documented. It is clear, however, that new transdisciplinary networks designed to stimulate collaboration are critical to achieving sustainable community development (BRADFORD, 2002; DALE, 2001). A transdisciplinary approach should allow the gap to narrow between research and decision making (RAMMEL, 2003), and of specific importance for the case study at hand, allow one tool to function well for diverse user groups. Building such networks would allow community groups to avoid resource-draining repetition, and allow them to learn from the mistakes and successes of other groups. But, how can such links be made, and how can the speed of knowledge sharing and the take-up of new technologies be increased (HORLICK-JONES & SIME, 2004)? [2]

Since adaptation, dynamic interaction (NORGAARD, 1994), innovation, and continuous learning are critical components of sustainable development knowledge and practice, in 2001, we began to explore the possibility of developing an online tool that would facilitate continuous learning and dialogue around critical public policy issues, focusing on sustainable development. Our societies are creatures of change, and the continually changing nature of society and the biosphere, rather than in balance (WEDDELL, 2002), challenges the idea that there is an ideal, static, equilibrium sustainable society to be achieved. As ecologist Christian RAMMEL notes (2003, p.396), "... there cannot be any best state, or stable equilibrium, or optimal path of development." It is a continuous journey for a destination that may always be unattainable (ROBINSON & TINKER, 1997). A sustainable society must be dynamic, and constantly rethink what is sustainable given current conditions (NORGAARD, 1994). [3]

Given all of the above, our tool needed to have the capacity for both dynamic interaction and be able to capture continuous learning and change as well. Facilitating interactions and capturing the learning requires clustering within networks, and clustering is a dynamic process (GARGIULO & BENASSI, 2000). Thus, any conversational analytical tool has to be capable of change and evolve with use, building through evolutionary and interactive knowledge and in a experiential capacity. Without being able to capture the diverse expertise and experience of the users, the tool would become a one-way interaction, rather than a diverse knowledge base used by multiple users and communities. [4]

There are many benefits of clustering (specifically referring to the bringing together of certain individuals and actors within networks). These include the ability of clusters to foster high levels of innovation, information and resource exchange, the ability to share infrastructure, and the ability to share specialist knowledge (GARGIULO & BENASSI, 2000). There is also much to be gained by encouraging education among a cluster, especially concerning the exploitation of knowledge. The question, of course, is how to facilitate this type of clustering? Our initial tool design was intended to go beyond the classroom and into the communities themselves in order to bridge asymmetries in networks of actors, experts, and stakeholders, and also to enhance research dissemination in communities and learning across communities. [5]

For group leaders, facilitators, and academics attempting to assist groups in creating ties through information sharing, the choice of the medium of information transfer and the form of that information is critical. One of the problems with non-disciplinary study is how various stakeholders will communicate (NARAYAN, 1999). A transdisciplinary approach that goes beyond traditional, singular-discipline academic pedagogy is needed. Therefore, another of our objectives was to create a forum for connecting the knowledge and learning of academics, community activists, decision-makers and innovators by providing a dynamic, interactive space and place that allowed communities to bridge beyond their geographical borders, and augment their access to resources outside their respective communities. [6]

The next section describes how the e-Dialogue system operates (Section 2.1) and then discusses the considerations in analyzing online dialogue transcripts (Section 2.2). Section 3 details a method for analyzing e-Dialogues and capturing ideas and patterns emerging through digital discourse using of a novel visual modeling technique. The aim of this research is to contribute to social science work that employs dialogue in its methodology by offering an approach to conducting and examining online discussions. [7]

2. E-Dialogues and Analysis of Conversation Transcripts

2.1 Enlarging the public sphere for dialogue

In 2001, the second author, in conjunction with Isabel CORDUA-VON SPECHT and Darren OXNER, began to explore the potential the Internet has for engaging diverse groups of people and multiple perspectives in substantive dialogue on sustainability while increasing literacy on key sustainable development issues and influencing the public policy community (DALE, 2005). The e-Dialogue platform, subsequently developed, uses an entirely text-based system for conversation to allow for accessibility to those with low-bandwidth (DALE & NEWMAN, 2006a), and thus has the potential to connect people from a variety of different community types (i.e., urban or rural) and technological capabilities. The system provides a transdisciplinary space for bringing together researchers, practitioners, policy-makers and leaders of communities of different scales, economy types, geographies, etc., ensuring that inclusive perspectives are captured while

simultaneously minimizing meeting transaction costs and carbon emissions associated with travel. In addition, although Internet forums can be prone to homophily, i.e., gathering likeminded participants (WITSCHGE, 2004), e-Dialogues can and have been used to deliberatively bring together parties of differing perspectives to stimulate dialogue and create comprehensive impressions on critical sustainability issues (DALE & NEWMAN, 2006b), and these dialogues have been actively moderated by the second author to ensure inclusivity of perspectives. To date, over 50 such dialogues have taken place on such diverse topics as urban infrastructure, nuclear waste management, green economy, including youth in sustainability initiatives, climate change innovations, food security, rethinking the meaning of growth and progress in modern times, and other topics relating to fostering sustainable futures. E-Dialogues are archived in a publicly-accessible, online repository for the reference of researchers and others parties interested in the topics discussed, including the media. [8]

