Mapping Ecotourism Learning: Using Concept Maps to Evaluate Visitor Learning During an Informal Boat-based Sea Life Viewing Program

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Project write-up
Marine Resource Management

Introduction

Tourism is an ever-growing economic force across the world, the United States, Oregon, and on the Oregon Coast. In Oregon alone, the tourism industry had an economic impact in the state of $7.9 billion in 2006, up from $6.9 billion in 2004 (OTC, 2007). Though economically beneficial, tourism can be controversial, with concerns about overuse of resources and harm to the environment (Miller, 1993). Thus, ecotourism, a subset of tourism in which the goal is sustainability, and of which education is a vital component, has grown in popularity (Orams, 1999). Whale watching, which is sometimes considered to be an ecotourism activity (and which definitely can be, under the right circumstances), is at least a $1 billion industry worldwide and grew at an average of 12% per year from 1991 to 1998 (Hoyt, 2001). Boat-based whale watching makes up 72% of all whale watching related tourism activity (Hoyt, 2001), creating a prime opportunity for the marriage of boat-based marine educational endeavors & nature-based ecotourism.

Marine Discovery Tours (MDT), a boat-based excursion company in Newport, Oregon, has been working since 1993 to develop its own ecotourism product incorporating whales and other sea life. As a corporation, profitability is a primary goal, and sustainability has been infused within the product as a means of meeting that goal, as well as the goals of conservation minded owners and staff to foster stewardship of coastal resources by educating and entertaining its customers (Mathews, 2007; personal communication).

But how does one measure the success of those goals? And, in general within a free choice learning environment, what strategies need to be in place to market and deliver the product successfully in order to bring in new customers and maintain a strong customer repeat base? How important is the education aspect of the product versus the entertainment aspect to meeting those goals? This study does not necessarily address all of these issues. It looks briefly at customer expectations and satisfaction, with a few findings related to marketing the product, but the overall focus is the aspect of educating the customer.

Free-choice learning is self-directed, voluntary, and guided by the individual's needs and interests (Falk & Dierking, 2002). The term was coined in recent years to describe the kind of learning that often takes place during activity that is not strictly defined as educational, especially by the consumer. Museums, aquariums, zoos, and other for-profit or not-for-profit educational entities fall easily into this category. Although research has shown that eco-tours may impact conservation attitudes, boat tours - even eco-tours - have not been studied much in light of their educational capacity and impacts. MDT, as discussed below, does offer a free choice learning experience, but educating tourists can be tricky. The very nature of "free choice" forces a situation where the company hoping to

gain and retain customers must create a product that will appeal to the masses in their leisure time. Adding sustainability into that equation means that the product must go beyond a standard expectation level and create something more – something that leads to repeat customers and word of mouth recommendations (to sustain the product itself) and fosters and/or grows an interest in the natural world (to sustain that which the product is based upon). In order to get a better feel for the complications of a company caught between the goal of profitability and a passion for education and the natural world, it was important to look more closely at the customer as a learner. What does the customer already know? And, more importantly, what part of that knowledge base does the customer find most meaningful? What can a company like MDT do to add to that knowledge base in a meaningful way? And lastly, are customers learning what is ostensibly being taught?

Marine Discovery Tours

When Marine Discovery Tours (MDT) opened its doors in 1994 as a new maritime attraction featuring bay tours and whale watching in Newport, OR, Fran Mathews and her husband Don, co-owners of the company, quickly realized that offering whales as their primary product did not create an ideal situation. While whales are easy to market, they are not a species that can be called forth at will for the customer. As a whale watching company, they were too much at the mercy of the whims of Mother Nature (weather, ocean conditions and the movement of the whales themselves). Plus, as a marine journalist and former Bering Sea crabber, respectively, they had a passion for the sea as a whole and wanted their company to be more than just a whale watch. So, they decided to develop their product into an overall nature-focused experience, which they dubbed the *Oregon Sea Life Cruise*. Looking for whales remained a large component of the program, but the Mathews and their staff incorporated a broader sea life focus into the product and added educational value (see below for specifics). They also incorporated a variable route, creating a situation where cruises were never cancelled due to uncomfortable or dangerous ocean conditions, but were re-routed through the calm bay and upriver, which also resulted in fewer incidents of seasickness. Over 14 cruise seasons later, the company is thriving, and Fran and Don continue to develop their programs to better meet the needs of their customer base, as well as to meet their own goals.

Many aspects of the 2-hour Sea Life Cruise program were developed with a K-12 educational framework in mind (e.g. scripted narration, video microscope, props such as whale baleen and oyster shells, hands-on activities, etc.), in order to accommodate a well-established “student field trip” customer base (5,500-7,500 student group passengers annually, including preK-HS students from OR, WA, CA, ID, and other states/countries). This educational component is apparent from the script

alone, and education is a clear goal of the company, as stated above. Marketing educational value to the general public is another thing entirely. Although educating customers always remains a goal, using the word "educational" turned out to be a turn-off for many customers (Mathews, personal communication, 2007). MDT can be termed what Falk and Dierking (2002) call a "value-added leisure experience." The ultimate goal of the customer is to have a fun time on their vacation, a sentiment that is often heard expressed in the lobby of MDT. The added value comes with the educational experience. So, the trick is to provide an educational tour, but not advertise the product as such, which is why the marketing for MDT states, "aquarium-style cruise with friendly naturalists and fun activities." So, MDT operates on the assumption that the tourist does want to be educated (and idea supported by Hodson & Russell, 2002, and Luck, 2003), even if it is perceived as a secondary goal to having a fun time. So, how does a company like MDT, which appears to be providing the fun experience, as well as the information that adds educational value, determine if the customer is actually learning, and specifically learning the concepts that the company deems most relevant?

One of MDT's key goals is to "deliver the principles of good nature-based tourism" (Mathews, 2007) by following certain guidelines, including the following: 1) Create a meaningful "experience" for customers by offering a lively aquarium-style program with friendly naturalists, fun activities, and a variable route while searching for all types of sea life; 2) Stress environmental awareness and stewardship by "sharing our appreciation and love for the coast"; 3) Add educational value (Mathews, 2007). They have been recognized as achieving this goal by the state of Oregon, as they were awarded the Gene Leo Memorial Award from the Tourism Industry Council of Oregon for creating "fun and innovative nature-based tours." A natural next step was to evaluate how well they are achieving this goal, and, in particular, how well they are educating their customers.

The purpose of this research has been threefold. An assessment of the effectiveness of the program in delivering certain types of information, as well as an evaluation of the overall educational value of the program, was primary. Second, a questionnaire was included to assess basic customer expectations and satisfaction with the experience. The questionnaire was also intended to assess effectiveness of marketing strategies for the product and effectiveness in creating a potential new customer base. The third purpose was to assess the usefulness of the modified Concept Mapping tool (Christensen and Rowe, 2007) as an evaluation tool in a free-choice learning environment.

Methods

The Study Site

MDT offers Sea Life Cruises during their main cruise season of March 1 - October 31. The study was carried out at the company's base of operations on Yaquina Bay in Newport, Oregon. The passenger numbers vary annually; in 2006 they cruised with almost 16,000 passengers total, 7600 of which were general public passengers (versus pre-booked student and adult group passengers). Over the course of the season, approximately 75% of MDT passengers are Adults (ages 14+) and 25% are children (ages 13 and under). During September, Adults make up closer to 85% of total visitors. Visitors to MDT are primarily from the United States (97%), with about 40% residing in Oregon.

This study was conducted during a 2 week period from September 10-22, 2006. During, September, MDT offers 1 cruise per day, on average, that is available only to the general public (versus pre-booked student and adult group cruises). For this study, 10 out of 11 possible cruises were sampled over 13 days. The 11th cruise was not sampled due to a lack of research facilitator availability that day. (There were 23 cruises total over this time period, but 12 of them were student or adult group cruises, for which this study did not apply).

2-hour Sea Life Cruise

MDT offers a variety of programs; the 2-hour Sea Life Cruise (see below for more in-depth description) is the main program offered to the general public, and so was the cruise type evaluated with these methods.

The 2-hour Sea Life Cruise program takes place onboard the 65' excursion boat, the Discovery. As the Discovery is the only vessel owned and operated by MDT with express educational purpose, it was the only vessel utilized in this study. The Discovery is ideally suited for sea life viewing with spacious outdoor decks (upper and lower) and a cabin that contains seating for the maximum passenger capacity (49) and has large viewing windows.

The program is delivered by a trained naturalist guide and experienced captain. The captain interprets any fishing boats and fishing activities that are observed and follows a scripted narration that includes information about the coastguard, fish plants and fishing industry as a whole, the Yaquina Bay Bridge, vessel navigation, and ocean conditions. He also visits with passengers in the wheelhouse throughout the cruise (as long as conditions allow passengers to remain on the upper deck) and answers any questions they may have. The naturalist guide conducts a large portion of the program, including interpretation of any sea life and scenery that is observed; following a scripted narration that includes information about many types of sea life that may or may not be seen on a particular cruise, as well as habitat and ecological information about the river, estuary and ocean; and leading passengers through a crab pot activity, a plankton collection activity, and a plankton viewing activity, the latter of

which includes a brief classroom-style discussion in the cabin that includes plankton definitions and identification, as well as elucidation of information on whale feeding, oyster filter feeding, and more.

The crab pot demonstration starts with dropping crab pots into the bay before heading out toward the ocean. The pots are picked up at the end of the cruise, and passengers get a chance to touch and hold the crab, as well as learning about crab life-cycle, crabbing, etc. Passengers are given the opportunity to participate in this demonstration at many points, including baiting the crab pots, placing them (throwing off boat), hooking the lines and pulling the pots back on board, and reeling up the line as it comes in. The plankton is also collected in the bay, and the sample is taken into the cabin to be viewed on a video microscope connected to a large screen TV. Passengers participate in the collection of plankton by helping to throw out the net and pull it back onto the boat, as well as pouring the water sample through the filter in order to collect the plankton sample.

The scripts for the captain and naturalist guide are somewhat standardized and have been developed and honed over time by MDT owners & staff, Oregon State University graduate students in Marine Resource Management and Fisheries & Wildlife, SeaGrant resources and staff, and others. There is, of course, variation in the presentation of the product, depending on the crew on board and the route the cruise ends up taking. In general, though, the standard script can be compared against the post-maps to determine if the cruise was the likely source of the concepts on the map. In cases that were unclear, the naturalist guide for the cruise was questioned as to the likelihood that he included the information in his presentation.

Participants

A total of 244 passengers (221 Adults; 23 Youth ages 4 – 13) were represented by the 10 sampled cruises, out of which 168 passengers (69%) participated in the study. This percentage may have been higher but for 2 circumstances: 1) younger youth (ages 4-6?) were counted as potential participants (ages 3 and under were not), but may not have been capable or likely to participate in the concept mapping activity (the youngest participant was 7); and 2) any late arrivals for cruise check-in, which happens often according to MDT staff, would have missed the opportunity to participate.

