AN ANALYSIS OF TRAVEL EFFICIENCY WITHIN THE CONTEXT OF

GEOGRAPHIC EDUATION AND THE DAILY TRIP PLAN

by

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DEDICATION

I dedicate this effort to my son Marcus, who will grow up having an enhanced knowledge and appreciation of the earth and how it works, and stand in awe of God's greatest creation. A co-dedication is in order: for my dad, Dr. Frederick Stutz, a fellow geographer, teacher, mentor, and critic. Thank you.

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ABSTRACT

This study, undertaken during the Spring 2012 academic semester, measures changes to transportation efficiency caused by intensive geographical training. In so doing, fifty-six college human geography students recorded trips on trip logs for two weeks (Phase I) without being given any suggestions as to how their travel behavior and patterns might be conducted in a more efficient manner. Almost 4,000 trips were recorded. Next, I presented as their instructor, four weeks of intense geographical training (treatment). During this time, to better familiarize them with surrounding land-uses and more efficient spatial opportunities, students reconstructed through direct observation mapping, four of the closest commercial districts to their place of residence, parcel-by-parcel, business-by-business. Students became acquainted with the spatial layout and alternative destinations in their geographical area through the internet, and through the use of maps and other learning tools. In-class discussions about travel efficiency, energy savings, sustainability, the principle of least effort, gravity models, the traveling salesman model, distance decay concepts, the value of a person's time, spatial analysis, and place utility were addressed as part of this 4-week geography education classroom component. After four weeks of intense geography education on these topics, students resumed keeping detailed trip logs for a period of two weeks (Phase II), in an effort to measure travel efficiency through geographical, spatial, and experiential learning. Upon completion of the study, "before," and "after," data sets were compared,

and conclusions were drawn, based upon both quantitative and qualitative information from the students.

Research employed a mixed methodology, using both quantitative and qualitative approaches. The trip log survey instrument included variables for each trip taken, such as origin, destination, departure and arrival time, distance from origin to destination, travel mode for each trip taken for each day, etc. For the Phase II travel diary, conducted four weeks later in the semester, students used the sketch-map concept, in which they used a base map of the San Diego region, and marked where they intended to travel over the network, at the outset of each day (or the night before). In addition to collecting quantifiable trip log data, students were required to submit the sketch map for each day of the second iteration of the trip logs (Phase II). This is what I call the daily trip plan (DTP), a term coined within the context of my research. The sketch map was drawn daily, just prior to that same day's travel diary in an effort to help students plan an efficient day of trip-making. Students wrote an in-depth qualitative analysis of their experience, including documenting their trip logs and mapping exercises, and the degree to which geographical training that they received in a classroom affected their "after" travel. Four of eleven quantitative questions seeking to measure dependent variables yielded results that were statistically significant using a one-tailed paired *t*-test, and six of the remaining seven hypotheses achieved the desired outcome in terms of direction of change. With regard to the qualitative component, responses were analyzed using both the segmenting and reassembling method, as well as the Likert scaling method. An

overwhelming majority of students reported positive results, i.e., making moves toward sustainability throughout the semester, based on the provided geography education and the use of the DTP. Improved urban travel efficiencies can seemingly be achieved with enriched geographic education, simple a priori planning, and basic sketch techniques.

Key Words: Travel Efficiency, Sustainability, Least Effort, Gravity Model, Traveling Salesman Model, Distance Decay, Spatial Analysis, Place Utility, Trip Log, Daily Travel Plan (DTP)

I. INTRODUCTION

Today's travelers are fundamentally unaware of the environment that surrounds them. A worldwide 1989 Gallup poll, found that (of) college-aged Americans ages, 18 to 24, 14%, could not find the United States on a world map (Science Daily 1999). In fact, Americans performed the poorest of any nation when asked to identify locations on a world map. A similar study conducted in the early 1980s, suggested that American students from kindergarten through graduate school were geographically incompetent (Petersen, Natoli, and Boehm 1994). Literacy on a local scale is not much better. A domestic poll of geographic knowledge among college-aged Americans was conducted for the National Geographic Society in 2006. Findings of that 2006 Roper poll claimed that college-aged Americans lacked basic map reading skills and boldly claimed that young Americans fail to understand the world and their place in it (National Geographic News 2006). In a time when geographic illiteracy is rampant, the teaching and learning of geographical concepts, especially spatial awareness, is essential at all grade levels.

Geographic knowledge is essential in our rapidly globalizing world. Some would argue that education, of which geography education is a critical component, is the door to involvement in our democracy and our economic market – the foundation of our civil rights (Boutrous and McRae 2014). The focus of my research, though localized in scale to include travelers' immediate action space, could offer broader assistance relating to issues of spatial and self-orientation in a larger framework. Equipped with enhanced spatial awareness through geographical education, it is hypothesized that students will better be able to solve societal problems that have spatial dimensions, such as increasing efficiency of personal transportation networks, traveler spatial decisions, and improving energy sustainability.

Geographers and geography students must be able to answer life's micro-level problems, such as restaurant locations, journey to work and school, police patrol routes, residential density and environmental limitations, the impact of hazards, neighborhood conflict and cooperation, and everyday use of maps (Boehm 2004). While studies have already shown that American persons from birth up to 24 years cannot read basic maps, scientists have only recently discovered what part of the brain may be responsible for constructing, reading and analyzing maps. The process within the human brain which assists with construction of mental maps and allows for self –orientation in space is of critical importance, according to scientists John O'Keefe, May-Britt Moser and Edvard Moser, who won the 2014 Nobel Prize in medicine for brain GPS. Their team discovered the mechanism in the brain that allows us to find our way around, and coined this mechanism the "inner GPS" (*New York Times* 2014).

Significance of Research

As of March 1, 2012, the cost of a gallon of gasoline averaged $3.80 nationwide, and exceeded $4.50 per gallon by October of 2012 in California. Gas prices in California hovered at an average of $4.22 per gallon in July 2015, and energy price forecasts project a steady increase in prices in coming years, based on 2014 projections by the U.S. Energy Information Association (U.S. Energy Information Association 2014), a sub-agency of the U.S. Department of Energy. Unfortunately for all of us, not only geographers, movements between origins and destinations and the physics and geography of work and home separation, not to mention social, personal business, shopping and recreation, generate distance between people and places, necessitating the consumption of energy to effectuate physical social networking (as opposed to virtual social networking). For these reasons, the importance and significance of the research proposed here has largely to do with improving travel efficiency, and thus, the consumption of energy.

Research Question

This study investigates the intersection of transportation efficiency as a byproduct of geographical and spatial learning. Due to increased global interconnectedness, the perceived fossil fuel shortage, anthropogenic ties to global warming, technological advancements, skyrocketing energy prices, and unprecedented needs toward energy sustainability, now is the time to study transportation efficiency. A communion between geographical learning and transportation (travel) efficiency is a logical step in an effort to interpret travel behavior, once enhanced spatial learning has taken place. Can improved spatial awareness of the urban environment, coupled with energy conservation training evoke a measurable increase in travel efficiency? This is my basic research question.

The following includes an overview of intended dissertation research. During the course of this paper, the thesis of my intended research is presented, and a framework established for why this vein of inquiry is necessary and relevant in today’s world. A body of literature is presented that attempts to explain the nature of corresponding research, complete with theoretical underpinnings that provide a platform from which further research can develop.

Historical Background

Though gas prices recently dropped to a 3-year low in California at $3.07 per gallon in November, 2014, energy price forecasts project a steady increase in coming years (U.S. Energy Information Association 2014). In fact, energy prices exceeded $4.50 per gallon as recently as 2012 in several states, including California. In July, 2015, the average cost of a gallon of gas in California hovered at an average of $4.22 per gallon. Unfortunately, perhaps, gasoline is the predominant source of energy for transportation in the world today, and, especially in America, where public transportation provisions have been minimal because of the suburbanized metropolitan structure and cheap energy availability. This has allowed everyone to have a comfortable, personal means of transportation that is private and, most importantly, on demand. Petroleum, up until now, has been reasonably abundant, inexpensive, and relatively easy to transport and distribute (Hanson and Giuliano 2004). Political situations in the Middle East require, further, that America regard its petroleum reserves as precious. Conservation provides political stability, reduction of climate-changing greenhouse gases, and the reduction of energy-cost per household, which will allow expenditures on other sectors of the economy which are important to the economic recovery of America.

The far-reaching implications of today's rate of unprecedented energy consumption are urgent and can no longer be ignored. In November, 2014, the

Intergovernmental Panel on Climate Change (IPCC) delivered the results of their latest report which included an assessment of 30,000 climate change studies that it says "establishes with 95% certainty that most of the warming since the 1950s is man-made…carbon dioxide has been accumulating in the atmosphere at an unprecedented rate as a byproduct of the burning of fossil fuels by automobiles, power plants and factories. Concentrations of the heat-trapping gas (CO_2) are 70% higher than in pre-industrial times, a level unprecedented in at least the last 800,000 years" (IPCC 2014). Similarly, NASA claims on their website that 97% of scientists agree that warming trends over the last century are very likely to continue to increase due to human activities, even referencing the previous 2007 IPCC report as the gold standard (NASA 2014).

Just thirteen years ago, atmospheric warming and the need to reduce energy consumption in order to preserve the Earth and its systems, was not perceived as "dire." In fact, there was wide disagreement among scientists as to whether humans were even linked to the atmospheric warming. In just over ten years' time, the science has changed dramatically; it has been an unbelievable process to witness as an educator in a discipline that is dedicated to the study of places and the relationships between people and their environment.

Today, there is no ambiguity in the message. "Science has spoken. Time is not on our side. Leaders must act," said the UN Secretary General Ban Ki-Moon, summarizing a not-yet-published assessment on the state of the global climate by the IPCC (*Economist* 2014, 1). For personal energy consumers, never has a more compelling set of reasons to reduce energy consumption ever presented itself in world history.

Based on the levels and growth of energy use in the transport sector, the need for measures to control the growth of and reduce the dependence on the personal auto and imported oil is pressing. Transport in undeniably a major contributor to rising levels of energy consumption and greenhouse gas emissions worldwide. More than one-quarter of total U.S. greenhouse gas emissions come from the transportation sector, making transportation the second largest source of greenhouse gas emissions in the United States after the electric power sector (Center for Climate and Energy Solutions 2014). There has been a wealth of research in recent years focusing on the associations between transportation energy consumption and the urban form (Marique et al. 2013). Energy consumption as it relates to transportation is a thought-provoking indicator because it combines variables of travel distance, transport mode choice and journey frequency (Banister 1998; Muniz and Galindo 2005).

Based on data available from the U.S. Department of Transportation's "2009 Summary of Travel Trends -National Household Travel Survey," it is estimated that each individual spends an average of one hour per day travelling and, approximately 20% of their income on movement between trip destinations throughout the year (U.S. DOT 2009, 30). In Western cities that are highly disbursed, such as Dallas, Los Angeles, and San Diego, an even larger proportion of income and time is spent on travel in order for workers to continue their incomes, maintain their standards of living, and their demand for personal business, socialization, and recreation beyond the home base. A recent study shows that the number of vehicle miles traveled each day in San Diego County is above the statewide average, exceeding the major population centers of San Francisco and Los Angeles. The average annual total hours spent idling during peak traffic periods by drivers in San Diego County in 2009 was 37, up from 8 hours in 1982 (Texas Transportation Institute 2011).

The United States is the world's most extreme case of private vehicle ownership, decentralization of the metro area, and necessary and nominal mobility of individuals and the family. America has the highest level of daily miles traveled, hours spent in travel, number of trips, range of daily trip-making beyond the household, and some of the lowest rates of travel by public transit, bicycle and pedestrian movement in the entire world (Hanson and Giuliano 2004). It is quite interesting that many countries of Western Europe have essentially the same personal incomes, yet all measures of individual transportation mentioned above, i.e., auto ownership, trips, travel time, costs, are much lower than in America, and total vehicle miles traveled per capita, is, on the average, half of that of the United States (Transportation Research Board 2001).

These substantial differences in personal travel are clearly related to the rather late development of the American urban system, cheap, available petroleum resources, the culture of dispersed living versus clustered living, and an ample supply of U.S. government policy allowing inexpensive, single-family home ownership, subsidized by the government, and a large expansive network of roads and highways (Rubenstein 2013; Hanson and Giuliano 2004). These historical, cultural, and governmental factors have created tremendous utility and benefits for households, workers, and businesses, in American society who have access to unprecedented world levels of transportation and mobility, and who have capitalized on it through their own personal lifestyles and unparalleled standard of living.

Rationale

In America especially, but certainly throughout the entire world, individuals highly value their personal mobility and right to move, while selecting a variety of trip ends with great flexibility and expected destination utility (i.e., place utility). Yet, most other developed countries have transportation systems that are more compact, more expensive, and more sustainable. For these reasons, the overall efficiency and sustainability of the personal transportation system in North America becomes subject to examination and potential calibration related to increased efficiency, travel reduction, trip reduction, energy reduction, and travel time reduction.

The rationale behind this study assumes that there is an enormous possibility for improvement in energy efficiency, reduction of greenhouse gases, reduced travel miles, reduced trips, reduced travel time, and energy conservation, given the inefficient nature of the US transportation system. America is waiting for ideas, for workable plans, for laws that would improve the efficiency of transportation energy use, reduce individual time travelled, and increase efficiency and sustainability. It is not clear where the sustainability will come from. It will not come from the auto companies, and has not come from Washington D.C. It has not come from the states, the cities, or even the employers, although van/carpool/and preferential parking has been provided by some large employers. This study attempts to sow the seeds of increased efficiency and sustainability at the person-level, as a result of increased place-based geographic knowledge.