The e-Dialogue platform was built using phpBB, an open-source software designed for constructing online forums. An e-Dialogue conversation is formed through text-based posts with options for attaching images and documents to these posts. A single conversation can split into smaller discussions through the use of "quoting," where one can write a post in response to another post. Participants of e-Dialogues post to the forum during a scheduled time to ensure the conversation is synchronous, allowing for responses to comments and questions to occur in "real-time." [9]

The participants of an e-Dialogue conversation are selected and invited to join the conversation specifically based on their knowledge and expertise in a particular topic. Because e-Dialogues are conducted online, participants of the conversations can be (and often are) geographically dispersed and working in different capacities and circumstances, which allows for diverse perspectives inputting into a discussion. For example, an e-Dialogue focused on how multi-functional spaces can contribute to sustainable community development brought together a manager of a co-working space in Toronto (Ontario, Canada), the Chief Administrative Officer of a small town in the province of BC (Canada), and the former manager of Granville Island, a shopping district in Vancouver (BC, Canada) (DALE et al., 2013). E-Dialogue discussions are moderated by the lead researcher (in most cases, the second author) and stimulated by a research team typically consisting of two to four researchers (which includes the second author and, from 2011 to current, the first author as well) depending on the discussion. The moderator maintains the focus of the conversation by posing particular questions to the invited participants, and the research team (including the moderator) stimulates and builds conversation momentum by responding to the participants' ideas with further questions, comments, and ideas from their own research and experiences. [10]

Most e-Dialogues are viewable by public audiences, unless the dialogue was specifically designed as a private conversation that could potentially involve sensitive information (i.e., opinions of public officials). Audiences of e-Dialogues

are not able to insert questions or comments directly into the conversation forum; however, they are able to input into a separate "e-Audience" forum. Questions and comments from e-Audience forums are integrated into the main conversation by the moderator. [11]

A completed conversation transcript displays a list of posts in the order in which they were posted. For all publicly viewable e-Dialogues, names of conversation participants are identified above their respective posts and this format is maintained when archiving the transcripts to ensure the sources of information are available (private conversations are not stored online). As a conversation builds, posts that were created in response to other comments embed the quoted comment. In this way, conversation threads or sub-conversations form within an e-Dialogue. A single comment can receive multiple responses, and thus multiple threads can stem from one post as people quote and add onto these threads. Consequently, e-Dialogues are branching, dynamic processes that do not follow a single linear track. Anecdotal evidence assumes they facilitate more lateral than literal learning styles, and the former may be more important to inter-disciplinary research and practices.