Out of 168 participants, 136 (81%) either completed or were part of a group that completed both sides of the activity, resulting in 123 fully completed pre- and post-maps. Out of the 136 participants who fully completed a map, 72 were female (53%) and 64 were male (47%). The average age of the sample was 44.86. Over 1/3 (37%) of participants were from Oregon. Looking at the west as a whole, over half (54%) were from Oregon, Washington, or California. Almost the entire sample was from the United States (98% of maps, representing 24 states), with international visitors from Canada and the UK.

Table 1. STATE of Residence	Total	%
OR:	46	37.40%
OR/WA/CA:	67	54.47%
USA only:	120	97.56%
International:	3	2.44%

For highest education level attained, 42% of participants stated they had completed college (advanced or other degree), while 38% had some college education, and 15% had attended (or completed) high school (some of whom were still in high school). The other category, representing 4% of participants and called, "other," ended up being marked by children at ages that would indicated they are still in elementary or middle school.

Table 2. Level of Education	# Participants	%
Advance Degree	18	14.63%
College Degree	34	27.64%
Some College	47	38.21%
High School	19	15.45%
Other	5	4.07%

Concept Maps

According to Novak and Canas (2006), meaningful learning requires the following 3 conditions: that the material is conceptually clear and relatable to learner's prior knowledge (a constructivist claim); that the learner possesses relevant prior knowledge (a constructivist claim), and that the learner chooses to learn meaningfully (i.e. free choice learning). Concept maps are node-linked, hierarchical representations of a set of concepts and the relationships between those concepts. Relationships are denoted by nodes and linking words, forming propositions. Concept maps can be a great way to analyze the knowledge structure and cognitive understanding of a person, as well as the link between prior knowledge and how new information adds to and incorporates into that prior knowledge (Novak, 2006). While concept maps have been widely used in classroom settings as tools of formative and summative assessment as well as research, their use in informal learning settings has been less well documented. Most often, pre- and post-maps are used to gauge changes in concepts that are ostensibly the result of the learning experience. Sometimes researchers ask people to do two separate maps (one pre- and one post-visit) and sometimes are asked to make changes to their pre-map in second colors (c.f. rebar, 2004).

Based on a pilot study by Christensen and Rowe (2007) it was decided to do 2-sided concept maps (using a new sheet for the post-map, versus adding post-map information onto an existing pre-map). The participating passengers were instructed to complete one map during the pre-cruise activity,

spend 2 hours experiencing the cruise, and then complete a new map during the post-cruise activity. Also based on that pilot map, an open-ended concept mapping technique was used, using one central node containing the concept "marine wildlife in Newport, Oregon." This node was identical on pre- and post-maps (see Appendix A (pre-map) and Appendix B (post-map) for example mapping activity sheet).

In order to look for trends within the participant population, demographics and customer satisfaction questions were also included. The front side of the concept mapping activity sheet (pre-map) contained a section asking demographics questions about passenger age, gender, state of residence, level of education, and previous visitations to coastal education facilities within the last 3 months. Questions were also asked to determine if passengers had been on an MDT cruise before, how they heard about MDT, and what the deciding factor for coming on the cruise had been. The back side of the activity sheet contained a questionnaire designed to determine if the cruise experience was perceived to match the description at check-in, if customer expectations were met, if the participant considered their experience to be educational and/or entertaining, and if they would recommend the cruise to friends and family. The questionnaire also addressed previous concept mapping experience and whether participation was as a group or individual.

In order to track trends based on the overall cruise experience, the naturalist guide was asked to record key features of the cruise experience, including weather, ocean conditions, time spent on the ocean, key sea life that was sighted, and other notes (see Appendix F).

Concept Map Activity

MDT customers make cruise reservations either over-the-phone or in person, and are requested to check in for their cruise at least 30 minutes prior to departure. This time-period at check-in (at which point the reserved party is paying, reading through a brief review of the cruise, and picking up a ticket) was used to invite the customers to participate in the study. This brief explanation was carried out by various MDT reservation staff, who were also supplied with a handout (Appendix E) for each customer that explained that participants would be asked for 20 minutes of their time (boarding 10 minutes early and staying 10 minutes after), would receive a small thank you gift (postcard or small toy), and would be entered into a raffle for a $25 Gift Certificate (1 per cruise). It also explained that the study was being conducted by Oregon State University graduate students and was completely voluntary and completely anonymous, following normal OSU IRB guidelines (see Appendix).

An announcement was made by the naturalist guide 10-15 minutes before regular boarding time for the study participants to board. The research facilitator was waiting on board with materials and instructions. In order to standardize instructions, the facilitator was provided with a detailed script

(see Appendix C). Over the course of this study, there were 4 different facilitators. (Plus, a naturalist guide facilitated the post-map instructions on one cruise, due to unexpected circumstances requiring completion before the boat reached the dock). A brief 30 second explanation of the study purpose was given, as well as a brief description of the informed consent letter (Appendix D), which was later handed out to all participants. The facilitator next held up a blank concept map and read the instructions. The sample map (drawn out on a large poster board and left at the front of the cabin for easy viewing – see example, Appendix G) was also explained. Then the concept map activity sheets, informed consent letters, and black pens were handed out to the participants. If available, a second person would hand out maps while the explanation continued, giving the facilitator the opportunity to repeat and/or emphasize points in the instructions. It was emphasized that participants were to only complete the front side of the activity sheet (labeled "front") at this time, and that the activity instructions were written at the top of the sheet if they needed a review. Total explanation/instructional time varied between 3 and 5 minutes, leaving the participants 5-10 minutes to complete the front side of their maps. While participants were working on their maps, raffle tickets were handed out to each of them, and they were instructed to also write their raffle number in the designated area on the front side of their map. As the rest of the passengers began to board, the participants were allowed to keep working and a brief announcement was made that the naturalist guide would be coming up to give a safety talk within a few moments and that the cruise would depart on time. It was also mentioned that all participants should return to the cabin at the end of the cruise to complete the back side of their map. As the safety talk began, the maps (activity sheets) and pens were collected by the facilitator.

At the end of the 2-hour cruise, as the boat was beginning to dock, the naturalist guide made a brief reminder announcement for participants to return to the cabin. After the boat was tied up at the dock, the facilitator would board, join the participants in the cabin, and hand their activity sheet back to them (with blue pens this time). Participants' raffle ticket numbers were used to correctly match up maps with participants. The map instructions were repeated and the participants were instructed to complete the back side only (labeled "back"). Most participants spent an average of 4-8 minutes on the back side of their maps, with none being allowed longer than 10 minutes, as the naturalist guide needed to start cleaning the boat.

Analysis

The researcher studied the maps and developed 13 conceptual categories into which most of the concepts present on the maps could be placed (see Appendix H). Each map was then coded accordingly. Some concepts fit into more than one conceptual category, and were thus coded as such – but only if the meaning was clear.

Seven (7) of the categories were broad designations of sea life types (e.g. "whales & dolphins" and "plants") and 2 were more specific sea life types (e.g. "crab" and "plankton"), whereas the other 4 categories covered broader ecological (e.g. "physical world") or social (e.g. "human impacts") concepts, with which the other 9 categories commonly overlapped. A 14th category, "Food Chains," was added after observing that this was the most common cross-link between the other broad domains. Again, a concept was only coded as food chain if the connection was clearly meant to denote a food chain.

A large portion of the concepts on both pre- and post-maps fit into broad sea life designations, probably because the starting node was very general ("Marine Wildlife of Newport, OR"); the maps included such a wide range of information that coding for specificity would have been very tedious, and would not have yielded much continuity. Two (2) of the categories were made more specific because they were based on concepts ("crab" and "plankton") that were explicit in the activities present onboard the Discovery, and thus showed up enough on post-maps to warrant their own category. Also, the concept "crab" was present on many pre-maps; on some of these maps, it could easily have been included in a broader category like "crustaceans," but there were quite a few pre-maps where crabs were mentioned separately, which should not be surprising, as Newport, OR is known as the "Dungeness Crab Capital of the World" (www.discovernewport.com, 2007). So, it was decided that "crab" should be its own category.

The standard accepted quantitative methods of counting categories, nodes, connections, and words on each pre- and post-map were used to measure "elaborateness" (Stoddard et al, 2000). These counts were repeated within each conceptual category. Based on a large sample size, normal distributions for some of the data and similar standard deviations and skewness (resulting in robustness of the T-tools) for the rest of the data, the averages for these counts were analyzed for significant differences between pre- and post-maps using Paired T-Tests (95% C.I.). Average number of words per category, average number of words per node, and average number of words per connection were also evaluated, in order to determine depth, another measure of cognitive understanding. Among all the data, patterns were searched for using many variables, including demographic variables and cruise variables.

In addition to the standard measures of elaborateness, measures were also developed for accuracy and complexity following methods from Christensen and Rowe (2007) and Stoddart et al (2000), and based in the grounded theory approach of making observations and discovering patterns (Babbie, 2001). Once the various variables were determined in this manner, Paired T-tests were used (as above) to analyze significant differences between pre-and post-maps. Significant differences among demographic and experience categories were analyzed using Chi-Square Tests (Pearson coefficient).

Accuracy

Both of the above papers recommend using measures of accuracy as one facet of cognitive understanding. Stoddart et al (2000) looked at sub-sets of accuracy, including scientific accuracy, common knowledge, inaccurate statements, and the use of affective words. Christensen and Rowe (2007) employed a similar methodology, with some modifications. For this study, accuracy was operationalized as the use of scientific language (a combination of scientific accuracy and common knowledge), inaccurate statements and affective words.

An increase in the use of scientific language can be used as an indicator of a more "expert-like" and in this sense more accurate understanding of a concept. Scientific language consists of words that are used in science classes, science programs, or the scientific community in general. Scientific words often have Greek or Latin roots or are nominalizations (verbs turned into nouns) used in ways to denote specificity (Gee, 2005). For this study, words were examined using the above definition, combined with a lack of everyday use and inclusion of exact numbers or measurements. A list of scientific terms was compiled (see Scientific Language Codebook, Appendix I) and strictly adhered to (for consistency) when coding each map for scientific language. Any map having terms deemed "most scientific" was considered to contain scientific language. Some words/phrases were considered to be "somewhat" scientific, but not enough so to be included for this analysis[1]. If the scientific language was part of an inaccurate statement (see below), it was not included in the count. Pre- and post-maps were compared to determine if the incidence of scientific language increased, decreased, or remained the same on the post-maps. Any change in scientific language was considered relative to the total number words on the map, to control for differences in time spend on the concept mapping activity.