The impetus for this vein of sustainability will have to start with the individual. Production of alternative-fueled vehicles has increased in recent years as more Americans begin to recognize both their fiscal and environmental value. The push for sustainability will have to come from grass roots organizations with the hope that obvious, new plans for efficiencies will be adaptable and adoptable across America, short of WWII-type gas rationing. Such a plan is the one proposed in my dissertation, with the use of the personal "daily trip plan" or DTP. What kinds of policies, programs, and adoptable behavioral practices might bring about the kinds of changes that would make America less dependent on fossil fuels in transportation, lower our carbon footprint, and allow Americans to be less influenced by foreign demagogues and the escalating costs of transportation in their monthly family budgets? How can citizens and activist groups, and even teachers of geography across America, propose and bring about positive change for the American urban transportation system?

It could happen through the new grass roots movement taking shape across America called "self-tracking," where people measure their everyday activities with the goal of improving their quality of life (*Economist* 2012). They are an eclectic mix of early adopters, including fitness gurus, "tekkies," green junkies, hackers, and patients with health problems. For example, GPS and accelerometers (which measure changes in direction and speed) used to be very costly, but are now relatively inexpensive and small enough to be included in smartphone applications, making it much easier to take the quantitative methods used in science and business and apply them to the personal sphere. Self-tracking is being taken very seriously by start-ups in Silicon Valley, California, and elsewhere, which are launching new devices (notably bracelets) and software aimed at self-trackers. Self-tracking offers a glimpse of the future of health care and, as I propose here, even energy use, in which a greater emphasis is placed on self-monitoring, using a range of devices, to prevent disease, record calories burned, and even reduce energy use (*Economist* 2012). I propose that the trip log and the DTP are viable forms of self-tracking, with smart phone apps and personal GPS/GIS origin-destination technology just now surfacing from ESRI, a California-based company with 40% of the global GIS product market share.

The global society is more concerned about individual carbon emissions than any other time in history. There is a growing sentiment that sustainability has to start at the person level, as opposed to waiting for action at the state, federal, or international scale. In order to shrink individual greenhouse gas emissions, consumers have to be able to make well-informed decisions about transportation and home energy use. Awareness of carbon emissions most often starts with the automobile and weighing its sustainability against other transport alternatives (Lee 2015), which is specifically what this research intends to explore.

II. LITERATURE REVIEW

In a time of economic adversity and perceived immediate fuel shortages, travel efficiency is a must. Myriad models in the literature attempt to explain why people make the spatial behavioral patterns that they do. Some of the models discussed in the following paragraphs are used during the course of my dissertation research. The literature also points to methods that have been used to not only attribute a value to trips, but also provides case studies where trip diaries are the tool used to collect the data. A review of the literature shows that more research is warranted in the field of trip efficiency, linked trips, and perceived and actual cost savings. No articles even suggesting something like the personal DTP have been located, therefore this term is coined within the context of my research. Furthermore, no literature that bridged geographical learning and travel efficiency could be found. The literature, therefore, encompasses three study arenas: 1) social and behavioral cognition; 2) geographic education; and 3) transportation and travel efficiency.

Social and Behavioral Cognition

Human Activity in Space

An imposing amount of literature exists that addresses human activities in space. Generally speaking, the literature explores how various forms of spatial presence in human contexts are manifested in behavior and experience, human perception and cognition, interpersonal relationships, and various situational circumstances or environments. In order to build a framework for spatial cognition and wayfinding as it relates to my dissertational research of geographical education and travel decisions, a broad selection of literature was reviewed.

Topics in human activity in space are extensively described in *Person Environment Behavior Research: Investigating Activities and Experiences in Spaces and Environments*," (Amedeo et al. 2009). Additionally, the book is dedicated to the exploration of the manner in which space and/or environments enter into human activity and experience. Frequently "space" is not given specific attention in social and behavioral research. Literature that speaks deliberately to the spatial dimension and has been influential in developing a framework for geographical learning as it relates to travel efficiency includes *Spatial Behavior: A Geographic Perspective* (Golledge and Stimson 1997), which contains an extensive discussion on the geographic perspectives of spatial behavior. Betchel (1997) uses a cross-disciplinary approach to assess some of the larger issues within the domain of environment and behavior, while others' research focusing on spatial orientation (Pick and Acredolo 1983) and spatial cognition as it relates to wayfinding (Golledge 1999), have helped to lay the groundwork for this research.

Memory-Based Environmental Knowledge

The meaning of external information is a byproduct that stems from a perceptual-cognitive process engaged in by those carrying on activities in immediate environments. Such processing mandates that a person have both a facility to sense information and an experiential base in which to interpret its meaning. In as much, perceiving meaning requires not only the presence of external information and its acquisition, but the application of previously learned knowledge that can guide information acquisition e.g., encoding, organization, and evaluation (Amedeo et al. 2009). Long-term, memory-based internal information helps people to form meanings from space.

Authors that have studied the importance of internal information in the context of memory-based environmental knowledge agree that both activity and experience in an environment depend, among other things, on the availability of external information and the way it is processed (Blumenthal 1977; Ittleson 1973b, 1973c; and Mandler 1985). People engage in a "knowing," or what I refer to as a "geographical analysis" process through which they acquire, synthesize and integrate environmental information with internal sources of information in an effort to form, in their perception, a contextual-arena basis for immediate ongoing behavior. Through this process, internal information or knowledge directs what external information is acquired during environmental perception, and the "geographic learning" helps to organize it (Moore 1979; Moore and Golledge 1976; Neisser 1976).

Mapping Features of Memory-Based Environmental Knowledge

Human movement almost always involves the negotiation of space, the expenditure of motions, and movement about to confront things at countless locations, judging or assessing both direction and distance. One way to envision one's immediate surroundings is from its "arena," or its spatial-structural features (Amedeo et al. 2009). Researchers refer to the forming of arena-type environmental schemas as "cognitive mapping," (Downs and Stea 1977; Neisser 1976).

Cognitive mapping is a sort of experience-driven development where, over time, a person's brain forms memory structures that represent spatial relationships among important locations in certain environments or settings. These memory structures then serve to direct the acquisition and processing of spatial information during perception, and, facilitate spatial functioning in the environment (Neisser 1976). Neisser (1976) also suggests that immediate surroundings have significance to individuals as contexts for assessing the "appropriateness" of intended activities. Early seminal research in cognitive mapping was conducted by MacEachren (1992). In his article entitled, "Application of environmental learning theory to spatial knowledge acquisition from maps," cognitive mapping was recognized as a field that is of broad interest to a number of disciplines (MacEarchren 1992, 245).

In November 2014, scientists broke the news to the international community that they had discovered the part of the brain responsible for constructing, reading and analyzing maps. The process within the human brain which assists with construction of mental maps and allows for self –orientation in space is of critical importance, according to scientists John O'Keefe, May-Britt Moser and Edvard Moser, who won the 2014 Nobel Prize in medicine for identifying a so-called "brain GPS." Their team discovered the mechanism in the brain that allows us to find our way around, and coined this mechanism the "inner GPS" (*New York Times* 2014). Understanding how memory-based environmental knowledge is both analyzed and mapped has suddenly come into sharp focus.

Early Spatial Choice and Behavioral Modeling

Early scientific work related to the area of spatial decisions and behavior modeling encompasses both geography and economics. Economists tended to focus on structural model development, while geographers focused on analysis of spatial decisions.

In the 1960s and 1970s, behavioral modeling and spatial decision geography was dominated by work on spatial interaction/gravity models, and probability models that attempted to first match, and then forecast future trip productions. There was a lack of behavioral content, and slowly this mechanical approach was criticized by some behavioral geographers, which gave rise to approaches that studied individual choice behavior and the discrete choice model (Wilson 1967, McFadden 1974).

Unlike the gravity and spatial interaction models, the latter behavioral approaches had the ability to match and predict individual decision-making at the micro level with travel flow and other aggregate data generated from the macro level. Desbarats (1983) also joined the dialogue about geographical investigations and the causal relationship between subjectivity and behavior in space. Her work embraced an integrated framework for spatial choice behavior, proposing that people make trips for both reasons that they can and cannot control. More research in spatial choice behavior followed the critical research Desbarats initiated, some of which is discussed in the context of this literature review.

Pipkin (1981) reviews research that may help to explain why people make the travel decisions that they do. The author states that his thesis is: "….to scrutinize the status of choice concepts in cognitive accounts of behavior and to comment, from this perspective, on the *a priori* descriptive and explanatory structure imposed on the data by the probabilistic spatial choice paradigm."

Disaggregate choice models began to develop an advantage, however, and the data requirements and analysis became more demanding. Disaggregate travel choice models did require less massive data sets but they were required to be more specific with regard to individual trip destination choices. There has been a battle to discover whether disaggregate choice models could actually provide better explanations and predictions than the corresponding gravity-type spatial interaction models. It seems that they will both coexist into the future, and that the transportation engineers will prefer the former i.e., gravity type models, because they are dealing with massive highway flows, whereas the latter will be preferred by behavioral geographers, psychologists, phenomenologists, and post-modernists (Fischer and Nijkamp 1985).

The very early work that began to drive the quantitative revolution and modern economic geography came from location theory for individual firms (Hotelling 1929), households (Alonso 1964), and public facilities. They were deterministic in approach, of course, but shortly thereafter, discrete choice models started to come on board (Hensher and Johnson 1981; Fischer and Nijkamp 1985) leading to quantum improvements demonstrated by decompositional preference modeling (Timmermans 1984). All of the latter of which are probabilistic in nature.

Environmental Perception and Geographical Learning

Geographers, cartographers, planners, psychologists, and others, have studied environmental perception and geographical learning as applied to a variety of public policy and urban planning issues (Zeigler et al. 1983). Cognitive maps of neighborhood spaces, as studied by social geographers, have resulted in municipal applications that have preserved the sense of community (Pacione 1983; Zelinsky 1980; Lloyd and Steinke 1986). Additionally, Geographic Information Systems, or GIS, have used cognitive maps and mapping to develop digital representations of mental maps and cognitive spatial data sets (Peuquet 1988; Kwan 2001; 2002).

Understanding behavior in space by individuals is strongly related to the individuals' knowledge of their immediate spatial milieu and their level of geographical knowledge regarding it. Almost everyone is faced with constant spatial directional decisions, for example, from home to a variety of discretionary trip ends, including shopping, personal business and the like. The knowledge of the spatial system acquired over time, in situ, will help determine an opportunity set for both potential trip destinations and routes taken to those destinations. Garling (1989) has shown that travelers generate mental maps as representations of the built environment and are able to select more efficient multi-stop trip chains throughout an average day, largely based on their ability to acquire spatial geographical education of their environment over time. The degree to which environmental spatial knowledge is acquired, and the basis on which it is mentally organized and stored in the brain appears to accumulate with time spent navigating the urban system and with increased geographical education on what the system offers (Lloyd 1989; Leiser and Zilbershatz 1989).

The process of spatial knowledge and geographical learning suggests that knowledge is incrementally added over time and that batches of knowledge are added in hierarchically discrete spatial units (Couclelis et al. 1987). Findings by Golledge (1978) and joint findings by Golledge and Stimson (1985) argue that people use primary nodes or reference points, such as landmarks, as key building blocks, with travel routes serving as axial links among them.

Maps Provide Spatial Information

As previously discussed, cognitive spatial schemata are generated from direct contact with the built environment and paths and landmarks serve as key building blocks for these cognitive representations (Stevens and Coupe 1978; Maki 1981; McNamara et al. 1989). Additionally, cognitive representations can also derive from maps and printed media. Findings suggest that cognitive map representations can be picture-like in the brain and can be mentally scanned over and over again for locational and directional information (Lloyd and Steinke 1986). There are differences between direct environmental experience and cognitive representations obtained from maps, however (Thorndyke and Hayes-Roth 1982), but both have been shown to be extremely useful in route navigation and travel planning (Tversky 1981; Lloyd 1989). There was, for example, a tendency to underestimate both long and short distances when environmental learning was used (Lloyd 1989). Lloyd (1989) also found that both directional and distance learning was superior when using cartographic maps, however, there was less understanding of land uses and the spatial texture of places.

Visual Scene Processing

Researchers have found that people use visual information to orient themselves in space, and that this orientation occurs on different spatial scales. One can use local cues to determine location and bearing in the observable environment. Epstein et al. (2007) adds to the body of literature that addresses how humans and animals use information obtained from the local visual landscape or "scene," to orient themselves. Past studies found that three regions of the brain respond strongly to visual scenes moreso than objects: the parahippocampal place area (PPA) (Epstein and Kaniwisher 1998), retrosplenial cortex (RSC) (O'Craven and Kaniwisher 2000), and the transverse occipital suculus (TOS) (Epstein et al. 2005; Grill-Spector 2003; Hasson et al. 2003). Epstein's research team found that all three brain regions responded more strongly to images of familiar locations than to images of unfamiliar locations, suggesting that "real-world" experience with an environment may increase the richness of the neural representation of scenes drawn from that environment without changing their essential character (Epstein et al. 2007).