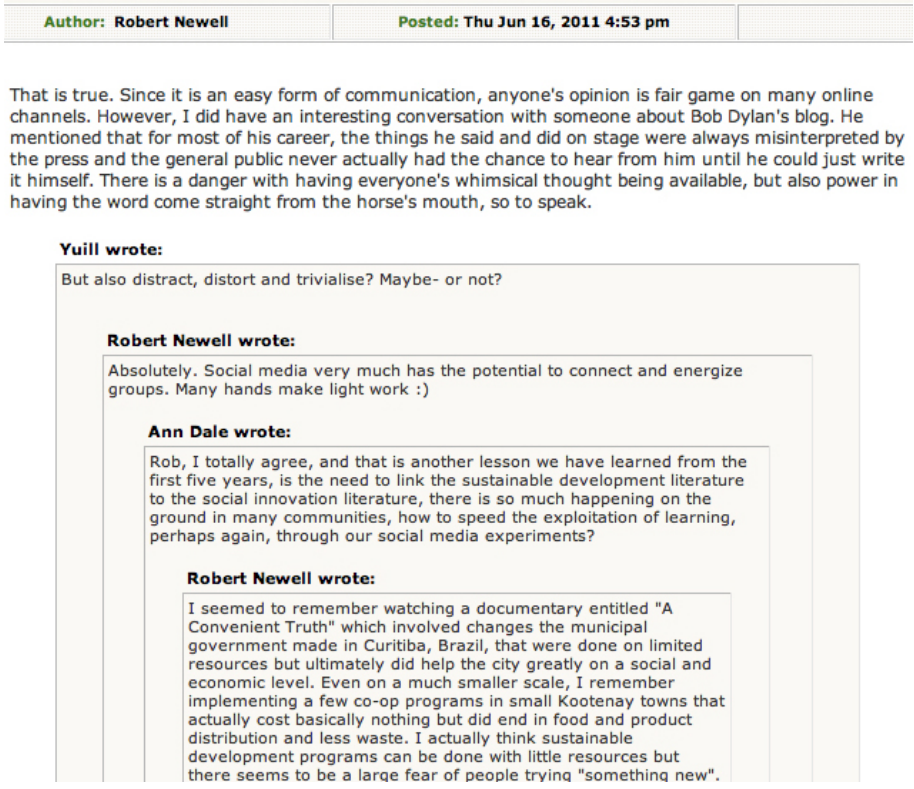


Figure 1: Image of e-Dialogue platform displaying posting and quoting functions [12]

The above figure displays part of a screenshot of an e-Dialogue conversation. The post displayed in the screenshot was authored by the first author, and the previous comments this post quotes (or refers to) are in the nested boxes below the text. The nesting order displays the order in which previous comments were quoted with the original post of a thread contained in the innermost nested box. [13]

2.2 Creating text visualizations

Although e-Dialogues have the ability to bring together diverse groups of people, the analysis of a conversation transcript is typically performed by one or two researchers and not by the same diversity of people. This presents challenges when attempting to interpret and understand key ideas and innovations produced through an e-Dialogue, especially considering that researchers interpreting the transcripts are also participants of the conversations. The participation of a researcher in the collection and interpretation of qualitative data contributes to observer bias, meaning that the perspectives of the researcher influence how he/she interprets and reports on research results (GREENHALGH & TAYLOR, 1997). In the case of e-Dialogues, researchers actively participate in the generation of the qualitative data (i.e., by participating in the conversation); therefore, the researcher's perspectives and pre-conceptions will affect how he/she engages in the conversation, thus affecting his/her overall impression of how the conversation progressed. In addition, because e-Dialogues are a conservation-driven research processes, they involve a collaborative (between researcher and participant) exploration of issues, which essentially positions researchers and participants in both roles of epistemological subjects (researcher) and the epistemological objects (research participant) (BREUER & REICHERTZ, 2001). Without clearly differentiating between sources and collectors of data, e-Dialogues explore issues through multiple perspectives, while conversation transcripts are analyzed through the lens of only one or two of these perspectives (i.e., one or two researchers). Consequently, the analysis is vulnerable to oversights in terms of omitting key ideas and innovations generated through the conversation, which can belie the richness of the discussion's outcomes. [14]

In an attempt to reduce observer bias and better capture the "emergent" themes and ideas produced from an e-Dialogue, we designed a method, the Newell-Dale Conversation Modeling Technique (NDCMT), that uses both computer assisted qualitative data analysis software (CAQDAS) and visual modeling. CAQDAS allows a researcher to examine data systematically, thoroughly, and accurately (in terms of identifying usage of terms and concepts), and thus can add rigor and validity to the analysis (WELSH, 2002). However, techniques using CAQDAS have been criticized for not being able to capture the context and comprehensive picture of the data (BHOWMICK, 2006); therefore, our method includes a visual modeling component. Creating visual models and text visualizations enable a greater understanding of inter-related text through visual pattern recognition and spatial reasoning (RISCH, KAO, POTEET & WU, 2008). For example, word clouds are a method of displaying words according to their relative frequencies in a body of text, and they have been used in the social sciences for research applications such as analyzing political speeches to determine presence of relationship marketing (DANN, 2008) and comparing prevalent concepts in different types of academic literature (BRAITHWAITE, 2010). [15]

Programs that are specifically designed to produce text visualizations for research purposes include Leximancer and Discursis. Leximancer analyzes data

thematically and conceptually, and produces graphical representations of the relationships between themes and concepts (ANGUS, RINTEL & WILES, 2013). Leximancer has been used in research for applications that include analyzing overlaps and gaps between consumer perspectives and marketing organizations (KATTIYAPORNPONG & NEL, 2009), examining maritime accident reporting to determine the relevance of situation awareness (GRECH, HORBERRY & SMITH, 2002), and investigating the focuses of academic journals (CRETCHLEY, ROONEY & GALLOIS, 2010). Unlike Leximancer, Discursis includes a temporal element to data analysis, and it can be used for analyzing conversation (ANGUS, WATSON, SMITH, GALLOIS & WILES, 2012**)** and changes in ideas over time (ANGUS, ROONEY, McKENNA & WILES, 2012). In this way, Leximancer and Discursis are complementary applications (ibid.) that produce different types of information. The analysis of e-Dialogues requires both types of information because capturing the complexity of the emergent ideas requires thematic, conceptual and relationship analysis and, as e-Dialogues are synchronous, real-time conversations, the temporal/evolutionary component is important in determining how and from whom the ideas emerged. Therefore, rather than using multiple complementary models, NDCMT was designed to capture both the conceptual relationships and the progression of conversation in the same visual model. The resulting model displays emergent themes and ideas, their relationships to one another, their strengths or prevalence in the conversation, and when they emerged (sequentially) within a conversation. [16]