[1]For example, the word "pelagic" was considered most scientific - a "classroom" word - and was counted as scientific language; whereas the word "aquatic," which is more typically used in everyday language, was not counted, but would still be more scientific than the words "water" or "sea," which opens up the possibility for future reanalysis of the data with a less stringent filter (but still based on the definitions above) for what is considered to be scientific language. Also, more specific identification of species from pre- to post-map (e.g. whale becomes grey whale, crab becomes Dungeness crab) was not considered to constitute an increase in scientific language, although it did occur often.

Propositions, or units of meaning (Novak and Canas, 2006), are composed of two nodes connected by a line. For instance, a node containing the word "crustacean" connected to a node containing the word "crab" could mean "crab are crustaceans." To be completely clear, the linking line would actually be labeled with the word "are," but linking words were rarely used in either the pre- or post-maps in this study. Generally, the meaning of the connection was very clear even without the linking words. For instance, when a node containing the word "sea gull" was connected to a node containing the word "fish," it could be assumed that the participant was saying that "sea gulls eat fish" and not "seagulls are fish." This was based on the reasonable assumption that everyone knows that sea gulls are not fish. All propositions were examined for correctness, with unclear or incorrect propositions being coded as such. When the connection was not clear, but correct either way (such as "shark-fish", which could mean that shark are fish, which is true, or that shark eat fish, which is also true), the proposition was not coded as unclear. An ambiguous connection like "dolphins-sea cucumbers" was coded as unclear. Inaccurate propositions were also coded, and were also usually pretty clear. For instance, a connection like "crustacean-sand dollar" was most likely incorrect, especially because the other nodes connected to "crustacean" contained words like "shrimp," "crab" and other animals that clearly belonged in that category. Inaccurate statements, once coded, could have been analyzed for patterns between pre- and post-maps. For this study, though, due to a low occurrence overall, incorrect statements were not examined closely. They were, however, excluded from any counts of propositional structure (e.g. incorrect propositions were not considered to be part of any exhibited hierarchy) and scientific language. Thus, they can still be considered to be a component of the measure of accuracy in this study.

Affective words (words of emotional or expression) could show participants' level of engagement in a free choice learning activity (e.g. "catching crabs was cool"). They could also show a lack of accuracy, in that affective words are often substituted for scientific terminology or more specific information (e.g. "huge!" to describe the whale instead of "whales are 45 feet long"). Affective words were coded and pre- and post-maps and analyzed for patterns.

Complexity

Overall complexity of a concept map also reveals understanding. According to Ruiz-Primo et al (1997), it follows that, as mastery of a domain increases, structure of a concept map will become more "expert." As early as the 1920's, researches like Vygotsky (1984) were examining how conceptual structures changed with mastery of a domain. Vygotsky (1984) outlined stages in conceptual development, moving from what he called unorganized heaps of information, through complexes, to pseudo concepts and finally full, expert-like concepts. Since this study's broad central

node resulted in many broad conceptual categories, there was a lot of room for hierarchy within each domain. Each map was qualitatively analyzed for complexity by looking at a number of factors. First, each map was labeled with a hierarchical structure. These labels included Concept Chain, a hierarchy of concepts linked by connecting lines that exhibit meaningful learning (full concept); Geographic Circular, concepts organized by domain around the central node, but not hierarchically (pseudo concept); Geographic Non-circular, concepts organized by domain at random places around the map – not hierarchical (pseudo concept); Meaningless Chain, which often appear to be hierarchical at first glance, due to connecting lines, but are in fact not, due to unclear or meaningless connections (chain complex); Random Circular, in which single concepts were placed in no particular order around the central node; and No Star, containing no organizational structure whatsoever (unorganized heap) (See Appendices K-P for example maps of each structural designation). These designations were used to estimate a beginning understanding of complexity of each map. To determine if complexity increased from pre- to post-map, each map was also evaluated for semantic levels (only necessary if hierarchy was present), propositional structure (simple versus compound), and depth of explanation (see examples in Appendix Q).

For those maps with a Concept Chain structure, semantic levels, or levels of concept hierarchy, were quickly estimated by counting out from the central node. Only meaningful, hierarchical connections were counted; a few maps showed nodes-connections that went out 4 or 5 nodes from the central node, but were only, in actuality, 2 nodes out hierarchically (e.g. crustaceans-crab-lobster-shrimp instead of crustaceans-crab, -lobster, -shrimp). Except for a few unclear cases, it was easy to quickly determine if the post-map increased in semantic levels overall with just a quick glance. Cross-links were also taken into consideration in this measure of hierarchical structure. These relationships between concepts in different domains can, according to Novak et al (2006) represent creative leaps, and thus play a part in cognitive understanding.

An increase in semantic levels (number of meaningfully connected nodes out from central node) usually resulted in an increase in propositional structure (correlates in 113 (91.87%) of maps), so propositional structure was only looked at closely if the complexity change at that point was unclear, or if there appeared at first glance to be a discrepancy between the hierarchical and propositional structure correlation. (For instance, some maps had few nodes and no linked hierarchy, but were written in full sentences, creating a high-level of propositional structure). A simple proposition contains just one subject-object clause and a compound proposition contains, in addition, 1 or more dependent clauses (Stoddard et al, 2000). If the change in complexity based on hierarchical structure

from pre- to post-map was unclear, a quick count of compound propositions compared to total propositions would be used as the determining factor.

Depth of Explanation, an idea elucidated by Stoddart et al (2000), is another quick way to evaluate propositions for cognitive understanding without needing to count each individual node & connection on every single map. This method looks at each proposition as either basic (addressing a factual "what" question) or higher-order (describing function or purpose, i.e., "how" or "why" questions). All higher-order descriptions were coded and assessed as part of the complexity factor.

This qualitative analysis did not take as much time as counting each individual category, node, connection and word on each map, and did not require statistical analysis (except to look at patterns between complexity and other variables. A few quick glances at each pre- and post-map, following the above measures, and it was easy to determine if complexity of the map increased, decreased or remained unchanged.

Comment [SR1]: Let's more this to the discussion as part of a short section on developing holistic qualitative measures that overlap with more

Focusing Effect

One can see from the quantitative analysis of conceptual categories (see results) that a focusing effect seems to be in place. To further evaluate that effect, this study looked at the overall context of each map (pre- and post-) and analyzed what changes in context may have occurred from pre- to post-map. Analysis was also done to see whether or not the concepts on the post-maps, in particular, would compare to the MDT script.

A context was defined as an overarching emphasis that tied the various aspects of the concept map together. For instance, all the concepts on a map might be related to things a tourist would see or do. Alternatively, they might be related to knowledge about marine animals. The maps were first evaluated to gain a feeling for the main contexts exhibited, and the following contextual categories were chosen: Natural World, namely plant & animal life; Tourism, things a tourist might see or do; Environmental, including conservation, human impacts, etc.; Industry, specifically the fishing industry; Physical World, including oceanography, geology and physical habitat; and Other, anything not fitting into a defined context (see Appendix R for more in-depth descriptions). It was usually very clear which context was overarching for the map, but often there were two fairly equal contexts present on the map, so it was decided that there would be co-contexts for each map. If a map was strong in just one context, it was weighted twice for that context. If the map had 2 co-dominant contexts, each was weighted once for that map. These were considered primary contexts. There was also an allowance for a secondary context, but this designation was not further analyzed by this study.

In order to evaluate the presence of concepts specific to the cruise offered by MDT, and thus begin to get at whether what is being presented is being learned (integrated into the customer's existing

knowledge framework), the MDT script outline was used, in relation to the content on the maps, to create an "MDT Concept List" (see Appendix S). If a post-map concept was not present on the pre-map (or only present in a general way) and was present on the MDT Concept List (or contained more specific information that could be found on the MDT Concept List), it was considered to be an MDT Concept. For MDT repeat passenger maps, both the pre- and post-maps were evaluated for MDT Concepts: on the pre-map, only the most obvious concepts were counted as MDT Concepts; on the post-maps, increased specificity of pre-map MDT Concepts, as well as concepts evaluated as above for all maps, were counted as MDT Concepts.

Questionnaire

A questionnaire was included on the post-map, in order to assess passenger expectations and satisfaction with the cruise experience. Five (5) questions were asked with the choices of "Agree Strongly," "Agree," "Don't know," "Disagree," and "Disagree Strongly" as answers. The participants were asked to circle one answer per question, and space was made available for them to make comments regarding their answer.

Results & Discussion

Conceptual categories

There were 14 main conceptual categories present on the maps (see analysis section and Appendix H). Out of these, the most common conceptual categories seen on pre-maps were Sea Lions (86% of maps), Whales (80%), Crab (69%), Other Sea Life (67%), and Fish (65%)

The most common conceptual categories seen on post-maps were Whales (89%), Crab (69%), Sea Lions (68%), Birds (63%), and Plankton (54%).

Table 3. Conceptual Categories (Concept Domains)

	Pre-map			Post-map			Change & p-value
	Rank	number Maps	%	Rank	number Maps	%	
Whales/Dolphins	**2**	99	80.49%	**1**	109	88.62%	*Increase* p<.05*
Sea Lions/Seals	**1**	106	86.18%	**3**	84	68.29%	Decrease* p<.01
Other Marine Mammals	11	24	19.51%	14	10	8.13%	Decrease* p<.01
Birds	6	73	59.35%	**4**	78	63.41%	*Increase*
Fish	**5**	80	65.04%	7	52	42.28%	Decrease* p<.01
Crab	**3**	85	69.11%	**2**	85	69.11%	*No Change*
Other Sea Life	**4**	83	67.48%	6	60	48.78%	Decrease* p<.01
Plants	9	30	24.39%	11	25	20.33%	Decrease
Plankton	14	10	8.13%	**5**	67	54.47%	*Increase* p<.01*
Physical World	8	51	41.46%	8	50	40.65%	Decrease
Industry (Fisheries)	12	21	17.07%	13	15	12.20%	Decrease

Tourism	8	51	41.46%	10	36	29.27%	Decrease* p<.01
Human Impacts	10	26	21.14%	12	19	15.45%	Decrease
Food Chain	*13*	*12*	*9.76%*	*9*	*39*	*31.71%*	*Increase* p<.01*
Top 5 (pre- and post-maps) = Bold							
*=Significant; Paired T-tests							

The number of conceptual categories used on the pre-maps decreased on the post-maps, showing a significant decrease in overall breadth ($p<.05$). A narrowing of focus to certain concepts can be seen by an increase in some concepts and a decrease in others. The following 9 conceptual categories decreased from pre- to post-maps: Sea Lions, Other Marine Mammals, Fish, Other Sea Life, Plants, Physical World, Industry, Tourism, and Human Impacts. Of these, the decrease was significant within the Sea Lions, Other Marine Mammals, Fish, Other Sea Life, Tourism and Human Impacts categories. Four (4) categories - Whales, Birds, Plankton and Food Chains – increased (The increase for Birds was not significant), while 1 category - Crab - showed no change. It is interesting to note that, although the frequency of the crab category on pre- versus post-maps did not change, the individual maps including the crab category did change. Out of the 38 pre-maps without the crab category, 19 (50%) added the domain in the post-map. And out of the 85 pre-maps with the crab category, 19 (22%) did not include it on the post-map. There is no way to tell if the category was excluded from the post-maps because it was already mentioned on the pre-map[2], or for some other reason.