Gender Differences in Spatial Knowledge

There is recent and abundant research that demonstrates disparities in acquisition of spatial knowledge by gender, much of it suggesting that males outperform females consistently on assessments of spatial performance (Linn and Petersen 1985; Voyer et al. 1995). A number of studies show that males favor strategies that rely on distance and directional cues while females often memorize landmarks (Galea and Kimura 1993;

Dabbs et al. 1998; Sandstrom et al. 1998). In a recent study, Tlauka et al. (2005) attempted to determine whether there were significant gender differences in spatial knowledge acquired through simulated exploration. His team found five significant findings including:

> "(1) female participants required more time to travel from the start to the finish location when following a route through the simulated shopping centre, (2) while following the route, they made more incorrect navigational decisions, (3) females required more time to make directional estimates, (4) females' wayfinding performance was inferior when they were asked to navigate back to the start location, and (5) female participants placed the target objects less accurately on a map of the simulated environment" (Tlauka et al. 2005, 116).

Results of Tlaauka's study submit that gender is an acute variable influencing spatial ability in both real world and virtual space.

Men and women use different navigation strategies; men prefer math-based strategies that incorporate the use of distances and directions, while women tend to rely more heavily on landmarks (Downs and Stea 1977). Additionally, it can be said that children, especially girls, rely more heavily on external cues such as the presence of landmarks when compared with adults (Jansen-Osmann and Wiedenbauer 2004). Research shows that men and women differ in their wealth of geographic knowledge, with males knowing more than females about distant world regions (Bein 1990; Eve et al. 1994). Boys perform consistently better than girls in the National Geography Bee, with only two females winning the Bee from 1989 through 2014 (*National Geographic* 2014). But what accounts for this disparity in geographic skills? Some researchers attribute the differences of sex related spatial competencies to what is known as the "hunter-gatherer theory," that originates from division of labor by sex stemming from the Pleistocene era

(Eals and Silverman 1994). Specifically, the determining factor in selection for human spatial sex differences was the belief that females gathered plant food and males conducted the hunting of game.

In a recent study keeping in mind the hunter-gatherer theory, Silverman et al. (2007) looked at spatial sex differences using data across seven ethnic groups in forty countries. Their findings mirror earlier studies in that males proved advantageous on spatial tests with three-dimensional mentation rotations (how the mind recognizes objects in the environment including identification of objects are and where they belong), while females scored notably higher than their male counterparts on tests of object location memory (an important form of spatial memory). Collucia and Louse (2004) conducted a comprehensive literature review of gender differences in spatial abilities and found, unsurprisingly, that it was possible to claim that when gender differences appear, they frequently arise favoring males. The question remains as to why the gender differences in spatial abilities emerge, and theories run the gamut from biological explanations, to environmental factors, to interactionist and evolutionistic theories.

Navigation and Wayfinding

Geographers and scientists in general, agree that an essential survival skill is the successful ability to navigate one's environment. Researchers on human and spatial navigation realize that we must learn something about the layout of our environment and that this knowledge is comparable to a cartographic representation, or cognitive map (Gallistel 1990; O'Keefe and Nadel 1978; Thinus-Blanc 1987; Tolman 1948). In contributing to the understanding of map versus landmark navigation, Foo et al. (2005) found that humans depend largely on (geometrically weaker) landmarks to guide navigation rather than from path integration, and that only when landmarks appeared unreliable did study participants rely on rough survey knowledge.

The ability to learn, recall, and follow a route through the environment refers to wayfinding. Put simply, wayfinding is the ability to move successfully through the environment (Blades 1991). Four stages of wayfinding have been identified by Downs and Stea (1973): (1) orientation to determine self-location and estimated target location; (2) initial route choice in selecting routes from origin to target location; (3) route monitoring; and (4) recognition of the target. Golledge (1999) proposed that successful wayfinding included: (1) identification of origin and destination, (2) determination of turn angles, (3) identification of segment lengths and directions of movement, (4) recognition of routes and distant landmarks, and (5) embedment of the routes taken in a larger frame of reference.

In a recent study, researchers asked whether being an expert at wayfinding in one environment had any effect on learning new spatial layouts. Woollett and Maguire (2010) found, in a survey of London-based taxi drivers, that it did. Their findings further suggest that wayfinding expertise in a distinct environment includes not only accruing a large amount of information about the layout and content of that environment, but being able to apply that information in an existing spatial representation.

Route-learning, which involves the encoding and recall of topographic information, is a complex activity and requires the use of a distributed network of brain areas (Maguire et al. 1996). Historically, route learning has been studied using several behavioral paradigms that include learning of routes or of whole maps through passive viewing, navigation through virtual mazes and mental navigation through previously constructed internal representations (Aguirre et al. 1996, 1998; Ghaem et al. 1997; Maguire et al. 1996; Shelton and Gabrieli 2002). Research has shown that these paradigms all involve a generally similar network of brain areas, and it can be determined that encoding and recall of topographic data in both route and map form all activate similar brain areas. A recent study looking for gender-specific neural substrates of route learning found, using MRI, that both men and women use the same brain areas to learn routes (Blanch et al. 2004). Additional findings also suggested that both men and women encode route information from both a survey perspective (such as the use of a map) and from a route perspective (through experience in a given environment).

Geographic Education

Geography Education in a Geospatial Context

Teachers from a wide range of social sciences embrace a conceptually similar, multi-stranded pedagogical model. The first strand includes tangible "facts," such as elements of the landscape or the layout of a particular place. The second strand holds explanatory theories. A third and final strand includes opinions and value judgments. By conceptualizing a three-stranded model of cognition, in order for geography education to properly occur, the teacher must facilitate the learning of three different strands simultaneously.

The “Three-Stranded Model of Geographic Education” was presented by Gersmehl (2008) in *Teaching Geography.* The first strand consists of images or “facts,” i.e., “visual images, sensory impressions, measurements, and other facts associated with particular places,” (Gersmehl 2008, 29). Gersmehl likened these so-called “facts” to letters and words forming the “language” of geography. For purposes of my intended research, the landscape, places, routes, and trips, as gathered in the trip logs, represent the first strand of my geographic education model.

The second strand consists of analyses or “theories,” i.e., “concepts that help geographers interpret or explain the features they see in different places,” (Gersmehl 2008, 29). Gersmehl likened these so –called “theories” to sentences and paragraphs forming the “language of geography”. In order to form sound opinions, one has to be able to form sentences and paragraphs in the “language” of geography. For purposes of my intended research, the spatial analysis models and concepts including time-space prism, distance decay, principle of least efforts, the gravity model, location theory, and place utility, serve as the second strand of my geographic education model. These are the theories of movement for an aggregate population, i.e., my 60 human geography students who serve as the sample population for my vein of inquiry.

The third strand of my model includes the evaluations or “issues,” i.e., “opinions and value judgments that people form about places,” (Gersmehl 2008, 29). Gersmehl likened these opinions and value judgments to “metaphors” and “semantic overtones” that help communicate some of the most important ideas in the “language of geography.” For purposes of my research, concepts and value judgments, such as perceived distance, frequency of travel, and cost of travel time, help research subjects form judgments and opinions about the "before" or Phase I, and "after" or Phase II, paired trip logs, and any resulting savings and efficiencies observed. Each student then composed their value judgments into an essay after the travel sequence occurred.

The Image/Word Strand – Strand 1

The first and perhaps most important strand of my geographic education model is concerned with building a "vocabulary" of words associated with places. These so-called "place words" are names of features that occur in a specific place. The process of attaching a name to a feature, i.e., San Diego Mission Valley Shopping Center, or San Diego Mesa College, is a critical part of trying to explain why the feature is there (my second strand mentioned above that addresses theories) and why their location may be favorable or non-favorable (which is the third strand of my model that deals with judgments and perceptions of places).

The geography learner must have some theoretical concept of a place. In other words, an impression of what's going on there, before he/she can make a valid observation about the place and its place utility. To accomplish image building, people (mainly teachers) use videos, slides, maps, photographs and verbal descriptions. Because a word can have different meanings in different places to different people, there is some degree of subjectivity when one is image-building. The teacher plays a critical role in the process of weaving together images and words so that the learner can more accurately form ideas and value judgments about a place.

Geographic Theory – Strand 2

An important part of geographic learning addresses explanatory theories. Gersmehl refers to these theories as the "sentences and paragraphs," that help people figure out why things are the way they are in a particular place (Gersmehl 2008, 35). To that, I would add models. He argues that all people use geographic theories when decision-making, e.g., "Let's move to neighborhood A since its closer to work and school than neighborhood B," and so on. Often, people use the geographic concept called the distance decay model or the gravity model without even realizing it. I used these theories in my class presentations to help students determine whether they were willing to travel to nearby places with more opportunities, than to places farther away, out of mere habit, with fewer opportunities. Additional theories discussed in-class included those relating to travel efficiency, energy savings, sustainability, the principle of least effort, the traveling salesman model, the value of a person's time, spatial analysis, and place utility.

Perceptions and Opinions – Strand 3

Theory-forming almost always leads to the realm of value judgments and personal opinions. Gersmehl refers to this third strand of geography education as the "metaphors" and "semantic overtones" in the language of geography (Gersmehl 2008, 29). In other words, these evaluations that people form about places help communicate some of the most important ideas. Part of the aim of the dissertation research is to encourage thoughtful evaluations and other higher-order thinking proficiencies about travel sustainability, and the trip destinations chosen. Opinions, of course, should be founded on thorough analysis of gathered data.

Spatial Thinking: Geographical Skills

The two primary goals of geography, as stated by *Teaching Geography* are:

1. "Knowledge of places, to guide us when we travel, and to help us understand what places mean to people, and why people in particular places act the way they do" (Gersmehl 2008, 97) and;

2. "Knowledge of how to arrange things (roads, houses, malls, stadiums, elections districts, etc.) in our own place so that the results are fair, safe, efficient, and beautiful" (Gersmehl 2008, 97).

In order to execute these goals, people have to use what geographers call "spatial thinking", or spatial cognition. Scientists are still collecting research about how the brain gathers, stores, processes, and retrieves spatial information – information about the locations of things and their relationships in space. Scientists believe that the human brain has several distinct "regions" that appear to be designed to perform specific kinds of spatial analysis. They also acknowledge that process within the human brain which assists with construction of mental maps and allows for self –orientation in space is of critical importance. In fact, the mechanism in the brain that allows us to find our way around, coined the "inner GPS," has just been deciphered. Scientists John O'Keefe, May-Brit Moser, and Edward I. Moser found "grid cells" or "place cells" that make up a coordinate system allowing humans to navigate and know where they are in space (Hjelmgaard 2014).

The National Geography Standards (Boehm and Bednarz 1994) were designed to help serve as an organizational framework for what a geographically informed citizen knows. The first three goal statements call for learners to be able to relate to the world in spatial terms. This dissertational research will require geography students to use maps to interpret the area around them (Standard 1). The data collection, unique to this research, required students to form a daily trip plan or DTP, by making a map before they conduct any travel for the day (Standard 1). Through this process, the students analyzed spatial organization and spatial interactions skills to help them make more informed, rational, and efficient locational travel decisions (Standard 3). Many of the other Geography Standards were taught in the classroom as the students received geography education training to help reinforce some of the other broad groups such as human systems, environment and society, and uses of geography.

Geo Diaries as a Geography Education Tool

As part of my research, students were given an especially instructive activity in which they traced their own activity patterns in a daily travel diary, or "geo-diary." A "geo-diary" is a record of the places that students are in and the movements they make every day. It is a useful skill-building process that could prove to be an essential tool in geography education. An excerpt from *Teaching Geography* (Gersmehl 2008, 26) gives the following design principles for personal "geo-diaries":

1. **"List events and places**. Think about a typical day in your life, and make a list of major events that occur in different places, such as home, school, work, shopping, and entertainment area.

2. **Make a map**. Make a sketch map (for the purposes of my intended research described here, a daily trip plan, or, as I have coined a "DTP") that shows where you travel and when you arrive at each place. Make accurate scale measurements, so that it clearly shows trip length (miles between destinations).

3. **Choose sites.** Decide what 10—15 photographs, sketches, recordings, or other impressions you want to use to illustrate your personal geography. If time permits, discuss them with your teacher…. or compare geodiaries with others."

Transportation and Travel Efficiency

Travelers' Spatial Behavior – A Historical Review

In his 2002 presidential address to the AAG entitled, "The nature of geographic knowledge," the late Reginald Golledge used a vast body of historical literature to highlight contemporary geographic knowledge of spatial behavior. He chronicles the evolution of geographic knowledge emphasizing spatial analysis and, in doing so, draws upon sixty bibliographic references to make his case. Golledge (2002, 4-6) informed the reader that published literature over a 50-year period was evaluated and a partial list of "thinking and reasoning processes" was compiled.

In his assessment of the literature linking geographic knowledge and spatial behavior, Golledge identified nineteen points of critical thinking and reasoning processes. In so doing, a historical evolution of the topic of interest - the evolving nature of geographic knowledge and spatial behavior – is established (Table 1). These processes serve as a guideline for researchers when analyzing myriad aspects of travelers' decision-making practices.

TABLE 1

KEY GEOGRAPHIC THINKING AND REASONING PROCESSES

Process	Description
1.	Comprehending scale transformations
2.	Ability to transform perceptions, representations, and images
3.	Comprehending superordinate and subordinate relations and frames of reference
4.	Comprehending problems of spatial alignment
5.	Comprehending distance effects
6.	Comprehending spatial association
7.	Comprehending orientation and direction
8.	Comprehending spatial classification
9.	Comprehending clustering and dispersion
10.	Comprehending spatial change and spatial diffusion
11.	Comprehending non-spatial and spatial hierarchy
12.	Comprehending densities and density decay
13.	Comprehending spatial shapes and patterns
14.	Comprehending locations and places
15.	Comprehending overlay and dissolve
16.	Comprehending integration of geographic features represented as points, networks, and regions
17.	Comprehending spatial closure
18.	Comprehending proximity and adjacency (nearest neighbor) and their effects (distance decay
19.	Recognizing spatial forms (such as city spatial structures; relating traverses or cross-sections to three-dimensional block diagrams or images)

Source: Golledge, 2002.