Our intention in developing this modeling technique was not to create a substitute for qualitative analysis of online conversations, as NDCMT does not adequately capture the tone, nuance and context of a conversation, but rather it serves as a complement and a means of triangulating the data. Models created through this research have contributed to new insights obtained from the archived conversation transcript and a greater understanding of conversation dynamics. In addition, NDCMT has shown potential for exposing interesting, non-intuitive relationships between themes and ideas (which could be overlooked in qualitative analyses that rely solely on text review), allowing for more thorough investigations of conversation transcripts. [17]

NDCMT was designed using a specific e-Dialogue held on June 16th, 2011, entitled "CRC Reflections: Past Five Years and Future Forward" (DALE et al., 2011), a review of the past five years of the second author's Canada Research Chair (CRC) in Sustainable Community Development and brainstorming session on the focus for the next five years. This particular sample was chosen as it involved a very complex and open-ended discussion, a brainstorming session between the CRC research team, involving multiple tangents and threads. Applying NDCMT to this specific conversation allowed us to investigate the potential of this modeling process to capture common concepts and emergent ideas in a very non-focused and lightly moderated discussion. [18]

3. Constructing the Model (NDCMT)

The following sections detail how themes, ideas and relationships were extrapolated and how they are represented graphically. The method for creating the model is provided below in detail to allow for reproducibility. Software programs used to develop the modeling technique (NDCMT) include NVivo (purchased software used for its CAQDAS application) and Gephi (open-source software used to plot the model elements and construct the visualization); however, it does not require these programs specifically. It is important to note that NDCMT was developed using a conversation transcript produced from the e-Dialogue system, and thus, to perform this technique, one needs a conversation record with a similar form and layout to that of an e-Dialogue (see Figure 1). Specifically, conversation records must be text-based consisting of posts that can be sequenced in order of time of post and displayed in terms of which posts are responses to other posts. [19]

3.1 Axes and plotting plane

The model is plotted on Cartesian plane with the x-axis representing when (more specifically, in what order) a theme or idea was discussed ("sequence") and the y-axis representing how long a theme or idea was discussed and when an emergent theme or idea reoccurred in a discussion ("span"). [20]

The sequence axis spans the entire length of an e-Dialogue conversation, and shows where in a conversation, i.e., in what order, themes and ideas emerged and were discussed. The purpose of adding the sequential component to a conversation model is to both sufficiently capture the geneses and origins of emergent ideas and easily index ideas and themes when cross-referring to the conversation transcript. Units on the sequence access represent the number and order of posts, and thus, this axis is strictly sequential and is not divided into temporal units such as seconds or minutes. The "CRC Reflections" conversation contains 96 posts; therefore, the origin is located at the "zeroth" post mark, i.e., before the conversation, and the terminal point of the time axis represents the 96th post, the final post of the conversation. The remainder of the axis is partitioned into equal units (i.e., the 24th post would align with a quarter along the axis from the origin, the 48th post would align with halfway along the axis, etc.). [21]

The sequence axis displays when a theme or idea was discussed in a conversation; however, because themes and ideas are graphically represented by circular markers on the graph (discussed in further detail below), this axis cannot accurately capture how long a theme or idea was discussed. For example, the idea of "landscapes" (referred to in this case in terms of how landscapes affect community design and people's connection with their community and local environment) was discussed near the beginning of the "CRC Reflections" conversation, and thus would be plotted nearer to the origin on the time axis; however, this idea was discussed for several posts, approaching the middle of the conversation. To capture the length in which an idea or theme was discussed, ideas and themes are also plotted along a span axis. This axis ranges from zero

(i.e., spanning no posts) at the origin to an idea or theme being discussed for the maximum duration (i.e., spans from the first post to the last post) at the terminal point of the axis. In reference to the "CRC Reflections" conversation, any idea or theme that was discussed in the first post and also in the 96th post would be located at the highest point on the span axis. [22]

3.2 Identifying common themes

As displayed in Figure 1, e-Dialogues allow for threads or sub-conversations to form because of the quoting function. NDCMT uses these threads to identify the majors "themes" of a conversation. A theme consists of the concepts or topics that form the primary focus of a thread of posts. The theme is extrapolated from a thread of posts by conducting a frequency analysis on the most common terms or concepts (using CAQDAS). Output of the frequency analysis is processed to ensure that only words relating to concepts are included, i.e., no grammatical words such as prepositions, conjunctions, etc., and synonyms and derivations of words are captured as part of the same concept, f.e., "innovative" and "innovation" would be captured as part of the same concept. [23]

When developing NDCMT using the "CRC Reflections" conversation, one or two terms typically comprise over 5% of the verbiage and then frequency drops dramatically for the next most common term and the following terms. In certain cases, more than one term would occur in a thread with the highest, but equal to one another, frequencies because they relate to one another. For example, "built" and "environment" appeared in one thread each with 2.54% frequency because the conversation focused on the "Built Environment." NDCMT characterizes a thread by its most frequent terms (see Figure 2) and identifies these as themes of a conversation.