Even though an examination of individual maps does not yield patterns that can be applied to the broader population, it can add layers of interest to the story. Two maps in particular are anecdotally interesting in relation to the crab category pattern observed above. This is because the post-maps did not mention crab or the crabbing activity in the map area, but did mention crab in the open-ended comment section of the questionnaire, in answering whether they considered the cruise to be entertaining; one participant noted that, "it was fun catching crabs" and the other listed "whales, crabs, dolphins and the ride" as the reason why the cruise was entertaining. They found the subject of crab meaningful enough to comment on it, but did not include it in their maps. Map #9120206 did include crab on the pre-map. The post-map was much less developed than the pre-map; it included only a few concepts from the pre-map and very little new information, so it could have been a time issue that led to crab being left off the map but included in the comments. Map #9221112, on the other

[2]Future research of this kind may benefit from separate sample populations for pre- versus post-maps in order to control for pre-maps influencing post-maps. This would require sampling at least twice as many cruises – and probably more - to yield a large enough sample size to allow for pre- and post-map comparisons controlled for weather and other cruise variables.

hand, did not list any specific sea life on either pre- or post-map (including crab) and demonstrated an 'Environmental" context. Thus, even though they enjoyed the crab and found it worth commenting on, it did not fit into the context they had chosen (from their perspective). For that matter, whales and dolphins, also mentioned in the comment section, were not present on this map (pre- or post-), either, which may show that this participant did not find the sea life viewing aspect of this cruise meaningful as part of his/her environmental framework. For this study, there is no way to know the motivations of the individual participants as to why they chose to include or exclude certain concepts. If one conducted post-map interviews motivations could be reconstructed, but this would be time consuming, and thus prohibitive in many free choice learning situations. Still, bringing in anecdotal points to back up or merely speculate on the observed patterns can be a valid way to add depth to the overall analysis, as well as spark future points of research.

Elaborateness

The narrowing of focus to key concepts that was observed in category frequency on post- versus pre-maps is further demonstrated by an analysis of the elaborateness (counts: average number of nodes, connections, and words) within each concept domain (Stoddart et al, 2000). Whales, Crab, and Plankton categories showed significant increases across all 3 counts (see Table 4). The Birds category showed increases across all 3 counts, with the increase in average number words being significant. The Plants and Physical World categories also showed increases, but they were not significant.

Table 4. Conceptual Categories: Counts of Nodes, Connections, and Words

	Ave number Nodes		T-test	**Ave number Connections**		T-test	**Ave number Words**		T-test	**Notes on results**
	Pre-map	Post-map	Sig.	Pre-map	Post-map	Sig.	Pre-map	Post-map	Sig.	(for all 3 counts)
Whales/Dolphins	**2.24**	***3.28***	**p<.01**	**2.45**	***3.48***	**p<.01**	**3.02**	***4.82***	**p<.01**	*Sig. **increase** across all 3 counts*
Sea Lions/Seals	**2.14**	**1.82**	**P<.1**	**2.42**	**1.89**	**p<.05**	3.42	3.34	n/a	Sig. **decrease** for 2 counts; decrease (not sig.) for Ave # Words
Other Marine Mammals	**0.40**	**0.17**	**p<.01**	**0.46**	**0.18**	**p<.01**	**0.64**	**0.30**	**p<.1**	Sig. **decrease** across all 3 counts
Birds	1.64	*1.87*	n/a	1.83	*1.90*	n/a	**2.06**	***2.48***	**p<.1**	*Sig. **increase** for Ave # Words; Increase (not sig.) for other 2 counts*
Fish	**2.16**	**1.32**	**p<.01**	**2.50**	**1.41**	**p<.01**	**2.92**	**1.99**	**p<.01**	Sig. **decrease** across all 3 counts

Crab	**1.41**	***2.10***	**p<.01**	**1.52**	***2.18***	**p<.01**	**1.94**	***3.57***	**p<.01**	*Sig. **increase** across all 3 counts*
Other Sea Life	**2.72**	**1.48**	**p<.01**	**2.97**	**1.67**	**p<.01**	**4.15**	**2.02**	**p<.01**	Sig. **decrease** across all 3 counts
Plants	0.53	*0.54*	n/a	0.59	0.59	n/a	0.80	*0.81*	n/a	***Increase** (not sig.) across 2 counts; No change in Ave # Conn.*
Plankton	**0.20**	***1.41***	**p<.01**	**0.28**	***1.50***	**p<.01**	**0.23**	***1.98***	**p<.01**	*Sig. **increase** across all 3 counts*
Physical World	1.93	*2.29*	n/a	2.07	*2.47*	n/a	3.00	*3.26*	n/a	***Increase** (not sig.) across all 3 counts*
Industry (Fisheries)	0.59	0.41	n/a	0.68	0.49	n/a	1.00	0.63	n/a	**Decrease** (not sig.) across all 3 counts
Tourism	**2.04**	**1.18**	**p<.01**	**2.20**	**1.23**	**p<.01**	**3.51**	**1.90**	**p<.01**	Sig. **Decrease** across all 3 counts
Human Impacts	**1.19**	**0.58**	**p<.05**	**1.44**	**0.66**	**p<.01**	**2.12**	**1.07**	**p<.05**	Sig. **Decrease** across all 3 counts
p<.1, p<.05, p<.01 = statistically significant; Paired T-test										

Whales, crab, and plankton are 3 of the main concepts covered by the cruise, so it fits expectations that significant increases would be seen within the counts of those conceptual categories. This increase in average number nodes, connections, and words shows an increase in cognitive understanding and demonstrates that the key concepts put forth in the MDT cruise script are being taken in by cruise passengers. Furthermore, it is interesting to note that even though the frequency of the crab category on post-maps did not change, the individual counts of measures within the category did increase significantly, showing that more crab information was showing up on post-maps than pre-maps. Thus, elaborateness is an important aspect of a detailed analysis of concept map data. How important may depend on whether there are also holistic measures that can yield similar results without the time consuming task of counting every single node, connection, and word on every single map, (one of the central themes of inquiry within this study). Plus, the fact that these counts increase does not say anything about the quality of information on the maps For instance, there is one map that has multiple nodes/words connected to a node containing the word "sea lion;" but when looking closely, one can see that it is merely the multiple repetition of the word, "bark." Also looking at specific maps, one can see that many participants moved from listing broad animal names (like crab or whale) to listing more specific names (Dungeness crab, Grey whale) and adding other specific information within the concept (crab: molting, size to keep, etc.). So, to see if these observed patterns were indicative of the participant population as a whole, some more qualitative and holistic analyses were conducted.

Out of the categories that showed decreases for all 3 elaborateness counts, Fish, Other Marine Mammals, Other Sea Life and Tourism, showed significant decreases. Even though Newport, Oregon is a fishing community and the cruise does cover aspects of the industry, it is not surprising that the fish concept decreased, as the Captain talks more specifically about fishing boats than fish species, and the naturalist really only mentions fish as prey for marine mammals, unless specific questions are

asked by passengers. MDT has another type of cruise that focuses much more specifically on fish and the fishing industry. It would be interesting to repeat this research on the alternate cruise, which has a very different route, script and overall focus.

It also makes sense that a narrowing of focus would be seen away from the general category of "other sea life." On pre-maps, many people listed all the sea life they could think of, without going into much depth within each species. Many of the species found on pre-maps were tidepool animals (various invertebrates, such as sea stars and anemones), which are generally not discussed at any length on the cruise. So, even though the concepts would be perfectly valid additions to the post-maps (they are "Marine Wildlife in Newport, Oregon"), many participants did not repeat this information, but instead focused on the specific concepts from their cruise.

The primary Other Marine Mammals mentioned on pre-maps (sea otters) are not found in Oregon, so were not usually mentioned on post-maps unless in reference to an absence from this area; this matches the significant decrease across all 3 counts that was observed for this category. Many of those mentioning sea otters had visited the Oregon Coast Aquarium, which houses sea otters, so this may be the primary reason they were mentioned on pre-maps. The absence of sea otter references on post-maps may be due to the fact that they were not seen on the cruise, and thus not on the minds of participants during the post-map activity, or may be due to the fact that a misconception that sea otters are found in Oregon was corrected.

The decrease in the Tourism concept also matched expectations. Even though the entire cruise is, in effect, a tourism activity, most participants did not tend to frame it that way on their post-maps, but instead listed individual sea life and sea life facts they had learned on their cruise. Many of these same participants, though, had included much more non-specific information on their pre-map; even though the central node contained the term "marine wildlife," many pre-maps listed the participants' other activities (shopping, seeing the ocean, walking on the beach, etc.), which were framed from the perspective of what a tourist would do on the coast, in general. (This will be discussed in more detail below).

The Sea Lion Category decreased across all 3 counts on post-maps, all significant except the decrease in average number words. Sea lions are prevalent in Newport (aquarium, fishing harbor and docks, docks in shopping district, etc.) and other areas of the central Oregon Coast (Sea Lion Caves, etc.), and tend to draw attention to themselves by exhibiting noisy and territorial behavior nearby human areas of activity, so many participants had a lot to say about them on pre-maps. The cruise script does contain sea lion information, but the specificity of the actual information given can vary

greatly depending on the amount of time for sea lion viewing at the end of the cruise, which is when most of this information is disseminated. Merely analyzing counts did not elucidate if a change in conceptual understanding related to sea lions was occurring, but a qualitative breakdown, based on analysis of key MDT concepts within conceptual categories (discussed below), reveals much more.

Overall, looking at a change in elaborateness from pre- to post-maps reveals an increase in conceptual understanding in key areas. For the Crab category, the increase in counts across all measures on post-maps, even without significant increases in frequency on post-maps, shows an increase in depth of understanding within these categories. Participants took existing, broad knowledge about this subject and added in specificity, a clear sign of learning from a constructivist viewpoint. The Whale and Plankton categories, which showed a significant increase across all counts and in frequency on post-maps, was for the most part not present on pre-maps at all (only 8.13%). The fact that 54.47% of participants had plankton information on post-maps shows that this concept was meaningful to almost half (47.15% - 1 of the 10 participants who had plankton on the pre-map did not include it on the post-map) of all participants, even though there is no way to know for sure if there was an existing knowledge framework related to Plankton (see MDT Concept section for further discussion).