Relationship Between Work and Travel Behavior

There are numerous studies that seek to understand the relationships between travel behavior, time use and work patterns. Zeroing in on factors that influence individual travel behavior, the literature reveals that one of the most significant factors influencing travel behavior is whether a person works outside the home. Space-time-constraints as they relate to both workplace location and work duration, play a significant factor in travel behavior. It has been noted that distance and time traveled for workers, versus non-workers, are significantly higher. In fact, the 2001 U.S. National Household Travel Survey found that workers travel approximately 12 miles more each day than those who didn't work outside the home (McGuckin and Srinivasan 2003). The greatest trip-generator is the home-to-work trip. The average duration of the home-to-work trip in the United States is approximately 30 minutes. McGukin et al. (2003) also found that non work trips were primarily determined by work schedules and geography, and that most non-work trips occurred near the workplace, near home, or along the route between the two.

Studies also suggest that workers also travel more frequently by car, often the most popular mode to reach the workplace, especially when traveling long distances (Aguilera 2008). An additional reason for frequent car use, as seen in San Diego, is that the journey to and from work is an occasion to make non work stops that aren't easily doable using public transit because of the long wait times, fixed route system, and limited service destinations. Policies promoting a better match between employment and location of residences are critical in order to reduce travel demand (Transportation Research Board 2013).

Due to gendered division of labor within households, women traditionally have higher levels of involvement in domestic and family tasks than men (Mattingly 2015). As a result, women tend to live closer to their workplace than their male counterpart (Turner and Niemeier 1997). Because of womens' higher level of household responsibilities, they have a greater tendency to work part-time and, as such, exhibit markedly different travel behavior than men (Kwan 2000). For example, women make shorter work trips than men, which generally corresponds with lower wages and more non-work trips, especially those related to child chauffeuring and shopping (Mattingly 1995, Hanson and Johnston 1985).

Route Choice Decision-making Process

Trip decisions are influenced by many factors such as an understanding of an individual's activity space, the activity destination, mode, and time-constraints. Literature that addresses studies of daily scheduling patterns exists (Damm 1983; Doherty and Papinski 2004; Hayes-Rothe and Hayes-Rothe 1979), however, there is not much emphasis placed on route choice information such as how personal perceptions and route choice attitudes affect observed travel patterns. If more data on route choice information existed, transportation modelers could use this information to improve trip assignment algorithms (Bekhor et al. 2006).

Understanding route choice necessitates that researchers understand various key constraints placed on individuals as they consider travel. The time-space prism is a concept that addresses three constraints: capability, coupling, and authority (Hagerstrand

1970). Capability constraints are those that limit human mobility when executing trips. Coupling constraints are in effect when a person has to be at a given location at a specific time (e.g. work from 8 am to 5 pm). Authority constraints suggest that certain people have access to specific locations, while others do not. The time-space prism model continues to provide both new ways of understanding human activity in space, as well as solutions for solving difficult issues of transportation and access in modern society.

The advent of modern communications technologies has had significant impacts on time savings. Global Positioning Systems (GPS) has been used to observe trip information (Papinski et al. 2009). Studies have recently shown that GPS data can be merged with travel diary data. A recent study that incorporated the combination of GPS, GIS and travel diary data revealed that a combination of tools provided invaluable insight into the route choice decision-making process which could ultimately lead to minimization of travel time (Papinski et al. 2009). More studies are needed to provide insight into the underlying route choice decision-making process using a combination of GPS and diary data.

Trip Chaining

Trip chaining, the act of combining multiple errands or trip destinations into one multi-stage trip, has been studied extensively in the literature, with initial areas of focus attempting to understand the geography of urban areas and the linkages between trips (Hanson 1980). The topic of multiple destination trips (versus single destination trips), was introduced by Mendelsohn et al. (1992). They found that the travel cost literature had, by and large, omitted multiple destination trips, until that time. They go on to describe techniques used to analyze multiple destination trips such as the multiple-site travel-cost model.

Current research is heavily concerned with improvements in modeling and forecasting travel. A recent study, for example, examined the relationship between mode choice and trip chaining, with emphasis on trips made using public transportation (Hensher and Reyes 2000). Hensher and Reyes (2000) found that with an increase in trip chaining (i.e., adding more links to the journey before returning home) the likelihood of using public transport decreases. When considering the sequence of activities in trip chains, Golob (1986) determined that life cycle of a household (also known as stage of family development, e.g., newly married, middle-aged adult, retired adult, etc.) is the most critical variable, followed by age and income. While gender and life cycle most affect trip-chaining behavior, it can also be confirmed that both higher income households and households with young children have more complex trip chains (Noland and Thomas 2007).

Travel choices are explained, in part, based on the spatial nature of residential location. Studies suggest that trip-chaining is becoming an increasingly common behavior, and that many factors influence trip-chain sequence (Levinson and Kumar 1995.) Residents of compact neighborhoods that exhibit multiple land-uses and which are transit and pedestrian-friendly, are more apt to make shorter trips and walk, or use transit, more than their neighbors in low-density areas (Ewing et al. 1994). Kitamura et al. (1997) contend strongly that trip generation is determined by demographic and socioeconomic characteristics and is not strongly associated with land use characteristic.

Urban Form and Commuting Efficiency

"Excess commuting," a concept first introduced by Hamilton (1982), refers to the additional journey-to-work travel represented by the difference between the actual average commute and the smallest possible average commute, given the jobs-housing distribution within a city. While Horner (2002) extended this concept of excess commuting, Ma and Bannister (2007) were the first to truly link urban form to commuting behavior.

Charron (2007) introduced groundbreaking research to the literature by suggesting that theoretical minimum and maximum commutes were not likely outcomes of the statistical distribution of commuting possibilities, but suggested that they were numerous commuting possibilities for different types of urban form. He called this approach, the "commuting possibilities framework". Yet another method proposed to evaluate the commuting efficiency of a city was proposed by O'Kelly and Niedzielski (2008, 2009), who explained urban form in terms of entropy, or degree of disorder in a system. Long commutes across the city resulted in "high entropy" measures, while short journeys-to-work resulted in "low entropy."

Spatially Disaggregated Land Use and Transit Data in Travel Demand Models

It is a widely accepted finding that transportation and land use patterns are closely related. There are a host of studies that have attempted to quantify the impacts of land use on travel behavior (Cervero 2002; Crane and Crepaeu 1998; Boarnet and Crane 2001; Boarnet and Sarmiento 1998; Frank and Pivo 1994; Giuliano and Small 1993). A classic methodology involves comparison of two models, one with and one without land use variables, in order to observe their effects. Measures of land use often include intensity of urban development, balance of land use patterns, accessibility of spatially separated destinations, and quality of transportation infrastructure. Travel behavior, on the other hand, encompasses mode choices, vehicle miles traveled (VMT), trip frequency, trip chain, and auto dependency (Cervero 2002; Cevero and Kockelman 1997; Srinivasan and Ferreira 1998; Zhang 2001).

Residential Dissonance and Travel Behavior

In recent decades, car use has rapidly increased around the world, especially in developing world regions, and congestion, pollution, and residential dissonance are commonplace, especially in cities. Residential dissonance denotes the incompatibility in land-use patterns between individuals' preferred residential neighborhood type and the type of neighborhood in which they currently reside. By adjusting the built environment, urban planners and geographers are attempting to minimize these problems. The push for sustainable communities, often referred to as "walkable communities," has been underscored by the New Urbanism movement in the U.S. and the Compact City movement in Europe, both of which target a reduction in car use and travel distances through high-density neighborhoods, diverse land-uses, and use of public transit (Cervero 1996; Friedman et al. 1994; Schwanen and Mokhtarian 2005a).

Building on the empirical studies that investigate the influence of the built environment on travel behavior, more recent research suggests that soft or 'subjective' variables such as personal lifestyle and attitude (in addition to the traditionally analyzed hard or "objective' variables such as the built environment and income) should be included when analyzing travel behavior (Mokhtarian and Cao 2008; Van Acker et al. 2011; Van Wee et al. 2009). For example, Van Acker et al. (2011) found that automobile use is related to family-oriented and/or active lifestyles. An individual who prefers to use public transit, may have an affinity for urban residential neighborhoods to facilitate use of this mode (Handy et al. 2005; Van Wee 2009).

Transportation-related Energy-saving Policies

Given the strong correlation between urban transportation and the production of carbon dioxide emissions, policies that aim to reduce emissions by saving energy in urban transport are critical. Policies of "urban compaction" encourage urban regeneration, the revitalisation of town centers, limits on development in rural areas, higher densities, mixed-use development, walkable communities, and the concentration of urban development at public transport nodes (IPCC 2007). Increasingly, policies that govern land use and transportation will guide the development of smart cities (Kii et al. 2014). In general, urban compaction policies strongly support reduction of carbon dioxide emissions and energy consumption without undermining resident welfare economically, socially or environmentally. We can interpret this to mean that energy efficiency and quality of life are closely correlated.

The world's people highly value mobility as it expands the realm of reachable destinations, and more opportunities that come with it. As economies become increasingly complex and specialized, wealthier and more technologically advanced, the demand for mobility of both persons and goods increase (World Business Council for Sustainable Development 2001). To put it simply, as developing countries madly rush to become industrialized and seek higher standards of living, the world's inhabitants will have to live within increasingly stringent environmental and resource constraints. Soon, North Americans will no longer be able to consume 25% of the world's resources, with only 5% of the population (Rowntree et al. 2013). Soon, disparities between and within nations will be greatly reduced and based on a more egalitarian society. If we are aiming for a socially and ecologically sustainable world, one that we agree has a finite amount of resources, energy saving policies need to be enacted immediately in all sectors, primarily in the industrial and transportation sectors.

While it is not realistic to revert back to non-motorized transport and public transport only, new aggressive energy-saving measures urgently need to be implemented. Petroleum, which has remained the dominant source of energy for transportation, is now the primary culprit when it comes to CO_2 accumulation in the lower atmosphere. CO_2 produced by combustion engines makes up 96% of all of transportation's greenhouse emissions, according to the US Environmental Protection Agency (EPA 2014).

With vehicular mobility on the rise, especially in developing countries, alternative energy vehicles may prove a viable answer to the economic and environmental problems created by traditional fossil fuels. Electric and hybrid-electric vehicles have the potential to reduce carbon emissions, help end the current dependence on limited fossil fuel supplies and improve energy security. The world's leading economies have increased their investment in alternative energy-based modes of transport in the last ten years

(Harder 2010). Until recently, no economies of scale were in place for alternative-fuel vehicle production, which makes them cost-inefficient (Ang and Lin 2011). Recent research from Princeton University offers some solutions to the fast-closing gap between the cost of traditional versus alternative-fueled vehicles: decrease initial purchasing price difference; decrease interest rate for loans; and increase the fuel price of gasoline (Ng 2011).

III. RESEARCH METHODS

Research Question

While quality research in the field of geography education has been growing, it has, historically, been in short supply (Downs 1994). Research regarding the intersection of transportation efficiency as a byproduct of geographical and spatial learning is even more limited, if not virtually non-existent. This study researches whether a communion between geographical learning and travel efficiency is a logical step in interpreting travel behavior, once enhanced spatial learning has occurred. The following research question drives the research methods selected for this study:

1. Can improved spatial awareness of the urban environment, coupled with energy conservation training, together referred to as geography education, evoke a measurable increase in travel efficiency?

In determining the answers to these questions, a mixed-method approach was used. The mixed-method design balances the strengths of both quantitative and qualitative methods. Quantitative data were collected using a trip log instrument, and eleven hypotheses, outlined in this chapter, were quantitatively analyzed using a one-tailed *t*-test for paired data. Additionally, six qualitative questions were used to generate 200 pages of student essay data. The essay data were analyzed using two methods, the segmenting and reassembling approach, and the scaling approach, in an effort to optimally interpret the relevance and significance of the essay data. The dual methods used for qualitative analysis are also discussed in depth later in this chapter.

Site Description of Present Research

The research was conducted is San Diego County, California. The County of San Diego claims that eighteen cities (plus many more unincorporated areas) make it the third largest county by population in the state at 3.3 million, and the sixth largest county in the country (County of San Diego 2015). All of the travel recorded by students in the trip logs occurred within this closed system of 4,500 square miles that comprises San Diego County. A site map of San Diego County is shown in Figure 1. This closed system is bounded by Mexico to the south, mountains and desert to the east, a large military base to the north, U.S. Marine Corps Base Camp Pendleton, and the Pacific Ocean to the west. In addition, the presence of major highways, an extensive network of surface streets, various modalities of public transit (i.e., light rail, passenger rail, commuter rail, and bus), and a strong pattern of urban sprawl, make it a good place to study urban travel behavior and potential changes to urban travel behavior, once geographical teaching and learning has taken place. Fair weather year-round makes walking and bike modes a viable alternative.

San Diego, California, was selected as the research site because it is my permanent, full time residence. San Diego Mesa College, the largest community college in San Diego County (25,000 students), one of three colleges serving the second largest community college district in California, was selected because it is my workplace and a group of student subjects are readily available. A convenience sample of two Human Geography lecture classes was conducted, and comprise the research population.