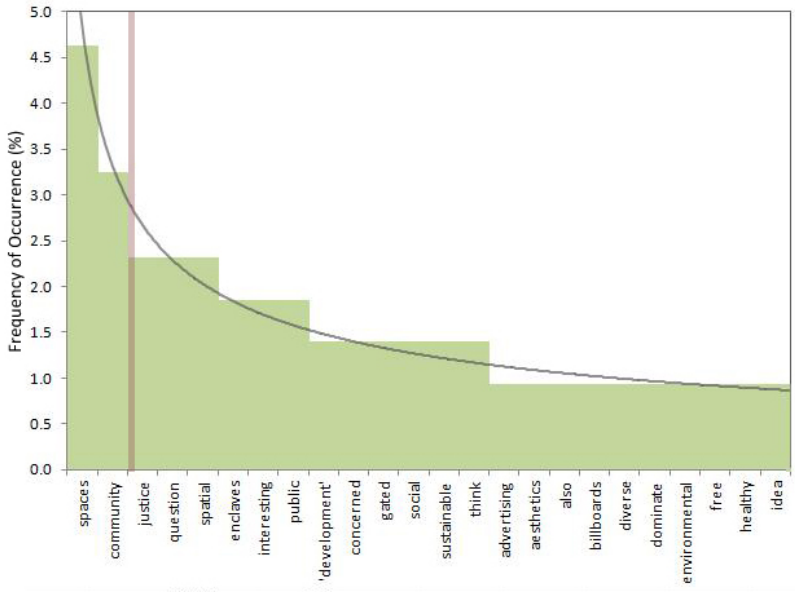


Figure 2: Term frequency curve for "community and spaces" theme identified in the CRC e-Dialogue [24]

The figure above displays frequencies of terms occurring within a conversation thread. Terms are plotted along the x-axis in order of highest frequency (closest to the origin) to lowest frequency (furthest from the origin), and the frequency trend among the terms is plotted with a black trend line. The red vertical line (roughly) demarcates the most dramatic decrease in frequency observed on the trend line. Terms to the left of the red line are used to characterize a conversation thread and identify a conversation "theme." [25]

Themes are represented in a conversation model by circular markers (see Figure 3). Themes are plotted on the sequence axis by centering the circle on the median post of the conversation thread surrounding the theme. For example, the theme of "Humans and Nature" was discussed in 7 posts and the median post was the 27th post of the "CRC Reflections" conversation; thus, it is aligned with increment 27 on the sequence axis. Median was selected as the appropriate statistical average for plotting a theme because mean averages frequently produce non-whole numbers, which would center a theme on a non-existent post value, and mode averages do not exist for post data sets, as all posts are assigned unique sequential values.

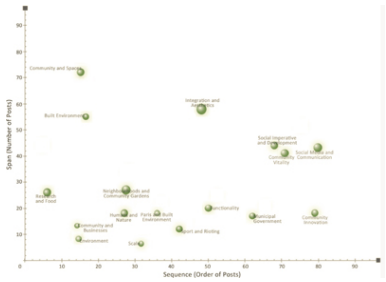


Figure 3: Plotted themes emergent from CRC e-Dialogue. Please click here for an increased version of Figure 3. [26]

The figure above displays a plot of main themes identified from the various conversation threads. The centers of the themes are plotted along the x-axis according to the order of their respective median posts and are plotted along the y-axis according to the number of posts present between their respective first and last posts. Theme plots vary in size according to the relative number of posts produced around a theme. [27]

The unit of "Number of Posts" on the y-axis (span) refers to the total number of posts between the first and last post on a theme; thus, this measurement shows the number of posts on all themes in the conversation that occurred between a theme's respective first and last post. [28]

Themes are plotted along the span axis according to the number occurring between the first and last post on the theme. For example, the first post of the "Neighbourhoods and Community Gardens" theme occurred near the beginning of the conversation, as the 14th post of the entire e-Dialogue. The last post of this theme was toward the middle of the conversation, the 40th post of the e-