As mentioned earlier, breadth (average number categories for all maps combined) decreased significantly between pre-and post-maps. The other measures of elaborateness (average number of nodes, average number of connections, and average number of words) also decreased for all maps combined, but only average number connections showed a significant decrease. These decreases may seem to suggest a decrease in understanding, overall, but it may be more complicated than that, which comes to light when looking more closely at the content on individual maps. One can see that most of the information within those categories that showed significant decreases across all counts on post-maps (Fish, Other Marine Mammals, Other Sea Life and Tourism) was not incorrect (see accuracy section for further discussion), so the fact that this information was excluded may not mean it is no longer part of the participants' conceptual understanding. Thus, from a purely anecdotal standpoint, much of the excluded data could be viewed as potentially additive to post-map data, which may mean that the participant's knowledge base, overall, is even more expansive post-cruise than would be expected based purely on the elaborateness measures. This cannot be proven from a quantitative standpoint that looks only at elaborateness, but analyses that take into account complexity and accuracy may reveal more as explained below.

Depth

Another measure of understanding is depth (average words per category, nodes, and connections). Although average words per category showed an increase on post-maps that was not significant, average words per node and average words per connection increased significantly on post-maps, showing an increase in overall depth from pre- to post-maps, exhibiting once again a positive change in knowledge structure.

Table 5. Depth (as part of elaborateness measure)

	Pre-map	Post-map	Change	Significance
AVE Words/Category	3.71	3.97	*Increase*	n/a
AVE Words/Node	1.50	1.66	*Increase**	**p<.05**
AVE Words/Connection	1.60	1.82	*Increase**	**p<.01**

*=Significant; Paired T-test

When looking at elaborateness for each cruise separately, no significant patterns are revealed, which could be due to the low sample size (average n=12.3) per cruise.

Going beyond traditional measures

As discussed intermittently above, looking more closely at particular features of concept maps revealed a more explicit and layered representation of changes in understanding from pre- to post-maps than counts of nodes and connections alone could provide.

Accuracy

The number of pre-maps showing use of scientific language was 27 (21.95% of maps). The word "crustacean" was originally deemed scientific, a decision that was later questioned: although the term is used as scientific classification, it is also a fairly common word that many people are comfortable using. Excluding any maps with "crustacean" as the only scientific word, the new total is 20 (16.26%). For post-maps, 55 (44.72%) contained scientific language, or 50 (40.65%) when excluding "crustacean" only maps. Whether or not the word "crustacean" is included, post-maps contain significantly ($p<.01$) more scientific language than pre-maps. The number of post-maps showing an increase in scientific language was 43 (34.96%) and a decrease in scientific language was 5 (4.07%); the remaining 75 (60.98%) maps showed no change.

Male and Female participants both increased their use of scientific language ($p<.01$). Among age groups, participants in the age categories 20-29, 30-39, and 40-49 showed a significant increase ($p<.01$, .<01, and .<05, respectively) in use of scientific language, while the older age categories (50-59, 60-69, 70+) had increases that were not significant. The youngest age categories either showed no change (10-19) or did not contain enough data to be analyzed (9 and under). Those participants that marked their educational level as some college (n=47), and college degree (n=34) and high school

(n=19) showed significant increases ($p<.01$, $<.01$, and $<.05$, respectively) in the use of scientific language. Those with advanced degrees (n=18) showed an increase, but not significant. Those participants who marked "other" educational level (middle or elementary school, n=5), showed a decrease in use of scientific language, but not significant.

Previous concept mapping experience may play a role in cognitive changes. 48.7% of those with previous concept mapping experience demonstrated an increase in scientific language post-map ($p<.1$), compared to 28.6% of those without mapping experience. Another pattern that emerged regarding the increase in scientific language was related to whale sightings. 38.4% of those maps from cruises where a whale sighting did occur (n=99), versus 20.8% of those with no whale sighting (n=24) showed an increase in scientific language ($p<.05$). Also, 38.38% of pre-maps that contained the category Whale showed an increase in scientific language, higher than the average for the maps as a whole ($p<.05$), which may show that those participants who come to MDT with an existing, basic conceptual framework of whale information will be more likely to increase conceptual understanding, overall.

In general, this increase in scientific language from pre- to post-maps demonstrated that understanding (based on scientific accuracy) increased in participants after experiencing the cruise.

There was only a very small incidence of inaccurate statements, due most likely to the wide range of possible topics on both pre- and post-maps creating a situation in which participants could easily leave a concept out of a map if they were unsure about its accuracy. The few examples of inaccurate statements on pre-maps were usually tide-pool animals being scientifically mis-categorized (e.g. sand dollars are crustaceans). This type of inaccuracy was not usually corrected on post-maps, most likely since tide-pool animals are not part of the standard cruise script. On post-maps, the few inaccuracies seen were usually slight mistakes on details from the cruise script (MDT concepts), such as crabs needing to be six and three-quarter inches across in order to keep, when the regulation is actually five and three-quarter inches. Due to the low incidence of inaccurate statements, they were not fully analyzed as a measure of accuracy of the concept maps as a whole. Presence of inaccuracies did affect other measures of understanding, though, in that they were excluded from any counts of propositional structure (e.g. incorrect propositions were not considered to be part of any exhibited hierarchy) and scientific language. Thus, coding of inaccurate statements is important for this kind of research in all cases, and would be especially important for more specific topics. For instance, if this study had been focused on just one animal, such as crab, the opportunity would be there for very specific information to show up on both pre- and post- map, such as life history, crabbing industry,

habitat, etc., leading to a potential for analysis of patterns based on frequency of inaccurate statements occurring on pre- and post-maps.

Although affective words (words of emotion and expression) were present on both pre- and post-maps, no real patterns emerged from pre- versus post-map comparisons. There were more affective words seen on pre- (n=42) versus post-maps (n=34), but the difference was not significant. It is possible, if this study had looked more closely at what kinds of emotional words were being used on pre- versus post-maps, that patterns might be seen, such as pre-maps containing primarily anthropomorphisms (e.g. dolphins are cute, friendly, etc.) and post-maps containing primarily words related to the cruise experience (e.g. catching crabs was cool, etc.). This would be an interesting topic for future study.

There were significant effects seem from certain demographic categories, though. Females used more affective words on both pre- and post-maps ($p<.1$) than males, which could be a reflection of the general observation that females in the US are more likely to use emotional and expressive language, in general (I'll send you a citation for this). Also, MDT repeat passengers used fewer affective words on post-maps than first-time passengers ($p<.1$), which could mean a number of things: repeat passengers are not as easily impressed by the "experience," and thus use fewer emotional words; repeat passengers have a more developed conceptual framework of MDT concepts going into the cruise (they may not have retained a lot of information from their last visit, but they are "sponge-like" in their openness to re-absorb information and make it a more permanent fixture in their long-term memory), so affective words are more easily replaced by more specific, accurate descriptions on post-maps. Another pattern relates to whale sightings. Maps from cruises with whale sightings showed increases in the use of affective words more than the general sample population ($p<.01$). 33.3% of post-maps from cruises in which whales were seen contain affective words, versus only 4.2% with no whale sightings. This suggests that the presence of the affective on post-maps may be due in large part to some aspects of novelty in the experience. (i.e., first cruise, whale sighting).

In summary, there are some interesting patterns to be observed surrounding the affective, but none that reveal any obvious conclusions about cognitive development within this study.

Complexity

Looking specifically at hierarchical structure as a preliminary measure of complexity, most maps did exhibit some level of hierarchy (concept chains) on both pre- and post-maps. Many were a mix of hierarchical structure plus another form of organization: it was often noted that, on the same maps, some concepts were highly developed, while others were not. Thus, maps were analyzed for hierarchical structure by assigning co-dominant primary structural labels (designations) to each map.

If the map only exhibited concept chains, that label was assigned with double weight. If the map exhibited a mix of concept chains and geographic organization, the labels were considered to be co-dominant, and each was given a single weight. Thus, the sample size for this analysis was actually double the number of maps (n=246). 77.65% of pre-maps and 83.74% of post-maps exhibited some level of hierarchical or geographic organization, showing a fairly sophisticated understanding of concept maps and organizational structure going into the exercise. This worked out well, as very little time was spent training the participants in how to do a concept map (2-4 minutes). This demonstrates the potential usefulness of this kind of concept mapping tool in a free choice learning environment, and dispels some of the concern over a need for a complicated training procedure for participants.

There is some evidence ($p<.1$) to suggest that participants who had done concept mapping before (Map Repeaters[3]) had a higher percentage (85% versus 58%) of hierarchically organized (Concept Chain) pre-maps than those who had not had concept mapping experience. This is quite different from the Christensen study (2007) that showed no effect based on previous experience with concept mapping. However, there was no evidence of a difference in complexity increase or decrease. These two findings taken together suggest that the concept mapping experience did not affect the overall integration of conceptual knowledge – just the starting point, which would seem to back up the original assertion that a short training time is adequate for this evaluation tool.

Comment [SR2]: You might move this to the conclusions/recommendations section, but it can work here as well.

Table 6. Structure

	Primary Co-dominant Pre-map	%	Primary Co-dominant Post-map	%
Concept Chain	161.00	65.45%	171.00	69.51%
Geographic Circular	23.00	9.35%	26.00	10.57%
Geographic Non-circular	7.00	2.85%	9.00	3.66%
Meaningless Chain	13.00	5.28%	11.00	4.47%
Random Circular	37.00	15.04%	27.00	10.98%
No Star (random)	5.00	2.03%	2.00	0.81%

n=246 due to co-dominant factor

Using the hierarchical structure measurement with the other measurements (cross-links, propositional structure, and depth of explanation) mentioned in the analysis section, a decision was

[3]See further discussion of Map Repeater effects in Scientific Language results/discussion section.

made for each map as to whether it increased, decreased, or saw no change in complexity. Out of 123 post-maps, 27 exhibited a decrease in complexity (22%), 31 (25.2%) had no change, and 65 (52.8%) increased in complexity. These results back up the previous conclusion - based on measures of numbers of categories, elaborateness, and depth - that the participants were adding to their knowledge structure. Those maps that showed an increase in complexity on post-maps also showed increases in average number of nodes and connections (not significant) and average number of words ($p<.01$) on post-maps. Those maps showing a decrease in complexity demonstrated decreases in categories, nodes, connections, and words ($p<.01$). Those that showed no change in complexity had decreases across all counts, but not significant. These comparisons reveal the usefulness of the complexity measure as a supplement to traditional count analysis, and possibly even a replacement. Thus, this kind of more holistic analysis also provides a high level of promise for future evaluation opportunities, as it is a more flexible technique, ideal for free choice learning environments lacking the resources of academia.

Maps that increased in complexity also showed a significant increase in scientific language on post-maps ($p<.01$). Once again, the comparison allows the researcher to rest assured that the data are all pointing in the same direction: learning is occurring within the participant population.