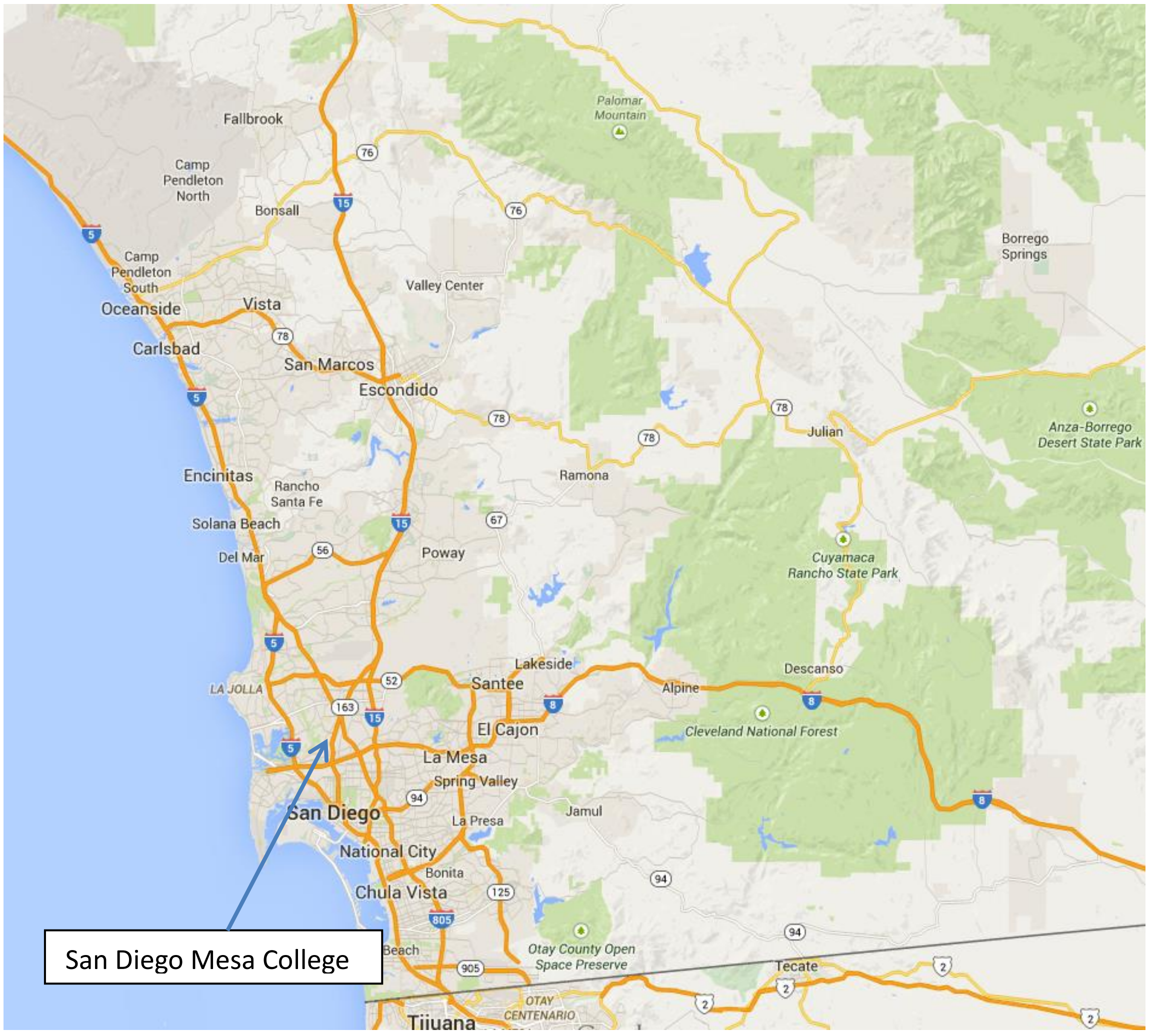

Figure 1: Site Map of San Diego County (source: Google Maps, 2014)

Hypotheses

The fifty-six Human Geography students kept “before” and “after,” trip logs of 14 days each (5 trips per average day), for a total sample of approximately 8,400 total trips. The sample of the two weeks of travel “before” geography education (treatment), or Phase I, was compared to the sample of the two weeks of travel “after” the geography education, or Phase II, i.e., baseline data (before), versus experimental data (after). Data sets were compared for significant differences in means according to the following research hypotheses $H_{A1....}H_{A11:}$

1. A statistically significant reduction in total number of trips will occur;
2. A statistically significant reduction in total miles traveled will occur;
3. A statistically significant reduction in total trip time duration;
4. A statistically significant reduction in average length of trips will occur;
5. A statistically significant reduction in average trip duration in minutes;
6. A statistically significant reduction in average number of miles traveled per day;
7. A statistically significant reduction in average number of trips taken per day;
8. A statistically significant reduction in average time duration of trips will occur;
9. A statistically significant reduction in proportion of auto trips will occur;
10. A statistically significant increase in proportion of trips taken by modes other than auto;
11. A statistically significant increase in percent trip-chaining will occur.

The null hypotheses, $H_{01}...H_{011}$, are that no statistically significant reductions will occur in Phase II.

Institutional Review Board Exemption

The Texas State University Institutional Review Board (IRB) approved an exemption for this research: application number EXP2012N3928. The project falls under the federal exemption category 1(ii) because the study researches "the effectiveness of or comparison among instructional techniques, curricula, or classroom management methods (Department of Health and Human Services 2009)." The certification of exempt status to conduct herein research is provided in Appendix A.

Data Collection

Pilot Study to Test Efficacy of Proposed Research

A pilot study (n=30) of students in a similar course, using a similar mixed-method approach, was conducted in Spring 2010, to indicate willingness and thoroughness of student participation. Though the data were not quantitatively analyzed, initial findings suggested that this method of data collection was not too rigorous, but instead, provided useful findings and promising energy conservation potential. Abrupt fluctuations in the price or availability of fuel and significant weather variability could affect the outcome of this study. However, neither scenario was reported during the period of data collection, i.e., price and weather fluctuations were, in effect, "held constant."

Travel Diary as Primary Instrument Guiding Quantitative Data Collection

Fifty-six students enrolled in a Spring 2012 Human Geography course used the survey instrument as part of their course requirements. Appendix B shows the original syllabus used for the course, detailing the geography education (treatment) and travel sustainability exercise. Data collection occurred during Spring Semester, 2012.

Data were collected using the trip log as the primary survey instrument. The trip log is a common instrument used for this type of research, and there is ample reference to it in the literature. Hubbard, an early proponent of travel diaries, extensively reviews literature on the topic of spatial and consumer studies, and, in doing so, proposes several strategies including time-activity budgets and travel diaries, the latter of which I have adopted in my research as part of my design (Hubbard 1978). Butcher and Eldridge (1990) also introduce the diary as a method of data collection. It is my primary quantitative data collection instrument.

In doing so, both the 1-day and 7-day diary is considered. A discussion of previous case studies that used a trip diary as the survey instrument was helpful in painting a picture of what is known in the field regarding this method of data collection. The research set out to determine what length of trip diary should be used when collecting journey data. Whether a trip log or diary is collected for one day or for seven days depends on the nature of the study (e.g., funding available, level of accuracy required, purpose of study, etc.).

I selected a two-week trip diary (as opposed to the commonly used 1-day or 7-day diary) to increase statistical accuracy. The trip log (instrument) for this research is shown in Appendix C and included the following variables:

1) Origin of trip;
2) Destination of trip;
3) Time of origin;
4) Time of destination;
5) Purpose of origin;
6) Purpose of destination;
7) Place of origin;
8) Place of destination;
9) Distance from origin to destination;
10) Mode of travel; and
11) Travel time for each trip.

The survey instrument also included odometer readings at both origin and destination for ease of distance calculations by the student traveler. A key, listing trip purposes, was also provided with the following values:

1) home;
2) work;
3) school;
4) shop;
5) recreation;
6) personal business;
7) social;
8) eat out;
9) go for ride; and
10) serve passenger.

Additionally, a key, listing trip modes, was provided with the following values:

1) car;
2) motorcycle;
3) bus;
4) trolley;
5) bike;
6) walk; and
7) other;

Data Collection Phase I

Two sets of trip logs were collected from each student. The first set of logs, a period I will call Phase I, was collected for two weeks, from March 12, through March 26, 2012. The instructor provided blank excel trip log forms, along with specific instructions about how to keep the logs, but did not provide any specific direction about the intent of the research. To be clear, the students were given the trip log instrument, and thorough instruction about how to fill it out. Trip logs were monitored and checked four times during the initial 2-week period. The trip recording went smoothly, and only two students were unable or unwilling to participate in the exercise. To the contrary, the trip logs were, by and large, very detailed, thorough, and neatly kept. Students asked insightful questions about the process each class period in an effort to clarify and refine any nuances of keeping a detailed, trip log diary. Student inquiries regarding the process covered a range of topics including clarification on: how to classify a trip by purpose, how best to calculate distance and time traveled, and how to record trip chains, and how to record trips when carpooling.

Immediately after the first set of two-week trip logs were completed and collected (Phase I), one month of intense geography education (treatment) occurred. During this time, through the teaching and learning of specific spatial analytic principles, along with philosophies of energy sustainability and conservation, students became better acquainted with their urban area and their impact on it. A series of exercises were introduced using the internet, maps and other geo-spatial learning tools, such as Google Earth, in order to cluster their trip destination along a rough "traveling salesman" circuit. The "traveling salesman problem" originated in mathematics and is widely used for purposes of planning and logistics. The traveling salesman's task is that, given a list of destinations and their pairwise distances, find the shortest possible route that visits each destination exactly once and returns to the origin destination (Applegate et al. 2006).

Demonstrations and discussions about travel efficiency, energy savings, sustainability, spatial analysis, the principle of least effort, gravity models, distance decay concepts, space-time prisms, the value of a person's time, and place utility were each included in the four-week instruction period. Each model was elaborated upon in the classroom, and explanations were given as to how the principles behind the models might be applied to the exercise that was being required of them (i.e., detailed trip log diaries). To facilitate understanding of the principles being presented in the classroom, a set of 63 powerpoint slides were introduced. In this way, students could learn the geographic principles through a visual representation that included maps and graphics. Students were also provided an electronic copy of the powerpoint slides on Blackboard, so that they could review the principles at home more thoroughly. (Appendix D contains the original 63 powerpoint slides that were presented during the geography education or "treatment" component.)

Data Collection Phase II

After the geography education (treatment) period, students resumed keeping trip logs for another two weeks, from April 30, through May 14, 2012. For the second set of trip logs, a period I will call Phase II, students were given an additional requirement. They were required to submit a DTP, one day in advance of their trips, for each day. These DTPs consisted of a city map, upon which students were required to draw lines over the network, to represent their intended travel paths for each trip, for each particular day (n=14 days). Maps were checked each class period for accuracy, for each day of recording, by the instructor, and homework credit carefully assigned per the course syllabus, the original of which is shown in Appendix B. Questions were also fielded by the instructor daily on email or by telephone, in an effort to provide instant assistance to students who had questions about the exercise.

To reiterate, each of the 56 students kept two "before" and "after" trip logs, of 14 days each yielding a total sample of approximately 8,400 total trips. The sample of the two weeks of travel "before" geography education (Phase I) was compared to the sample of the two weeks of travel "after" the geography education (Phase II), i.e., baseline data (Phase I), versus experimental data (Phase II), were compared for significant differences $(\bar{x}_{1,} - \bar{x}_2)$ in means according to:

- Total number of trips;
- Total miles traveled;
- Total trip time duration;
- Average length of trip;
- Average trip duration in minutes;
- Average number of miles traveled per day;
- Average number of trips taken per day;
- Average time duration of trips;
- Average number of auto trips;
- Average number of trips taken by modes other than auto; and
- Percent trip-chaining before and after

The samples "before," and "after," contained exactly two weeks' worth of trips, i.e., seven days per week, Monday through Sunday, with no holidays included. The two sample periods, Phase I and Phase II, were carefully selected so that they were identical in terms of the total number of days of school and/or typical workdays (ten), number of weekend days (four), number of holidays (zero), and number of expected unusual circumstance to deter the comparability of the sample periods such as a spike in gas prices or inclement weather (zero).

Upon completion of the course, students were also required to conduct simplistic, preliminary calculations of the trip log data and submit these calculations on a two-page summary sheet that was provided by the instructor. Students were given thorough directions on how to fill out the two-page summary calculation sheet. (This two-page summary calculation sheet is shown in Appendix E.) The trip logs themselves, as well as the calculation sheets were rechecked by the instructor for errors and an independent party prior to running statistical analyses.

Essay Questions as Primary Instrument Guiding Qualitative Data Collection

In addition to the quantitative assessment, the analysis also included a qualitative assessment. Each student was asked to describe their response to the overall attempt to generate energy and travel time savings and efficiencies by responding in written format to the six following essay questions shown below as they appear in the original instrument (Original qualitative instrument shown in Appendix E):

1. Were any of your 12 calculations significantly different from TRIP LOG I TO TRIP LOG II? Summarize your numerical calculations.
2. Please evaluate, to the best of your abilities, the 60 sustainability SLIDES and instruction given in class and on the e-mail, which included models of efficient

travel behavior such as the traveling salesman trip chaining, carbon footprint, value of time, the principle of least effort, etc.

3. Summarize the effect that this sustainability exercise has had on your awareness of the true costs of travel? Describe value of time savings Have you saved any time? Any money?
4. Summarize the effect that this SUSTAINABILITY TRIP LOG exercise has had on your ability to make more efficient and sustainable travel.
5. Will you be able to make any sustainable changes in your travel in the future because of this exercise? What are your intentions?
6. What would it take for you to become permanently more sustainable in your daily travel in the future?