Dialogue. Therefore, the span of this theme was 27 posts (being inclusive of the first and last post), and is plotted at increment 27 on the Span axis. [29]

It is important to note that the "Neighbourhoods and Community Gardens" theme consisted of 10 posts in total and the span of 27 captures total number (i.e., posts related to other themes as well) of posts between the theme's first and last. Themes are plotted in this manner to ensure the model captures concurrency of conversations and moments when certain themes might be revived in a dialogue. To exemplify, Figure 3 shows that both the themes of "Community Spaces" and "Built Environment" were discussed early on in the conversation because they are close to the origin on the sequence axis; however, the discussion on these themes are high in span. Therefore, we can infer from the model that these themes were discussed early on in the e-Dialogue (and the majority engagement in these themes was early in the e-Dialogue); however, the themes were revisited much later in the conversation, i.e., an idea, thought or comment later in the e-Dialogue prompted a conversation for participants to revisit and add to the conversation thread around the theme. In contrast, Figure 3 shows that "Municipal Government" and "Community Innovation" were discussed later and these discussions had low span. We can then infer these themes emerged at the end of the conversation and were only discussed at the end, i.e., they were topics the conversation shifted to rather than reoccurring ideas from the beginning of the conversation. [30]

3.3 Degree of engagement in themes

Certain themes receive greater participant engagement than others, which is calculated through the number of posts created around each theme. NDCMT captures the degree of engagement in a theme by plotting themes sized according to their relative engagement. For example, discussion on "Integration and Aesthetics" consisted of 14 posts, where discussion on "Paris and the Built Environment" consisted of 3 posts; thus, "Integration and Aesthetics" circle is larger than that of "Paris and the Built Environment." [31]

Analysis of both the position and the size of the themes plots provides a high level of understanding of when a topic was discussed, how long it was discussed, and how in-depth was the discussion. "Integration and Aesthetics" is plotted high on the span axis, received a relatively large amount of engagement (large circle), and is centered in the middle of the sequence axis. Thus, we can infer from the model that this theme was reoccurring and prevalent throughout the e-Dialogue. In contrast, "Scale" is low in span with relatively low engagement (small circle); thus, we can infer that this theme was discussed only briefly about a third of the way into the e-Dialogue (where its the positioned along the sequence axis). [32]

3.4 Identifying ideas within themes

Identifying the ideas that emerge from the themes creates a greater understanding of the conversation surrounding a theme and allows a researcher to identify the ideas that connect themes. Some posts and comments converge on multiple themes, and examining the ideas within a conversation helps identify these convergence points, providing insights on the flow of a conversation and the genesis of concepts and thoughts that emerge from online conversations. [33]

Ideas are identified by examining which terms occur most frequently throughout the entire e-Dialogue. Similar to the theme analysis, only concept-related terms are considered in the model (i.e., excluding grammatical words such as prepositions, articles, conjunctions, etc.) and the derivations and synonyms of a term are included as part of the same idea. The ideas included in the "CRC Reflections" e-Dialogue were discussed in the conversation with a frequency of 0.5% and higher (i.e., mentioned a minimum of 12 times in a conversation). At a minimum frequency of 0.5%, all identified emergent ideas were present in at least 3 separate conversation posts and related to more than one theme, ensuring that they provided information on thematic relationships and conversation flow. [34]

Figure 4 displays ideas (small, light green circles) plotted with themes. NDCMT plots ideas on the sequence and span axes in the same manner as done with themes. Ideas are plotted along the sequence axis according to the median post in where they were mentioned and along the span axis according to the first to the last post in where they were mentioned. In the "CRC Reflections" conversation, the idea of "adaptation" (circle #43) was mentioned briefly in the last half of the conversation; thus, it is located at the 57th increment on the sequence axis and has a low span, i.e., is close to the origin on the span axis. In contrast, "diversity" (circle #8) was frequently noted throughout the conversation, from the 2nd post to the 86th, and thus is high in span and located toward the center on the sequence axis.

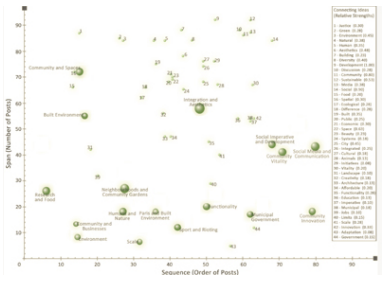


Figure 4: Plotted themes and ideas emergent from CRC e-Dialogue. Please click here for an increased version of Figure 4. [35]

The figure above displays a plot of both the main themes identified from various conversations threads and the ideas emergent throughout the entire dialogue. Similar to themes, the centers of idea are plotted along the x-axis according to the orders of their respective median posts and are plotted along the y-axis according to the number of posts present between their respective first and last