Although depth of explanation was assessed as part of the overall complexity measure, it is worth noting that 20 (16.26%) of the post maps contained higher-order description (24 instances), while only 7 (5.69%) of the pre-maps contained higher-order descriptions (9 instances). The measure correlated quite nicely with the other complexity measures mentioned above (no significance tests done on higher order descriptions). Only 1 map had an increase in higher-order descriptions but a decrease in overall complexity based on the other measures. In only 3 maps (2.44%) was the complexity change still unclear after using the first 3 measures, in which case the increase in higher-order descriptions was used as the determining factor. In other words, it is good to code higher order explanations within the data as a reference point, but there is no need, with this type of holistic analysis, to spend much time on the analysis of this particular measure; it adds to the overall picture of complexity, but does not tell a separate story, necessarily.

67.7% of post-maps that showed an increase in complexity also contained the Plankton category, versus 48.1% of post-maps with decreased complexity ($p<.01$). This is an interesting idea: take one specific, traditionally complex concept, which is also a key concept presented by the program being evaluated, and use it as a general indicator (a "keystone" concept, if you will) of overall increases in conceptual understanding and program message assimilation.

Focusing Effect

Comment [SR3]: In your conclusions you may want to address Michael's comments that the learning that is occurring is not just any kind of learning (and not even the learning that the learner would necessarily choose) but is the learning that MDT intends to happen -- that is that the MDT curriculum is working at some level. People are also learning things that MDT didn't necessarily intend.

Natural World was the primary context seen on both pre- and post-maps, which makes sense considering the central node was "Marine Wildlife of Newport, Oregon." For pre-maps, tourism was a fairly popular context, but decreased quite a bit on post-maps; this matches with the significant decrease in the counts associated with the conceptual category tourism. The environmental and industry context also decreased. Physical World did show a slight increase on post-maps. As can be seen in Table 4, the decrease in most of the other contexts led to the increase of the Natural World Context on post-maps, exhibiting the narrowing of focus elicited by the MDT experience.

Table 7. Contexts

	Primary Co-dominant		Primary Co-dominant		
	Pre-map	**%**	**Post-map**	**%**	
Natural World	153.00	62.20%	192.00	78.05%	*Increased*
Tourism	53.00	21.54%	27.00	10.98%	
Environmental	24.00	9.76%	15.00	6.10%	
Industry	5.00	2.03%	1.00	0.41%	
Physical World	9.00	3.66%	11.00	4.47%	*Increased*
Other	2.00	0.81%	0.00	0.00%	
n=246 due to co-dominant factor (123 maps total)					

Overall, 99 post-maps (80.49%) contained MDT Concepts. If one particularly poorly performing dataset (cruise 922.11) is excluded, in which the percentage of maps with MDT Concepts was only 47.62%, the range of the percentage of maps with MDT Concepts varies between 70% and 100% by cruise, and the overall percentage jumps to 87.25%. The most common MDT Concepts present on the post-maps included those related to the crabbing activity, the plankton activity, and whales. This correlates with the counts of categories, nodes, connections, and words discussed in the quantitative section. For crab, common information found almost exclusively on post-maps includes specific crab species, native and non-native, size and sex regulations for harvest, and some life history information (e.g. females have eggs). This specificity correlates with previous claims that participants acquired new knowledge about crab and added it into their existing conceptual framework, resulting in learning (constructivism).

As mentioned above , plankton seemed to be a fairly unfamiliar concept to most participants (based on incidence on pre-maps). Although plankton is a difficult concept to understand without an existing conceptual framework, MDT may be accomplishing integration by relating the scientific concept to more commonly understood ideas, such as whales feeding and common everyday items that contain plankton (e.g. makeup). It is also possible that it merely did not occur to many people to include plankton as "marine wildlife of Newport, Oregon" on their pre-maps. Either way, a lot of very specific information, including definitions of plankton, types of plankton, phytoplankton

photosynthesizing, and whales filter-feeding on zooplankton, all directly from the MDT script, was found on post-maps. The most prevalent sign of integration into an existing framework was an addition of plankton information into the whale concept.

For Whales, species, physical characteristics, feeding and migration information was most common on post-maps, and many participants did integrate the new information into their existing framework (see Appendix T). And, although the Sea Lion category and counts did not show increases when analyzed quantitatively, very specific sea lion information was present on post-maps that was not present on pre-maps (head bumps, dominance, migration, bachelor herd, etc.), which shows a clear integration of new concepts into a highly developed conceptual framework (hence the lack of significant differences in counts). This is a clear example of how holistic analyses of context, accuracy and complexity may yield information not readily detected by counts of nodes and connections alone.

Out of the 14 MDT repeat passenger maps (11.38%), 5 (35.71%) conclusively had MDT concepts on their pre-maps, and all 5 of those showed expanded MDT concepts on the post-maps. The sample size of MDT repeat passengers was quite small (n=14), so it is difficult to conclude much, except to say that it would be valuable to conduct further research with larger sample sizes of repeat passengers, in order to see to what extent information is being retained.

Due in part to small sample sizes of sub-grouping of data (demographic & cruise variable categories), few patterns were observed within those categories. It is also possible that few patterns would have emerged, regardless of sample sizes. The patterns that were observed have been outlined within each individual result heading (e.g. counts, complexity, etc.).

It would have been especially interesting to have been able to better analyze the data by cruise (date and time) to look for patterns. As already discussed, the sample sizes were very small, which may be why little difference was seen between cruises. Few patterns were observed among the different cruise variables, as well (other than whale sightings, which is discussed in various sections of this paper), but this is more likely due to poor data collection regarding cruise details. In the future, the researchers and/or facilitators should conduct brief personal interviews with the naturalist and captain of each cruise, rather than leaving a form for them to fill out, as this may increase specificity and accuracy of cruise experience reporting. Another option would be to send the facilitator out on each cruise to actively observe and take notes. This could be useful, as naturalist guides expressed the opinion that it was difficult to remember and actively record details of sightings, in particular, and still carry out all required tasks as boat crew and naturalist guide. Other details, such as ocean conditions, could be recorded in a more meaningful passenger-centered way, as well. For example, naturalist guides often used terms like “4-6 foot swell,” or “wind chop” whereas this study would have benefited

from more specific observations related to how the conditions were affecting passenger comfort and level of participation in activities. Even if personal interviews and/or direct cruise program observation was not possible, the form used in this study to query the crew could be much better designed.

Tracking group versus individual concept map participation is another sub-grouping that this study could have looked at, based on other similar studies (Christensen et al, 2007). This question was asked of participants, but the data was not useful, due to the variable being confounded by a specific instruction within the concept mapping activity facilitators' script that created an unintentional bias toward completing the map as an individual[4].

Questionnaire

The overall results of the questionnaire showed that passengers were generally satisfied with their experience. They found the cruise experience to accurately match the description given at check-in (82.1% agreed or agreed strongly), although quite a few (12.2%) marked "don't know," for this question, and many of those admitted in the explanation section that they were not paying attention at check-in. MDT' staff does their best to explain the cruise carefully to all parties, but an increased effort might be made to ensure that the entire party is present during check-in explanation. Participants also agreed that the cruise experience matched their prior expectations (74%). There were a number of "don't know" answers (11.4%) for this question, as well, with many of the corresponding comments suggesting they didn't have any basis for prior expectations for their experience (e.g. "never been before" or "this is my first time"). Most of the participants found the cruise to be educational (93.5%) and entertaining (93.5%). Even the 1 participant who was disgruntled over not seeing a whale and marked "strongly disagree" on the other questions agreed that it was an educational and entertaining cruise. Finally, 91.9% of participants agreed that they would recommend the experience to friends and family, the key to a growing business. For those who did not agree, 1 person was unhappy over not seeing a whale, 1 found the cruise to be "informational but not interpretive," and 1 thought they "would see more." The other 5.7% simply did not answer the question (or any of the questionnaire

[4] Concept Mapping procedural note: to increase likelihood that participants would return at the end of the cruise to complete their map, it was stated that each ***completed*** map would be entered to win the raffle. This may have inadvertently led to very few participants choosing to do the activity as a group, confounding any possible individual versus group analysis. For those who did state on the questionnaire that they worked as a group, many still completed their own individual maps. It would have been better to state that each individual participant would be entered into the raffle, regardless of whether they worked individually or as a group, as long as they were part of the effort that resulted in a completed map.

questions). Ultimately, the cruise product can be considered successful when only 0.8% of the sample population is dissatisfied and only 1.6% is ambivalent.

There are some patterns that emerge when looking at the demographic and cruise variable categories. Most notably, whale sightings do have an effect on customer opinion of their experience. The majority ($p<.05$) of the 4.9% to 8.9% of participants who did not answer questionnaire questions did not see whales on their cruises. This may be why, for instance, 96% of participants who did see whales found the cruise educational, whereas only 83.4% of those who did not see whales found it educational. If the "no answer" data are removed, the percentages are closer to 100%, regardless of whale sightings. It is tempting, then, to view skipped questionnaires as signs of dissatisfaction with the overall experience, but there may be many other factors.

Table 8. Questionnaire Results

	Agree Strongly		Agree		Don't Know		Disagree		Disagree Strongly		No answer	
Statement	#	%	#	%	#	%	#	%	#	%	#	%
My cruise experience today closely matched description given at check-in.	39	31.70%	62	50.40%	15	12.20%	0	0.00%	1	0.80%	6	4.90%
My cruise experience today closely matched my prior expectations.	30	24.40%	61	49.60%	14	11.40%	6	4.90%	1	0.80%	11	8.90%
My cruise today was educational.	48	39%	67	54.50%	1	0.80%	0	0.00%	0	0.00%	7	5.70%
My cruise today was entertaining.	59	48%	56	45.50%	1	0.80%	0	0.00%	0	0.00%	7	5.70%
I would recommend this experience to my friends & family	63	51.20%	50	40.70%	2	1.60%	0	0.00%	1	0.80%	7	5.70%

This questionnaire did not examine how important education versus entertainment is on this kind of cruise, although this would be a great topic to address further. For the purpose of this study, it can be noted that a good proportion of participants who made comments as to why they would recommend the cruise to others used the word "fun" or said things like "great experience," which demonstrates further that marketing for the cruise should focus on the fun aspect, with education as an "added value." This is the tactic that MDT currently uses, and it seems to work. In addition, marketing whales as the primary product is not the goal of MDT, although whales will also be a large part of the product. Although overall satisfaction was very high regardless of whale sightings, the need to continue with at least a partial whale focus, at this point in tourism development on the Oregon Coast, anyway, is further demonstrated by the apparent correlation between whale sightings and at least a slight difference in customer satisfaction. The effect of whale sightings on increased use of

scientific language may also mean that whales are a great vehicle for disseminating general sea life knowledge – the "charismatic megafuana" effect.