IV. ANALYSIS AND RESULTS

Because data were collected from the same group of students, both before and after geographic instruction/learning took place in the classroom, dependent samples were generated. The four weeks of trip log data collected were quantitative, ratio data, and could be analyzed using the paired *t*-test for dependent means, also called the mean difference *t*-score, or the paired student *t*-test. Dependent samples (or "paired") *t*-tests generally consist of a sample of matched pairs of similar units (i.e. numerical data from Phase I versus Phase II), or one group of units that has been tested twice. This is also referred to as a "repeated measures" *t*-test (Zimmerman 1997).

In this case, the geography education served as the independent variable or “treatment,” and the trip log data (e.g. total number of trips taken, total number of vehicle miles traveled, total trip time duration, etc.), served as the dependent variables or “outcomes.” The trip log data was spot checked by me and another independent party, a student biomedical researcher at University of California – San Diego (UCSD), to ensure that simple calculations on the trip log instrument (such as distance traveled and trip duration) were recorded accurately. Partially completed trip logs were removed. With the spot-checking of the trip logs complete, I turned my attention to checking the two-page summary calculation sheet (comparing Phase I and Phase II). The students were required to submit the calculation sheet at the end of the course, therefore, putting the preliminary burden of early number-crunching on the students. This exercise, however, was twofold. Not only did the students conduct some of the number-crunching, but, in doing so, they got the opportunity to see some of their results quantitatively. In other words, students were immediately able to see if they had taken fewer trips, for example, during Phase II, the second trip log period.

After the independent party, a student biomedical researcher at University of California – San Diego (UCSD), and I, thoroughly checked the two-page summary calculation sheets submitted by each student, the numerical data was ready to be submitted into excel format. Once the data was entered into excel format, it was uploaded into SAS (Statistical Analysis System). A paired *t*-test was used to look for a significant difference between the first two weeks' travel data (Phase I) and the second two week travel data (Phase II) were calculated.

The observations were based on 49 student respondents. Students 5, 7, 11, 21, 30, and 31 from Monday's class, and student 12 from Tuesday's class were not considered due to faulty recording. To reiterate, for accuracy purposes, all numerical calculations were initially conducted by students after thorough, in-depth direction was provided in the classroom regarding methods for generating necessary calculations. Once calculations were submitted upon semester closing, a majority of the calculations were spot-checked by me and two independent analysts, a student biomedical researcher at University of California – San Diego (UCSD), and a professor emeritus from San Diego State University.

In addition to keeping a somewhat standard trip log for a period of four weeks (two weeks "before" and two weeks "after" geography education), the students were also asked to submit a daily trip plan (DTP) for Phase II, the second two weeks of log-keeping. The DTP is similar to the concept of flight plans, which are documents filed by pilots, prior to departure. The aviator's flight plan, includes departure and arrival points, estimated time en route, and alternate landing locations, etc. (FAA 2012). The students participating in this research were required, for the second two weeks of trip planning, to create a daily DTP or flight plan, in addition to each daily trip log. The flight plan, or what I refer to as a DTP, was designed to be created daily, (or the night before) prior to any travel for the day has been conducted (Appendix B- course syllabus noting required student participation).

In other words, the students that participated in this experiment were required, like a pilot, to create an a priori sketch map (the DTP), requiring them to employ geographic knowledge and spatial planning skills, before they made any trips for the day. No students were chastised if their actual travel deviated from their DTP for a particular day. However, prior trip planning, using the DTP, was stressed, much like the use of "to do" lists, for people who plan their day in advance. Students were encouraged to use an online mapping tool, such as Google Maps, to provide a road network upon which students would plan their routes before undertaking travel. Sample DTPs are shown in Appendix H. The original unaltered base maps that were used as a template from which to create an individualized DTP have been reprinted in this dissertation with permission from Google (Appendix I).

Restatement of Basic Research Question

Can geography education (treatment) and prior planning of daily activities cause a reduction in wasted travel and repetitive behavior? This was the fundamental research question that drove all aspects of this study.

No literature using "before" and "after" trip logs, nor anything suggesting something like the personal DTP (a term I coined completely within the context of this research) has been found in the literature except for computerized fleet route planning for large companies like UPS or the US Postal Service. Yet the DTP seems a viable approach toward sustainability in 2015, in the face of upward trending gasoline prices. Meanwhile, the urgent need for sustainable practices is front and center, as our planet's resources rapidly deplete, threatening to soon lower the quality-of-life for citizens of the developed world.

Besides the quantitative assessment described above, the analysis also includes qualitative essay portions in which each student was asked to describe their responses to the overall attempt to generate energy and travel time savings and efficiencies. (Sample student essays are shown Appendix H.) Due to the large volume of data to process, an exhaustive effort to determine if the research questions were answered was needed. Toward this end, two distinct analysis approaches were adopted to best interpret the relevance and significance of the essays. The first method, a segmenting and reassembling method, called for the development of a coding tool to assist in the data processing. This tool, developed by the researcher, is shown in Appendix F. The second method, a scaling method, required the researcher to rank and convert essay data by using a Likert scale. This matrix is shown in Appendix G. Both qualitative methods are discussed in more depth later in this section.

Quantitative Findings

Paired comparison tests were used since the data consisted of two related measurements. My dissertational research presented a “before and after” experiment in which measurements were taken on the same subjects both before and after they were exposed to some intervening treatment, e.g., geography education. As such, the one-tailed *t*-test for difference of means for paired observations was the appropriate parametric inferential procedure (McGrew and Monroe 2000). In doing so, the differences between each pair of measurements were obtained and the resulting sample differences were analyzed. My primary motive was determining whether or not I could conclude that the mean differences were significantly different from zero for each of the hypotheses.

After removing partially completed trip logs, the results of the paired *t*-test testing for a significant difference the first two weeks’ travel data recorded (Phase I) and the second two week travel data recorded period (Phase II) were calculated. These are given where noted. The observations that follow are based on forty-nine student respondents. Students #5, #7, #11, #21, #30, and #31 from Monday’s class, and #12 from Tuesday’s class, were not considered due to faulty recording. All numerical calculations were initially conducted by students after thorough, in-depth direction was provided in the classroom regarding methodology for generating necessary calculations. Once calculations were submitted upon semester closing, the calculations were spot-checked by three independent analysts. Partial responses and gross numerical miscalculations resulted in the removal of seven respondents from the quantitative analysis. (There were fifty-six respondents in the qualitative, however, but only forty-nine in the quantitative analysis).

H_{A1} – Total Number of Trips Taken

The paired sample *t*-test for mean difference between Phase I trips taken and Phase II trips taken was statistically significant (mean difference = +5.3061, t = 2.9628, df = 48, p = 0.0047). Sixty-five percent of students reported taking fewer trips during the second trip log period, or Phase II. The average savings during Phase II was 5.3 trips per student. A discussion of the factors contributing to an increase in travel for a handful of respondents during Phase II is discussed later in the manuscript. Based on this analysis, H_{A1}, which stated that a statistically significant reduction in total number of trips will occur, the H_0 was rejected. Table 2 summarizes these findings.

H_{A2} – Total Number of Vehicle Miles Traveled, All Trips

The paired sample *t*-test for mean difference between Phase I total vehicle miles traveled (VMT) and Phase II total VMT was not statistically significant (mean difference = +22.5320, t = 1.5974, df = 48, p = 0.1167). Though the findings were not statistically significant, 59% of students reported fewer total VMT during Phase II, with an average savings of 22 miles per student during Phase II. Based on this analysis, $H_{A2,}$ which stated that a statistically significant reduction in total miles traveled will occur, I failed to reject the H_0. Table 2 summarizes these findings.

H_{A3} – Total Trip Time Duration, All Trips

Question three asked students to calculate their total time duration for all trips during the second week period. The paired sample *t*-test for mean difference between Phase I total trip time and Phase II total trip time was statistically significant (mean difference = +97.0204, t = 2.8843, df = 48, p = 0.0059). Sixty-one percent of students reported shorter total trip duration during the Phase II. Only thirty-nine percent of students reported more time duration during the Phase II. The average total travel time decrease per student from Phase I to Phase II was 97 minutes, an average savings of seven minutes per day for the two-week period. Based on this analysis, $H_{A3,}$ which stated that a statistically significant reduction in total trip time duration will occur, the H_0 was rejected. Table 2 summarizes these findings.

H_{A4} – Average Number of Miles per Trip

The paired sample *t*-test for mean difference between Phase I miles per trip and Phase II miles per trip was not statistically significant (mean difference = -0.1987, t = 1.0257, df = 48, p = 0.3102). Though the findings were not statistically significant, 51% of students reported a reduction in average number of miles per trip in Phase II. Forty-nine percent of the students reported traveling more miles per trip during Phase I. In light of the percentages, however, the average number of miles per trip overall ended up increasing by a slight 0.2 miles during Phase II, suggesting that a portion of respondents were making notably longer trips in Phase II. Based on this analysis, H_{A4}, which stated that a statistically significant reduction in average length of trips will occur, I failed to reject the H_0. Table 2 summarizes these findings.

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H_{A5} – Average Trip Duration in Minutes

The paired sample t-test for mean difference between Phase I trip duration and Phase II trip duration was not statistically significant (mean difference = +0.3545, t = 1.0873, df = 48, p = 0.2823). Though the findings were not statistically significant, 55% of respondents reported reducing the elapsed time per trip during Phase II. The average number of minutes saved per trip in Phase II was less than one minute. Based on this analysis, H_{A5}, which stated that a statistically significant reduction in average trip duration in minutes will occur, I did not reject the H_0. Table 2 summarizes these findings.

H_{A6} – Average Number of Miles Traveled per Day

The paired sample t-test for mean difference between Phase I miles traveled per day and Phase II miles traveled per day was not statistically significant (mean difference = +1.6502, t = 1.6250, df = 48, p = 0.1107). Though the findings were not statistically significant for hypothesis six, 57% of students reported that their average number of miles traveled per day in Phase II declined. The average mileage saved per day during Phase II was 1.65 miles per respondent, or a total of 23 fewer miles traveled for the duration of Phase II. Based on this analysis, H_{A6}, which stated that a statistically significant reduction in average number of miles traveled per day, I failed to reject the H_0. Table 2 summarizes these findings.

H_{A7} – Average Number of Trips Taken per Day

Question seven required students to calculate their average number of trips taken per day. The paired sample t-test for mean difference between Phase I trips per day and Phase II trips per day was statistically significant (mean difference = +0.3898, t = 2.9646, df = 48, p = 0.0047). Seventy-one percent of respondents reported fewer trips taken per day in Phase II. The average number of trips saved was 0.4 trips per day per student. Only 29% of students reported more trips taken per day during Phase II. It may be interesting to note that the average number of trips taken per day by each respondent was 3.9 in Phase I and 3.5 in Phase II, which roughly equates to a 10% reduction in travel during Phase II. Based on this analysis, H_{A7}, which stated that a statistically significant reduction in average number of trips taken per day will occur, the H_0 was rejected. Table 2 summarizes these findings.

H_{A8} – Average Time Duration of All Trips per Day

The paired sample t-test for mean difference between Phase I trip time duration and Phase II trip time duration was statistically significant (mean difference = +7.1346, t = 2.9379, df = 48, p = 0.0051). Sixty-three percent of students reported a shorter trip duration during Phase II. Their average time reduction was 7 minutes per student per day. Only 37% percent of students reported a greater time duration during Phase II. Based on this analysis, H_{A8}, which stated that a statistically significant reduction in average time duration of trips will occur, the H_0 was rejected. Table 2 summarizes these findings.

H_{A9} – Proportion of Auto Trips Decline

The paired sample t-test for mean difference between Phase I proportion of auto trips and Phase II proportion of auto trips was not statistically significant (mean difference = +0.0292, t = 1.4658, df = 48, p = 0.1492). The percent of trips made by auto declined from approximately 86% in Phase I to approximately 83% in Phase II. Though this is a three percent reduction in percent trips made by auto, the proportion was not statistically significant. A majority reported no other modal use of transportation besides the automobile, yet, as students experimented with public transit, the number of auto drips declined slightly when compared to other modes. Based on this analysis, H_{A9}, which stated that a statistically significant reduction in average number of auto trips will occur, I failed to reject the H_0. Table 2 summarizes these findings.

H_{A10} – Proportion of Trips Taken by Modes Other than Auto

The paired sample t-test for mean difference between Phase I proportion of trips other than auto and Phase II proportion of trips other than auto was not statistically significant (mean difference = -0.0147, t = 0.9985, df = 48, p = 0.3230). Approximately 15% of trips in Phase I were made by forms of transport other than the automobile, while that percentage increased to approximately 17% in Phase II. Though the findings were not statistically significant, students increased their use of alternate forms of transportation by approximately two percent. Based on this analysis, H_{A10}, which stated that a statistically significant increase in average number of trips taken by modes other than auto will occur, I failed to reject the H_0. Table 2 summarizes these findings.

H_{A11} – Percent Trip-Chaining Increase

The paired sample t-test for mean difference between Phase I trip chaining and Phase II trip chaining was not statistically significant (mean difference = +0.0119, t = 1.2065, df = 48, p = 0.2336). Although the findings were not statistically significant, during Phase I, 26% of respondents' trips did not originate at home. During Phase II, 27% of respondents' trips did not originate at home. Based on this analysis, H_{A11}, which stated that a statistically significant increase in percent trip-chaining will occur, I failed to reject the H_0. Table 2 summarizes the quantitative findings.