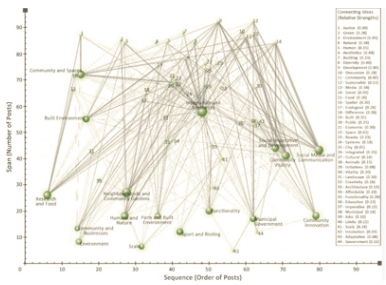
posts. Idea plots are identified in the legend by their respective markings. Relative frequencies in which ideas were discussed are provided in brackets next to their respective idea in the legend. [36]

Because far more ideas are plotted than themes, ideas are plotted with smaller circles than those of the themes, and thus their relative strength (or frequency) in the conversation is not easily exhibited through size of circle. Therefore, their relative strengths are identified through index values, which are displayed in the legend. Index values are calculated by assigning the most prevalent idea a value of 1, which is "development" in this case, and all other idea index values are calculated as frequencies relative to frequency of the most prevalent idea. [37]

3.5 Relationships between themes and ideas

NDCMT draws the connections between themes and ideas by identifying which ideas emerged from the different conversation themes and how the themes converged on these emergent ideas. The grey lines in Figures 5a and 5b connect lines between the idea markers and the theme markers. Convergent ideas between themes are observed as an idea connected to multiple themes. Connected lines are weighted to display the degree to which an idea emerged in discussion on a particular theme, that is, the thicker the line, the more times an idea was noted and discussed. This system allows the user of a conversation model to gain insights both on which ideas connect to which themes and how prevalent certain ideas were in a conversation theme. [38]

Figures 5a and 5b show that common ideas between the themes of "Neighbourhoods and Community Gardens" and "Integration and Aesthetics" were "public," "space" and "beauty." This diagrammatic relationship alludes to the use of community gardens to integrate aesthetics and beauty into public spaces in neighborhoods. Previous research has shown that creating and developing garden spaces in communities can help develop a sense of place in local residents (NEWMAN & DALE, 2009) and can provide important meeting areas for community members to connect with one another (ARMSTRONG, 2000). Thus, by analyzing the connections between ideas and themes in online conversations, we can begin to discern the higher concepts formulated from the conversations and either relate it to previous research or explore them as newly emerging issues and public policy priorities.



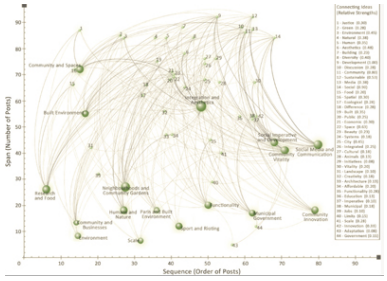


Figure 5a and b: Connections between ideas and themes in CRC dialogue. Please click here for an increased version of Figure 5a, here for Figure 5b. [39]

The figures above display connections between themes and ideas. A theme plot is connected with an idea plot when the idea emerges or is discussed within conversation around the respective theme. The weights of the connecting lines vary according to how frequently an idea emerged or was discussed within the theme. Figures 5a and Figure 5b display connecting lines with straight and curved shapes (respectively) to expose connections in one figure that might be obscured in the other. [40]

3.6 Flow and focus of a conversation

Applying NDCMT to the "CRC Reflections" online dialogue identified 17 distinct themes in the conversation and connected them through 44 emergent ideas. Because the themes and ideas are plotted according to when they were discussed (sequence) and when they emerged and reoccurred (span), one can get a sense of the "flow," or how a conversation progressed from topic to topic, and "focus," or the main topics discussed, of a conversation by strategically analyzing the model. [41]

Figure 6 displays a method of determining the flow and focus of a dialogue from a conversation model generated through NDCMT. Creating a path through the model in the shape of a low-bottomed arc allows one to see the main sequence of discussed topics and themes, while identifying topics that were discussed frequently throughout the conversation and, thus could have had a guiding influence on the discussion. [42]

The themes near the bottom of the arc include topics that were discussed in sequence, and, since they are low in span, one can regard them as part of conversation that sequentially jumped from one focus to another. Examining the ideas that connect the themes at the arc bottom provides insights on which ideas moved the conversation from one theme to another. [43]

In contrast, when examining the peak of an arc, one sees topics that are centered near the middle of the conversation (on the sequence axis) and are high in span. Discussion on these themes spanned the majority of the e-Dialogue, and, because these themes are aligned with the middle of the sequence axis, they were discussed fairly evenly throughout the conversation. These themes are important to note when considering the flow and focus of a conversation because

they could be acting as influencing factors in the transitions from one topic to another and/or they could contain integrative ideas that relate to all the conversation topics. [44]

Themes and ideas at the top-left, top-right, and the bottom centre of the model are excluded when ascertaining flow and focus of a conversation because they are outliers in terms of the fluidity of conversation progression. Themes and ideas at the top-right and top-left are high in span but located towards the origin or terminal end of the sequence axis (respectively), which means that they were heavily discussed at either the beginning or the end of the conversation but "stray" points were added to the thread elsewhere in the sequence. This makes the progression of the conversation around these themes "jumpy," and thus they do not provide an accurate impression of the overall flow of conversation. The themes at the very bottom centre are excluded from the arc because they are very low in span, which means they represent side conversations that also do not contribute to the overall flow of the e-Dialogue.