Conclusion

Combining the primary holistic indicators of learning – accuracy and complexity – with the supplementary measures used in this study – context and MDT concepts – the assertion can be made that there was a change in conceptual understanding by the passengers who experienced the MDT Cruise. In addition to a clear focusing-effect onto key MDT concepts, it was shown that those concepts were also added into an existing conceptual framework to create meaning making, resulting in the potential for learning. This finding was backed up by parallel analyses of more traditional concept map measures of numbers of categories, depth/breadth, and elaborateness. It has also been shown that the combined analysis of accuracy and complexity can act as a good substitute for analysis of elaborateness (node, connection, and word counts), as well as a supplement to basic breadth analysis (category counts), while a more qualitative analysis of key concepts, context, and outliers (individual maps) can add depth to both accuracy and complexity measures, as well as any of the more traditional measures. This study and other similar studies will be analyzed for common points of procedure yielding repeatable results to create a standardized set of evaluation tools that will be made available to informal education entities.

Although it was clear from this study that the MDT customer is gaining knowledge by participating in the cruise program, and that information about whales, crabs, and plankton are the primary concept domains into which that information falls – which fits quite nicely into the broad goals of the program - it could be made more clear what specific knowledge is coming across clearly and being emphasized in meaningful ways. If this research study were to be repeated with more specific central nodes, there could be further insight into visitor learning. There was difficulty in determining within this study what specific information was known (based on pre-maps) because the central node was so broad, leaving room for a myriad of areas of focus, with little time and space for the participant to include them all. If separate evaluations were conducted (using a sampling of the above qualitative measures) for crab knowledge, whale knowledge (or more specifically, grey whale knowledge), plankton knowledge, bird knowledge, fisheries knowledge, etc., the results would allow MDT to better tailor their program script in a way that will create meaning making opportunities for their customers, thus further enhancing the possibility for long-term changes in attitudes about the natural world.

These same studies could include a component to test how much of this information is added into a participant's long term memory framework (phone interviews, for instance, which could be mapped by the researcher similarly to the original concept map done in person; or simple questionnaires). The research, if done over a long enough time period, could sample only repeat customers, as well. The sample of repeat customers to MDT that participated in this study is interesting to look at, but the sample size was quite small and the repeat number and amount of time since the last cruise were not taken into account. A more in-depth study of long-term learning and meaning making would be advised. To measure any changes in participant's overall perception of the natural world and how that may play out once they return to their daily lives could lead to further focus of the message offered by marine science educational entities, particularly in free choice learning environments.

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Appendix A: Pre-map (Blank)

☐ *Raffle # (last 3 digits)* **FRONT SIDE (start here)**

Date:_____ Cruise Time:_____

Please write down as many words, ideas, images, phrases, or thoughts that come to mind related to the term **"Marine Wildlife of Newport, Oregon."** Draw lines between these concepts to **SHOW** how they are related to one another. Write linking words between concepts to **explain** how they are related to each other. Thanks!

Marine Wildlife of Newport, Oregon

Please answer the following questions:

1) Have you been on a Marine Discovery Tours cruise before?_____ If yes, how many?_____

2) If not, how did you hear about our cruises?_____

3) What was the most important deciding factor in choosing to cruise with Marine Discovery Tours today?

_____

4) Please tell us about yourself:

a) Age(s):_____

b) Gender:_____

c) Residence (City & State):_____

d) Highest level of education (please check 1 box per person):

☐ High School ☐ Some College ☐ College Degree ☐ Advanced Degree ☐ Other:_____

5) Have you visited any of the following in the last 3 months? (Please check all that apply)

☐ Oregon Coast Aquarium ☐ "Whale Watching Spoken Here" Program

☐ Hatfield Marine Science Center Visitors' Center ☐ Other Coastal Education Facilities:_____

☐ None of the Above _____

Appendix B: Post-map (blank):

BACK SIDE (fill out at end of cruise)

Date:_____ Cruise Time:_____

Please make a new map, again following the instructions on the opposite side. You may use the same words as before, or new words. Thanks!

Marine Wildlife of Newport, Oregon

Please answer the following questions:

1) Did you complete this map as a *Group* *Individually*

2) Have you ever done a concept map before? *Yes* *No*

3) My cruise experience today closely matched the description given at check-in. (Please circle one).

Agree Strongly Agree Don't Know Disagree Disagree Strongly

Please explain:_____

4) My cruise experience today closely matched my prior expectations. (Please circle one).

Agree Strongly Agree Don't Know Disagree Disagree Strongly

Please explain:_____

5) My cruise today was educational. (Please circle one).

Agree Strongly Agree Don't Know Disagree Disagree Strongly

Please explain:_____

6) My cruise today was entertaining. (Please circle one).

Agree Strongly Agree Don't Know Disagree Disagree Strongly

Please explain:_____

7) I would recommend this experience to my friends & family. (Please circle one).

Agree Strongly Agree Don't Know Disagree Disagree Strongly

Please explain:_____

Appendix C: Concept Map Script:

Please put Dated "Naturalist Guide Notes" onto Boat Note clipboard for Kevin or Eric to fill out at end of cruise.

Have Kevin/Eric board participating passengers 15 minutes before cruise time.

Hand out black pens as they enter the cabin and point them toward their seats.
• Hello, and welcome to Marine Discovery Tours! How is everyone doing today? Your naturalist guide will begin his introduction and safety talk in just a few minutes. You cruise will get underway at its regularly scheduled time, not to worry!

• **We appreciate YOUR help today!**
• You are helping Oregon State University students with their graduate project!
• We're looking at how people learn, and testing out a technique called Concept Mapping.
• Plus, we're helping Marine Discovery Tours to improve their cruise program for future visitors!
• The activity today is brief AND fun - and you can work on it individually or as a family group! And for helping out today, you'll get to pick out a thank-you gift + be entered to win the $25 Gift Certificate to the Gift Store! *(point up toward store)*. The raffle will be drawn at the end of the cruise, after you've completed the second half.

• Participation is completely voluntary and completely anonymous - your answers will in no way be linked to any identifying information. You can choose to do any part, none, or all, of this activity. This letter *(hold up letter)* further explains your rights as a participant, and each of you will get a copy to keep.

Explain how map works:
• Just write down **any** words that first come to mind about marine wildlife - facts, ideas, thoughts, feelings…it's a creative process, so there's no one "right" way to do it.
• Then draw lines between words to **show how** they are related.
• And use linking to **explain how** they are related.
• You don't have to spend a lot of time on this!

Show example map & briefly run through part of example map with them.(e.g. Australia-Crocs-Conservation)
• This map is a fairly complicated one, but it only took a few minutes!

Start handing out blank concept maps & informed consent documents.
• At this time, only complete the 1st side, which says "FRONT SIDE" in the upper right hand corner. The back is for after the cruise! You can work as a group or individually. Each completed concept map will be entered to win the raffle at the end of the cruise.

While they are working, hand out raffle tickets. Have them write the last 3 digits of their ticket in the upper left and corner of the front side. This will make it easier to hand them back their map at the end of the cruise.
• This is the first part. When you are finished, please hand the map back, and enjoy your cruise! At the end of the cruise, just as we dock, please return to the cabin. I will return your map to you, so you can create a new map on the back side of the page. You can pick up your thank-you gift at that time, and we will see who wins the raffle!
• *Just before SAFETY TALK*: For those of you still working, your Naturalist Guide will be starting his safety talk in just a moment. Please listen carefully to this important information!

AT END OF CRUISE:
As cruise is docking, Naturalist Guide will make this announcement: For those of you helping us out with the concept maps please return to the cabin now. *Integrate with regular "end of cruise" speech.*

Hand out blue pens as they find their seats. Read ticket #'s listed on maps & hand back to passengers.
• Now we would like you to do the same thing as before, but on the other side. You may use the same words you used the 1st time, or different words - it's up to you!

*When they are finished, **thank them** and have them pick out thank-you gift. After most are finished, draw raffle and hand out gift certificate. (If a few are still finishing, let them work while conducting raffle).*

Appendix D: Informed Consent Letter:

Shawn Rowe
Marine Education / Learning Specialist
Sea Grant Extension
Hatfield Marine Science Center
2030 SE Marine Science Drive, Newport, OR, 97365
T 541-867-0190 | F 541-867-0320 | E shawn.rowe@oregonstate.edu

We are asking people questions about their experience on the Sea Life Cruise today. This form is to help answer any questions you have about what we are doing and why. It will help you decide whether you would like to participate today or not. You may ask any questions about the concept mapping activity & evaluation, what you will be asked to do, the possible risks and benefits, your rights as a volunteer, and anything else about the evaluation or this form that is not clear. When all of your questions have been answered, you can decide if you want to be part of our study or not. This process is called "informed consent." You will be given a copy of this form, in case you have questions later.

You have been selected at random to participate in a brief concept mapping activity & answer a few questions about our cruise program. We are asking questions to adults and families who come on board today, in order to find out how we can help them have a great experience with our program.

Participating in this activity will take about 10 minutes of your time. Participation is voluntary. **You may choose not to participate in any part or answer any particular question. You may also choose not to take part at all. You may stop participating at any time**.

There are no risks for you associated with this study, and there are no specific benefits for you associated with this study. Your help is extremely valued, because you will be assisting us in improving our cruise for future visitors.

You have been selected at random to participate. We will not be taking your name. All answers will be grouped together, so there is no way that your answers can be linked to you. You will remain completely anonymous. Only the researchers will have access to this data. The findings will be shared with other professionals in the field.

Questions are encouraged. If you have any questions about our work, please contact: Shawn Rowe at 541-867-0190. If you have questions about your rights as a participant, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator, at (541) 737-3437 or by e-mail at IRB@oregonstate.edu.

Thank you for your help. We appreciate your cooperation

Sincerely,

Betsy Rollins, Marine Resource Management Graduate Student
Oregon State University

Shawn Rowe, Marine Education & Learning Specialist
Hatfield Marine Science Center / Sea Grant Extension

Appendix E: Research Invite:

You could win a ***$25 Gift Certificate*** to the **ANCHOR PIER GIFT GALLERY**!

- Help out OSU grad students with their research & help Marine Discovery Tours improve their cruise program for you and future visitors!
- *We only ask 10 minutes of your time, before and after the cruise, to write down your ideas about wildlife. (Plus, it's a fun activity that your can do individually, or as a family!)*
- You'll receive a Thank-you Prize for helping us out, PLUS be entered to win a $25 Gift Certificate (*good at this gift store, or to use toward a future cruise with Marine Discovery Tours).* The drawing will take place at the end of your cruise!
- Participation is COMPLETELY VOLUNTARY and results are COMPLETELY ANONYMOUS!

If you'd like to help us out, just arrive 20 minutes before cruise time for early boarding.