TABLE 2

SUMMARY OF MEAN DIFFERENCES (p_2-p_1), N= 49

Factor	Output	p	Significance
Trips Taken	Decreased	0.0047	S
Vehicle Miles Traveled, All Trips	Decreased	0.1167	NS
Trip Time Duration, All Trips	Decreased	0.0059	S
Miles per Trip	Increased	0.3102	NS
Trip Duration in Minutes	Decreased	0.2823	NS
Miles Traveled per Day	Decreased	0.1107	NS
Trips Taken per Day	Decreased	0.0047	S
Duration of All Trips per Day	Decreased	0.0051	S
Proportion of Total Trips made by Auto	Decreased	0.1492	NS
Proportion of Trips Taken by Modes Other than Auto	Increased	0.3230	NS
Percent Trip-Chaining	Increased	0.2336	NS

Qualitative Findings

Students were asked to write essays on six questions regarding the trip log/travel sustainability exercise. (Appendix E displays the original qualitative instrument.) Over two hundred pages of student qualitative responses were examined. Due to the large volume of data to process, an exhaustive effort to determine if the research questions were answered was needed. Toward this end, two distinct analysis approaches were adopted to best interpret the relevance and significance of the essays, a segmenting and reassembling method (active coding), and a scaling method (Likert scale).

The findings for both approaches will be discussed, in turn, for each of the six essay questions. A twenty-five percent random sample (n=14) of student essay response paragraphs was selected for illustration purposes in this dissertation. Some of these sample student responses have been transcribed and are included, sequentially, after the findings for each question are presented. In an effort to uphold accuracy in reporting, quotes from respondents are verbatim. Some quotes have been abbreviated by the author, however, spelling, grammar, and content have not been edited, except in the case where it wasn't legible in its original form. Additionally, respondents' full nomenclature has been withheld for anonymity purposes and instead, assigned a case number, depicted at the end of the excerpt.

Segmenting and Reassembling Method

The first approach involved the segmenting and reassembling of the data, the principal activities of qualitative data analysis (Boeije 2010). The initial step included the segmenting of the data into relevant categories and the naming of the categories with codes while simultaneously generating the categories from the data. The generation of categories and codes was driven by the six topical essay questions, shown below, that the students were given as a guideline for forming their essay responses.

1 Were any of your 12 calculations significantly different from TRIP LOG I TO TRIP LOG II? Summarize your numerical calculations.

2. Please evaluate, to the best of your abilities, the 60 sustainability SLIDES and instruction given in class and on the e-mail, which included models of efficient

travel behavior such as the traveling salesman trip chaining, carbon footprint, value of time, the principle of least effort, etc.

3. Summarize the effect that this sustainability exercise has had on your awareness of the true costs of travel? Describe value of time savings. Have you saved any time? Any money?
4. Summarize the effect that this SUSTAINABILITY TRIP LOG exercise has had on your ability to make more efficient and sustainable travel.
5. Will you be able to make any sustainable changes in your travel in the future because of this exercise? What are your intentions?
6. What would it take for you to become permanently more sustainable in your daily travel in the future?

Once the relevant categories or themes were identified, they were then placed in meaningful groups. Additionally, code trees were generated within each category. In this way, a master code sheet was developed. Each of the fifty-six student essays was then analyzed using this assessment tool. Specifically, each respondent's essay was then reviewed, and tallies noting the frequency of each code were made. (The code sheet, or qualitative coding tool, is shown in Appendix F).

Reassembling the data required the researcher to synthesize the results of each of the fifty-six code sheets, and convert the comprehensive tallies into a percentage. The end result transformed the data into some very powerful interpretations of the six essay questions first provided to the student.

Scaling Method

In the second approach toward qualitative data analysis, responses for five of the six essay questions (for all fifty-six student respondents) were converted to a psychometric Likert five -point scale by the researcher, with "1" representing "very positive", "2" representing "positive", "3" representing "neutral", "4" representing "negative", and "5" representing "very negative," in relation to the question proposed. The researcher read all 56 student responses to question one, and, using skilled judgement, assigned a Likert score to each of the 56 essays after analyzing the content of the passage, and keeping in mind the comparative content of the other 55 responses to question one. If, for example, the written response for the student was extremely or overwhelmingly positive, a score of "1" was assigned. If the student response was extremely negative concerning the question asked, a "5" was assigned, etc. After question one was fully analyzed, all of the responses to question two were then discretely analyzed, and so on. Assigned scores were entered into a Likert matrix, with rows representing all fifty-six student essays, and the columns representing the five-point Likert score for each question. The average Likert value was then calculated for each question. (This matrix is shown in Appendix G).

Question #1: Findings

The first question that students were asked to respond to in essay format posited the following question, "Were any of your 12 calculations significantly different from Trip Log 1 to Trip Log 2? Summarize your numerical calculations." As a reminder to the reader, terms Trip Log 1 and Trip Log 2, jargon used at the time of data collection, have been subsequently referred to as Phase I and Phase II in the context of the written dissertation.

Question #1: Segmenting and Reassembling Method

With regard to the first question, using the segmenting and reassembling method, fully sixty percent of the respondents reported a reduction in both total travel time and the number of trips taken between Phase I and Phase II. Additionally, seventy-two percent of the respondents reported that the miles traveled actually declined in the second trip log, or Phase II. These two results alone suggest that the geo ed travel reduction experiment posed by this research was extremely successful!

Those respondents who did not report a decrease in travel time, number of trips taken, or total vehicle miles traveled in Phase II, indicated that the underlying reasons for no observed savings could be attributed to factors such as increased bike usage (and, therefore, increased travel time and increased numbers of short trips), very unusual or atypical circumstances such as getting a job across town, or having to travel to Los Angeles to visit a sick relative (thus greatly increasing typical number of vehicle miles traveled in a given time frame). Such answers played into the experiment. Others reported that they had no decrease in travel time, number of trips, or miles traveled because they were already, absolutely efficient, and did not need to make any changes to their travel behavior.

Question #1: Scaling Method

Using the scaling method to analyze written responses to the first question, the results were, again, extremely positive, overall. The average Likert scale value for this question was a 1.893. Students reported overwhelmingly that there was a significant difference in trip-making between Phase I and Phase II. The numerical calculations showed that this strong and significant difference was due to a reduced number and duration of trips during Phase II. Two hundred pages of student qualitative responses attested to these results and excerpts from student essays follow.

Question #1: Sample Student Responses

David stated, "I find that the total number of trips taken, total number of vehicle [miles] traveled and total number of trip time duration calculations were significantly different from Trip Log 1 comparison to Trip Log 2. For instance, on the second trip log, because I was planning my trips, I ended up with 18 less trips, 44 miles les traveled, and saved 81 minutes of my time. With my cost of travel being 40.76 per mile (see [calculations] below), the amount I save on my second trip log is roughly $33.44. Not to mention the wear and tear of my vehicle and a peace of mind. Comparing the two trip logs, I calculated that I saved on average 3 miles per day and lessen my minutes of duration per trip by 3 minutes and 6 minutes duration saved of trips per day. Cost of Travel: Operating cost: Truck: 17 mph, $4.00/17=$0.48. Time Cost: Wage $17 per hour – 17/2, $8.5/30mps (avg) = $0.28. Operating Cost = time Cost: $0.48 = $0.28 = $0.76/mile." n=T4

Nicole states, "None of my calculations were significantly different. I already employ the idea of putting forth the least amount of efforts to get the maximum result. I preplan my trips daily so as to save time and gas. If this exercise were not already a daily ritual for myself I believe the results of the trip log experiment would have varied greatly." n=T2

William says, "Surprisingly, segment 1 had less trips than segment 2 – 47 and 50, consecutively – but despite this increase in trips, I had a much larger decrease in mileage (segment 1 VMT 242 and segment 2 VMT 131.75). Another interesting number was time spent on travels. I spent 667 minutes traveling during segment 2 and 594 during segment 1. This is directly related to the number of trips taken by modes other than auto. This was a 0.15 for segment 1 and more than doubled at 0.36 for segment 2. The numbers regarding chaining and going home between trips were less significant for me. …The reason for more trips in segment 2 than segment 1 was simply because I utilized my bicycle and local walking capabilities to their fullest during segment 2. This includes walking to the grocery store, restaurants, social gatherings, and riding my bicycle to the pool, work, and anywhere else I wanted to go and was not in a hurry. These trips were so easy to take that I ended up taking more of them and enjoyed them because I was not watching the gas dial go down. It is these trips that were logged as the 'other than auto trips' and that is why it was more than double for segment 2." n=T5

Michael commented that, “The traveling salesman method was easily implemented into my schedule due to my student life being split between two campuses, and work often being attached within the same day. This yielded to smaller gains that could be applied almost on a daily basis, making trip-chaining the largest contributor to streamlining my travel distance and travel time. In comparison between the first and second week, the calculations underline a significant impact of trip planning on the efficiency of travel. There is a sizeable decrease in the number of overall trips, which can be attributed to trip-chaining. Subsequently, there is also a large amount of distance that has been shaved from the total in the second week. This in turn, of course, led to a difference in the amount of time spent traveling overall. The true impact however can be felt in the subsequent calculations. The average number of miles and time spent on any given trip were completely unchanged. The number of trips decreased by a staggering total of 25%. This means that although the average time and distance of of trips were the same, the overall distance and time have been significantly reduced. Considering that almost all of the destinations in my travel log were of fixed origins, a 25% increase in efficiency could translate to huge monetary, time, and environmental savings.” n=T6

Aaron made the following comments, “During Log II, I made one less trip, traveled 8.5 fewer miles (reducing total trip time by 158 minutes), reduced the number of miles per trip by an average of 4.09, reduced the average time of each trip by 7.94 minutes, reduced my average miles per day by 1.13 miles, reduced my average travel time per day by 22.57 minutes, reduced trip-chaining by 15%, and reduced the number of home-based trips by 26%...As I don't drive, automotive trips were achieved by asking friends for rides." n=T7

Kaleena stated the following, "Due to my tight schedule, I anticipated my figures to roughly be the same between the two periods that we compiled data, but I was excited to see that there was a difference. Right away when I made my first Daily Trip Plan (DTP) I saw ways to chain my trips a bit more. As a result, not only did I make fewer trips in the second two-week period, and there were approximately 26% more chained trips (0.269). In addition to reducing the amount of miles driven (34.4 miles), I eliminated 83 minutes spent in my vehicle. That time was better spent studying or sleeping than sitting in the car." n=T8

Talina commented that, "It goes without saying, that by decreasing my miles traveled by 385 miles, I too was able to lower the total trip time duration during a two week period from 1,508 minutes to only 899 minutes in my second two weeks of this project. This astonishing 609 minute difference allowed me to add ten hours and fifteen minutes of much deserved 'me time' to my schedule this past two weeks." n=T9

Jeff said, "The total number of trips from Log I to Log II decreased from 80 to 60; a decrease of 25%. I attribute this decrease to a number of factors ranging from planned trip-chaining to reducing unnecessary trips such as for meals. With an average of 6.4

miles and 11.425 minutes per trip (Log I), a decrease of 20 trips is significant in terms of sustainability. This should translate to a savings of 128 miles and 228.5 minutes by multiplying the averages with the 20 trips reduction. Data from Log II supports this – from Log I to Log II, differences of 126 miles and 279 minutes were calculated. Trip-chaining has reduced the amount of trips originating from and arriving to home, which reveals the unnecessary nature of returning home in between trips. It is best to prepare for trips the day before heading out in order to maximize trip-chaining as much as possible. Preparing for trips of the day can best be thought of in terms of eliminating normal reasons for going home such as changing clothes, taking care of hygiene, eating food, packing necessary things, etc." n=T14

Michael made the following comment, "I have started collaborating with my roommates and neighbors to make other substantial changes in the way we travel after explaining this project to them and noticing how much we all make needless trips and spend money on gas and time when it is not needed." n=T19

Timothy said, "In trip log II the average number of miles traveled per day was 33.43 compared to 44.86 miles per day in trip log I. The average time duration for trips per day on trip log II was 36.71 minutes per day and that's a big decrease from trip log I with 45.64 minutes per day. After going over the calculations I've concluded that being more sustainable saves money and time by planning out your day like a traveling salesman." n=T20

Robert stated, “ This semester-long [geo ed/mapping] activity was one that I initially thought was going to teach me nothing and just be a waste of time, but the further along I went with it, I came to realize how important this type of information could be to various types of people. Having visual aids showing how often I travel and where I go, will help me in the future planning where exactly I would want to live.” n=T21

Question #2: Findings

The second essay question asked, “Please evaluate, to the best of your abilities, the 60 sustainability slides and [geography education] instruction given in class and on the electronic blackboard (e-mails), which included models of efficient travel behavior such as the traveling salesman trip-chaining, carbon footprint, value of time, the principle of least effort, the Daily Trip Plan (DTP), etc.”

Question #2: Segmenting and Reassembling Method

Approximately ninety-six percent of the students reported positive and helpful comments regarding the geographical education, instruction, slides power points and documentation concerning efficient travel making. This result is extremely encouraging since the main thesis of this dissertation was that geographical education could make a difference in people's travel behavior, environmental consciousness, and sustainable behavior. A handful of respondents reported that they felt very strongly that this instruction should be a required state mandate and that such geographic education should be a part of the California State driving test to receive one's driver's license. Another student was very adamant that such geographic education be a part of the high school curriculum in the state of California for drivers' education because of the beneficial nature and the predisposition of such geographic education towards sustainable travel and efficient trip-making for the future generations.