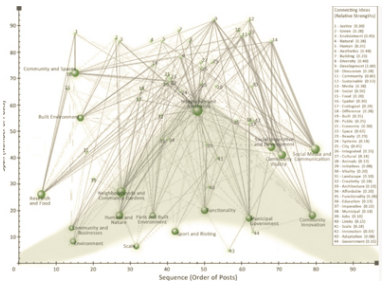


Figure 6: Analysis of "CRC Reflections" conversation model to determine flow and focus. Please click here for an increased version of Figure 6. [45]

The figure above displays a pattern that depicts the overall flow (how a conversation progressed from topic to topic) and focus (main topics discussed) of the conversation. [46]

Determining the flow and function from the "CRC Reflections" conversation model, and, by following the arc shape, one can deduce the following conversational dynamics.

- The themes of community businesses and the environment occurred at the beginning of the e-Dialogue, and this implies the conversation opened with discussion on businesses in communities and also environmental issues.
- The conversation then narrowed (and shifted scale) in on more specific aspects of community development, particularly neighborhoods and community gardens, and this led to discussion on humans and their relationship with nature.
- Tied together by ideas under the theme of integration and aesthetics, specific examples of a city (Paris) and the built environment emerged from the conversation on neighborhoods, community gardens, humans and nature.

- While maintaining conversation on the theme of aesthetics, the discussion moved into more applied topics on how to make community changes through encouraging multi-functionality, which then brought in the role of municipal government.
- The conversation wrapped up with community innovations, thinking beyond the box to encourage desired transformations to sustainable communities. [47]

4. Conclusions

Online conversations are proliferating on the Internet (BRENNER, 2013), as well of the diversity of forums in which people are interacting. As previously discussed in this article, online real-time forums can be a highly effective and efficient way to bring together a wide diversity of researchers, practitioners, and policy makers in a common space to discuss real world problems, but more importantly to share expertise and identify solutions to complex social issues. How we capture the richness and convergence of these proliferating online conversations in order to identify points of convergence and divergence is critical information to these online communities, as well as for researchers. [48]

NDCMT was designed for an in-depth analysis of online conversations, focusing specifically on our e-Dialogues platform, to capture ideas, identify the connections with themes, and provide a coherent synthesis and deeper understanding of the underlying patterns of online conversations. E-Dialogues bring together diverse conversation participants and build through multiple threads allowing for emergent ideas and more lateral thinking, which potentially can encourage the holistic and adaptive thinking necessary in considering sustainability and potential approaches to sustainable development (STERLING, 2010). This is both a strength and a weakness as it introduces a particular anarchy to the normal conversation flow, so a new form of analysis is necessary to capture "thicker" data. NDCMT facilitates this analysis by mining and aggregating dialogic data and creating visualizations from this process to develop snapshot(s) of the collective mind (DRON & ANDERSON, 2009). This analysis and understanding can then be used to inform policy and mobilize further social innovations and perhaps over the long term, social change. [49]

Because NDCMT employs an empirical methodology, models produced through this technique can be used as powerful tools for examining the outcomes of unscripted dialogue with minimal bias. NDCMT is not a substitute for reviewing a conversation transcript when conducting research on dialogue; however, the technique organizes emergent themes and flow of conversation with minimal bias before conducting an in-depth review of a transcript, which can potentially contribute to greater coding rigor for a research project. In addition, NDCMT can illuminate conversation outcomes a researcher might miss through a simple review of the transcript. [50]

As noted by GRADY (2008, §68), "[v]isual research has much to offer the social sciences. To fulfill its promise, however, it should be subjected to scrutiny and

evaluation." The intention of this research is to offer an approach for creating visualizations of conversation data in a manner that allows other researchers to develop and improve the technique, ultimately furthering the development of social research methodology that employs empirically built visuals. Continual application and improvement of techniques such a NDCMT by researchers that employ dialogic processes in their work can lead to methodologies that capture the richness of conversation outcomes and processes, improving synthesis of ideas and innovations formed through digital discourse. It also provides a tool for an iterative analysis into how issues are addressed in virtual space and the extent in which online dialogue can build consensus around these issues, which may be increasingly important to decision-makers in highly plural democracies. [51]

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