☺ **Thanks for Your Help!** ☺

Appendix F: Naturalist Guide Form:

Date:_____ Cruise Time:_____

NATURALIST GUIDE & CAPTAIN NOTES:

Guide:_____ **Captain:**_____

Brief description of weather & ocean conditions:_____

_____

Time spent on ocean, compared to optimal conditions maximum (Circle one):

0% 1-25% 26-50% 51-75% 76-100%

Wildlife (Check all that apply):

☐ Gray Whales (how many & main behaviors seen):_____

_____

☐ Other Whales (please list):_____

☐ Harbor Porpoise:

☐ Harbor Seals:

☐ Sea Lions:

☐ Birds (please list):_____

☐ Other (please list):_____

Crabbing Activity Notes:

☐ Dungeness (about how many):_____

☐ Red Rock (about how many):_____

Plankton Activity Notes:

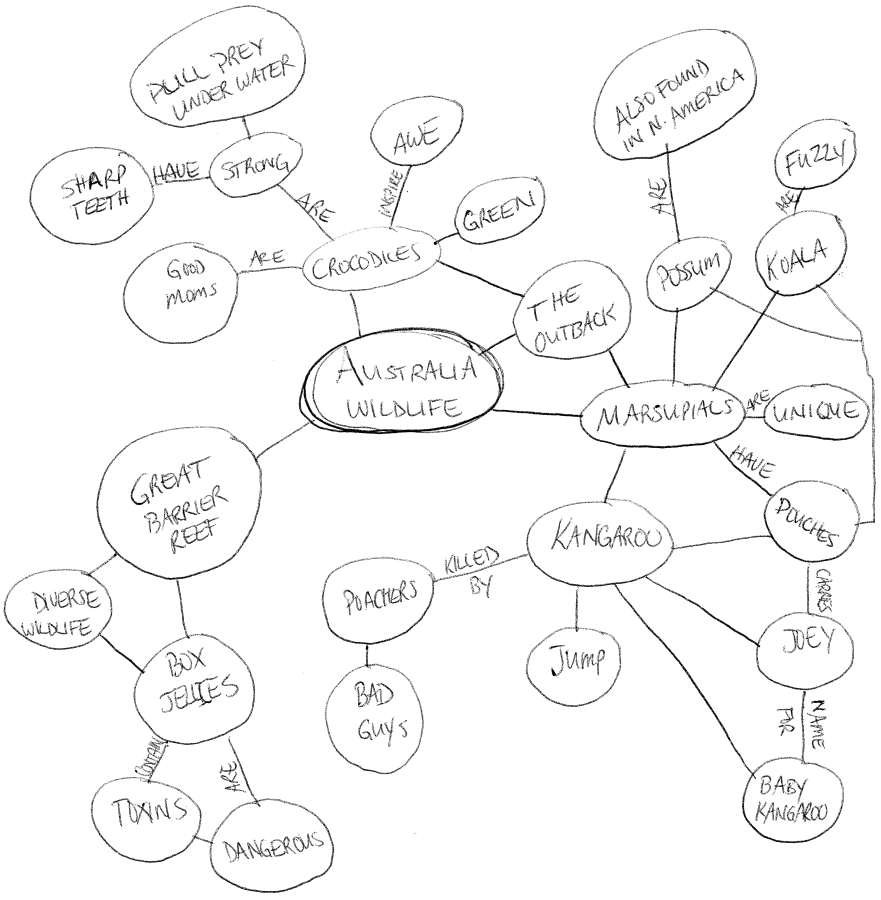
☐ Phyto (please list):_____

☐ Zoo (please list):_____

Other Cruise Notes:

Appendix G: Sample Concept Map:

Sample Concept Map



The above concept map was written out on a 15”W x 20”H piece of poster board in permanent black marker and displayed for participants to view.

Appendix H: Conceptual Categories + Coding:

1) Whales = Whales and Dolphins: all species, behavior, life cycle, habitat, etc. (Blue)
2) Sea Lions = Seals & Sea Lions: all species, behavior, life cycle, habitat, etc. (Red)
3) Other MM = Other Marine Mammals: e.g. walrus, sea otters, etc. all species, behavior, life cycle, habitat, etc. (Carnation Pink)
4) Birds all species, behavior, life cycle, habitat, etc. (Indigo)
5) Fish: all species, behavior, life cycle, habitat, etc. (Violet)
6) Crab: All species, behavior, lifecycle, habitat, etc. + Crabbing. (Periwinkle)
7) Other Sea Life – any sea life that doesn't fit into other categories. (Orange)
8) Plants (excluding plankton, unless participant makes direct connection – indicating understanding of plankton as a plant, in which case plankton can be double-coded. (Green)
9) Plankton: zooplankton & phytoplankton. (yellow green)
10) Physical World: Geological, oceanographic, physical habitat, etc. (Black)
11) Industry – commercial fisheries. (Brown)
12) Tourism: what a tourism would do and/or be interested in along the coast (Robin's Egg Blue)
13) Human Impacts (on ecosystem, wildlife, etc.) – environmental/conservation, etc. (Dandelion)
14) Food Chains

Categories 1 – 13 were color coded (color in parentheses).

Category 14 – food chains: propositions were coded with symbol = □

Affective words: code with star

Scientific Language: code as "SL"

Inaccurate propositions: code with "X with circle around it"

Unclear propositions: code with "?"

Appendix I: Scientific Language Codebook

Scientific Language Codebook

Most (Counted as YES)	**Somewhat (Counted as NO)**	**Least (Counted as NO)**
Pelagic	Aquatic	Water, sea
Trough	Swell, current	Wave
Invertebrates, Cephalopod, Cnidarian, Nematode	Anemone, Barnacle, Sea Star, Jelly, etc.	Starfish, Jellyfish
Cetacean	Gray Whale, Beluga, Narwhal, Orca	Whale, Killer Whale
Baleen, Keratin, "filter", 2 blowholes, fluke	Spout, solitary, pods	Tail, travel alone
Vertebrates	Marine mammals	Mammals
Anthropod, Molt	Crustacean, Dungeness Crab, Red Rock Crab	Crab
	Albacore Tuna	Tuna, Fish
Avian	Tufted Puffin, Great Blue Heron	Puffin, Heron
Bivalves, Mollusks		Shellfish
Pinnipeds, bachelor herd, ear flaps	CA Sea Lion, Stellar Sea Lion, Harbor Seal, territorial, dominance	Sea Lion, Seal
Phytoplankton, zooplankton, diatoms, dinoflagellates, microorganisms, red tide	Plankton, sea microbes, microscopic, organisms, algae	Plants
Detritus	Sea foam	
Photosynthesis		
Migratory	Migrate	Move, Swim
Ecosystem, ecologists, dissolved oxygen, dead zone, sustainable	Environment, conservation, endangered, climate change, global warming, urbanization, diversity	habitat
Estuarine	Estuary	Bay
Indigenous, Non-indigenous	Introduced species	Native, non-native
Tidal basin		tidepools
Plate Tectonics, subduction, volcanic ridge	Underwater vents	
Predatory, opportunistic	Scavengers, predators	eat
Designations of weight, size (e.g. whales are 45 ft. long, crab 5¾" to keep)		Whales are huge

Appendix R: Contexts:

- NW: Natural World = list sea life (more scientific); animal categories, interactions, behaviors, life histories, etc.
- TO: Tourist = list sea life they expect to see plus local activities related to sea life (includes recreational fishing)
- IN: Industry = sea life and coastal activities related to commercial fishing
- EN: Environmental: Human impacts, ecology; any sea life listed would be related to conservation issues, impact human have on habitat, etc.
- PW: Physical World: list sea life within framework of physical world – oceanographic/geologic + physical habitat characteristics.
- OT: Other (usually not definable)

Appendix S: MDT Concepts Codebook:

Info from Maps / Correlates directly with MDT Script

• Crab Activity: Crab pots/bait General Crab Info: Crustaceans -Barnacles on crab? -Molting -Cook alive -How to hold (back claws) -Can survive 4-6 hrs out of water -Other Species: Hermit, Kelp, Decorator -Commercial v. Rec Crabbing Grow new limbs? Territorial?	Dungeness Crab -Native (Indigenous) -Big, serrated claws -How to tell M/F apart -Keep males only–must be 5 ¾" (Rec) Measure with dollar bill -Females / eggs -Live 5-7 yrs.	Red Rock Crab -Non-native (not indigenous) -Transplant
• Plankton Activity: Net/Microscope -"Drifters" -Found in ice cream, cosmetics (e.g. lipstick), shampoo -Microscopic -Dead & alive – in sea foam -Largest = jellies	Phytoplankton / Plant -Photosynthesis / sun -Create Oxygen -Diatoms Red Tide? (sometimes talk about)	Zooplankton / Animal -Eaten by whales -krill *(distinction made by passengers – zoo vs. phyto eaten by whales?…or just plankton in general?) – plankton in general*
• Gray Whales: -45 ft long -Feed in shallow water by jetty -Solitary -Mating – males tire out females -Right/Left Brain -Blow, spout, spray, plume -Dive, breach, fluke -2 blow holes -Knuckles -500 Resident Whales -Covered w/ Barnacles	Baleen Feeders -Baleen plates – 300 rows -No teeth or upper jaw -Keratin -"brush" -Filter plankton Mammals -Breath air -Warm-blooded; have hair -Have live young; feed young	Migratory -AK in summer -Baja CA in winter – to give birth to calves in warmer water -Calves can't survive colder water until build up blubber layer
• Other Whales/Dolphins -Toothed Whales – 1 blow hole *-Humpback? Pilot? Sperm? Blue? Do we talk about these??*	Orca -Eat sea lions -Groups/pods	Harbor Porpoise -Lack blubber layer -Shy, elusive -Follow schools of fish
• Seals / Sea Lions - Pinnipeds Harbor Seals -Smaller than sea lions -Rocks	CA Sea Lions -Territorial, aggressive (males) -Big teeth / bite -Head bump / dominance (males) -600 lbs. -Ear flaps -Eat salmon (35 or 60? lbs per day) -Flippers-regulate body temp -Migratory Females in S. CA Males in OR – Bachelor Herd Males Travel to CA to mate once/yr -for 2 months -Skim Bubbles / sea foam ?? -Rocks	Steller Sea Lions -usually not in bay -ocean
• Sea Otters – not found in OR		

• Birds -Diving -Different species	Land vs. Sea -Sea Birds drink sea water, eat fish -Gulls not sea birds -Osprey = sea birds	-Gulls -Osprey -Cormorants (Chinese fishing birds) 3 types -Common Murres – females & chicks -Brown Pelicans -occasionally – Great Blue Heron
• Boat info – stern/bow -different kinds – pleasure/fishing -buoys, piers -crossing the bar -dredging	• Estuary/Bay + River -Salt/freshwater -Protected by jetty -Tides -Bridge -Fresh water - Yaquina River • Ocean -Waves, swell	• Fish -bait balls
• Oysters -Filter water	• Jellies (not jellyfish) -can be plankton -not fish -have stingers	• Nematodes
• MDT -Herbal remedy for seasickness -Kevin, "marine biologist" -Education, fun, etc.		