Question #2: Scaling Method

The average Likert score for question two relating to training evaluation by students revealed a 1.339, and therefore judged as extremely positive, by most all accounts. According to student responses and essays, the spatial analysis, sustainability, and geography education material and its presentation was extremely significant in helping students move in the direction of a more sustainable urban travel lifestyle. Two hundred pages of student qualitative responses attested to these results and excerpts from student essays follow.

Question #2: Sample Student Responses

Danielle said, "The 60 sustainability slides explained what the principles of sustainable transport are. Sustainable transport is an approach to transportation that meets the needs of all segments of society while minimizing environmental, societal, and economic costs. The slides brought forth geography education ideas of what and why society needs to change and implement to reduce their carbon footprint. Some of the ways to do this were expressed by showing us how to shorten our travel distances and highlighting how what we do and where we live determine much of our ability to travel shorter distances. They also covered how much of our time, money and energy goes into our transportation needs… impact on the environment and where the world's oil comes from. The instructions for the assignment were for the first two weeks, records all of your stops, mode of transportation, the time and distance you traveled. You were not to change what you normally would do in that time. During the next two weeks [after the month of geography education in the classroom] you were to try and reduce your travel distance to see if you could reduce your carbon footprint. We also mapped out or days' travel plans the day before to see if we could reduce our travel distance by combining trips, not going home as much and by looking at an actual physical map and drawing out our plans, seeing if there was a shorter route." n=T1

Ralph commented, "Because I completed a daily trip plan map (DTP) before each trip on the second trip log I find that I become more aware of all the things I have to complete, like getting a haircut, picking up groceries, getting gas, and lunch. Without prior planning I would have otherwise added more trips to my log which would involve additional cost of travel. Without question I learned how to become more of an active participant in my surrounding with the different kinds of services available, by planning my daily trip, rather than an observant. I find it better knowing what I need to accomplish rather than guessing or acting on an as-needed basis." n=T4

Michael said, "The two rules that stood out to me during the presentation were the hierarchy of efficiency when it came to modes of transportation, and the traveling salesman method." n=T6

Aaron noted the following, "Due to its efficiency, I attempted to follow the traveling salesman model of trip-chaining to become more sustainable in my travel. The use of the Daily Trip Plans greatly aided in this when I was required to travel to more than one non-home destination." n=T7

Kaleena makes the following observations, "The information that we went over in class was vital to our understanding of calculating out value of time, which in turn helped for me to see the value to make changes…I did find the principle of least effort and the value of time to be the most meaningful for me…" n=T8

Talina said, "The traveling salesman model is designed to take a predetermined set of locations and calculate the most efficient way to reach every location once and then return to the origin…Trip-chaining is combining multiple errands into one trip that will help save gas, money and time. Doing this and planning what I needed to have done during the course of the day and over the two week period, I was able to get more tasks done, in less time, and with less gas because I eliminated the need the backtrack to places I had already visited." n=T9

Rafael made the following assertions, “One of the sustainability slides that I found interesting was the ‘mobility vs. accessibility’ slide. I never imagine my geographical location to be a factor on the house that I should live in. I always consider the area, and the cost to live there…this slide shocked me was how I should look into the distance it will take me to get to a certain place, and how much time. The closer I am to a shopping center, or business, the likelihood of me saving time and money…If it wasn’t for having to figure how much my time was worth, I wouldn’t have noticed how much I waste time driving, and how much money I actually lost being behind the wheel; especially when I am driving when I could of taken another mode of transportation. Since I am currently a salesman, the salesman transportation method worked flawlessly for me. I was making fewer trips and getting more stuff done at any given day.” n=T10

Benjamin stated, “My first thoughts when the ‘traveling salesman’ vs. ‘wheel-and-spoke’ came up in class were something along the lines of ‘is this not common sense?’ It is, of course, but I’m sure we both find ourselves often reminded that ‘common sense’ is not at all common. In that same vein, there was very little in the presentations that I haven’t heard before, but please, do not be offended; I was simply that nerdy kid that preferred watching the ‘Discovery channel’ far more than I did sitcoms and other forms of intellectual junk food…As far as the concept of putting a value on my time, I find this something I’ve never really thought of before, and still have a hard time putting a dollar value on time…thus, coming up with a hardline monetary value [of my time] is difficult, but to answer the ‘what is the minimum amount of money required to lose between 7 pm and 8 pm on Wednesday nights' question, I'd wager I'd do it for $24, or $12/hr." n=T12

Manuel noted the following, "The [geo ed] instruction given in class, on the e-mail, and through the slides made me aware of how wasteful we can be without us noticing it. For example, I did not know that traveling like a salesman saves significantly total miles traveled in a day. I did not see time as have value. Traveling by car has costs greater than just the fuel spent. Also, the attachments of the slides provided on e-mail made it easy for me to review what was taught in class afterwards." n=T16

Bumwoo said, "The PowerPoint presentation slide showed the evaluation of mobility and its relationship to time and money. There are many modes of transportation ranging from cycling to public transportation. Everything has an economic and time value to it and the decisions you make determine the outcome for your actions. One topic covered was accessibility vs. mobility. Instead of zigzagging your way through your daily routines, it is a much more wise choice to plan out your day and take routes that would be most optimal for you. Our duties were to record how many miles travelled, the amount of time it took to get there, the time duration spend, and our mode of transportation for that course." n=T18

Michael commented, “This sustainability project, geo ed, and DTP, has had a major effect on the way I think about traveling and the way I will travel from now on.” n=T19.

Kyle made the following observations, “The [geo ed] slides, and lectures during class about sustainability were very interesting. I thought that I was being cost efficient during my use of my vehicles, but found out that there was plenty more that I could use to make use of my time and money. With my house being so far away from my work, and school, the traveling salesman is definitely a skill I will master. It has made me more aware of things I can do to prevent trips back home, which would put a huge strain on my wallet.” n=T22

Question #3: Findings

The third essay question asked, “Summarize the effect that this sustainability exercise has had on your awareness of the true costs of travel. Describe value of time savings. Have you saved any time or money?”

Question #3: Segmenting and Reassembling Method

The students, by and large, reported an overwhelmingly increased awareness of the need and method of sustainability of travel based on this simple exercise. Approximately eighty-eight percent reported a better awareness of the total cost of travel and approximately eighty-two percent reported a greater awareness of time savings due to the sustainability exercise and conservation activities proposed in this study.

Two percent of respondents reported no better awareness, and four percent reported that they are already aware of most all sustainability dimensions before instruction was given. Again the geographical education presentations seem to substantially increase the awareness of the need for improved efficiency in travel, as well as the methods whereby to effectuate such travel. Commensurate with question number 1, two-thirds of the students reported saving both time and money. Many described the value of their time savings and their monetary savings with lengthy paragraphs and examples of each.

Question #3: Scaling Method

Question three asked students to evaluate the effect of the sustainability exercise on their "awareness" of true travel costs. The average Likert score was a 1.536. According to student qualitative responses, this exercise has had a very positive impact on their true awareness of the true costs of travel. A great majority described that they have saved time and money because of this exercise. Two hundred pages of student qualitative responses attested to these results and excerpts from student essays follow.

Question #3: Sample Student Responses

Danielle made the following observations, “I have become much more aware of what my actual cost of travel is. First by logging my time and then adding it all up, I was surprised how much time I actually spend driving, it wasn’t something I had thought about before and I certainly didn’t plan my trips ahead of time very well. I found with just a little bit of travel preparation, I was able to combine certain activities that previously I would have gone home in between for. That has been my biggest lesson from participating in this exercise…Once I was able to grasp this concept; I was able to summon the energy to make those extra trips while I was already on the road. I also saved money by thinking about how much time it takes for me to leave campus to eat lunch, which gave me the extra motivation I needed to pack my lunch a few days. I also just bought my lunch on campus rather than driving unnecessarily to go get food once I realized how much time I was really wasting on leaving to go get ‘fast’ food. Another action I did to decrease my travel was after looking at the [DTP] map and seeing that I would be going to be traveling to almost the exact place at two different times that day for two different appointments, I picked up the phone and scheduled them at closer times so I didn’t have to come back home in the meantime.” n=T1

David noted, “The sustainability exercise has made me more aware of how much I’m spending on gas every month. This makes me analyze every move I make now and I am constantly thinking about how to save gas.” n=T3

William said the following, “I clocked my value of time at $50.00 an hour because of the full time load of credit hours I am currently taking at Mesa College, and working two part time jobs making my workload equivalent to one full time job…I normally draw out a daily [trip] plan just so I can remember the things I need to do on any given day. This assignment has helped me to understand the importance and worthiness of time…” n=T5

Michael commented, “The more travel is taken up by routine, the easier it is to implement efficiency changes. However, one of the calculations that stood out to me during this project was the cost per mile…However, in light of this project, my sights are set on the new Tesla Model S, an all-electric sedan that reduces pollution from its engine to zero, and whose cost of maintenance, depreciation as well as wear and tear parts are far below that of a petroleum engine. My carbon footprint would be greatly reduced, my cost per mile as well, and I would find minimal impact into my daily life by these changes.” n=T6

Aaron states, “This exercise has made me more aware of the potential costs of travel in terms of both time and money. Since I use a long-term bus pass, the monetary cost of public transit travel remains constant for me no matter how many trips I take, or their duration. However, traveling more efficiently reduces my personal time cost. Based on the value of 7pm to 8pm on Wednesday evenings, my time is valued at $80.00/hour. By reducing average travel time by 22.57 minutes per day, I saved an average of $30.00 per day in time costs. This was NOT offset by my increased use of automotive travel since I was not the one driving…As such, while I was able to save time; I was not able to save any money due to the 'flat-rate' nature of a long-term bus pass." n=T7

Kaleena noted, "I am an incredibly busy student: I work full time, am a fulltime student, and am the president of a club at Mesa. Each and every day is packed full of responsibilities and it was eye-opening to figure out that for every mile my time is work $2.50. Putting a number on it made me want to find want to not be in my car as often. Then we had to come up with an amount of money we would be willing to accept to lose an hour of our week I realized just how precious my time is – I wouldn't want less than $500.00, that hour could be used to study for class so that I would not have to sacrifice sleep. Before this exercise, I knew that my time was precious and definitely finite, but it was not until assigning a value to it that I fully understood what that meant." n=T8

Talina made the following observations, "This sustainability exercise has definitely affected my awareness of the true costs of travel. Especially as someone who delivers flowers for a living, it really is an eye opener for me because not only can I see how much time I have gained during this past two weeks of this exercise, but now I am capable of actually calculating the exact cost of driving and operating my vehicle. I now can figure out if it is even worth my time and energy to make certain trips. Even more so, if the trips are necessary is it practical and or economical to make those trips in a car, as opposed to another form of transportation. I drive an SUV…This means I get 16 mpg. So with gas prices being about $4.00 and rising, divided by my 16 gallon tank it is costing me $0.25 per mile. Then I times this by 2 in order to add in the depreciation, maintenance, and insurance cost. This brings my cost for operating my car to $0.50 per mile. If I then take the 480 miles I drove during the past two weeks I 'lost' $240. However, I compare it to the miles traveled during the initial two weeks, in which I drove 866 miles and 'lost' $433; due to this project I was able to save $193 using my newfound sustainability methods. In addition, with the decrease in trips taken and miles traveled I was also able to save 609 minutes, which is time that is much needed elsewhere in my life." n=T9

Rafael said, "The month of trip logs has been probably one of the easiest steps I could have made to not only save physical money, but to reduce the amount of my valued time driving. It has changed the way I travel. I am more hesitant to go eat out somewhere because not only am I wasting gas and time for something unnecessary, but I'm almost wasting money on wherever I decide to go; which ultimately creates a larger expense. An example of this would be how I used to make 3 trips to the gas station a week because I wanted to spread the amount of money I spend on gas a week to fewer, smaller payments. I've come to realize that the [three] times that I take to drive out of the way, is actually making me spend more time and money, than if I just fill my gas tank and make it last longer…Thinking that I'll save money by going somewhere cheaper [to eat], I never calculating the actual cost of traveling back and forth, and 'spending time' just to get something cheaper, which, in the end, probably balanced out to me making better, healthier, and cheaper lunches." n=T10

Benjamin draws the following conclusions, "…I have had four very unusual [driving] weeks, so I have lost money and time, but of course not as a result of this project. There is however the price of gas, something I tended to try not to pay too much attention to, but have most certainly taken more notice of because of this project…Having to fill out a daily trip log and calculating the cost of how many gallons burnt in the extra miles I've been traveling has been sobering. I've recently started a project of my own, to see if the higher-octane fuels and/or octane boosting additives will improve my mileage, or rather, improve it beyond their added costs. This was born from this assignment." n=T12

Jeff noted, "The sustainability exercise has opened my eyes to how expensive it truly is to travel. Not only do we need to calculate fuel costs but we also need to calculate other factors [estimated in class] such as time, car depreciation, insurance, finance charges, maintenance, tax, license, etc. The greatest factor of these costs is time – that which we can never get back [also estimated in class]. Many people think of time as a non-assessable asset; however, it is actually a value that you can measure using how much you earn as a basis…Moderate driving practices as well as a keen sense of safely predicting light patterns have become important in my travels now. However, the best way to reduce costs is to keep an efficient daily trip plan [DTP] to minimize unnecessary trips and maximize chain trips." n=T14

Bumwoo said the following, "We may never realize our situation in our daily lifestyle but this trip log activity has made me realize that I took my resources for granted and that I have not used them to its full potential. In certain areas I have saved time and money but in certain areas I have not. With a little effort I believe I can truly make a positive impact on my budget and time."n=T18

Michael states, "After taking this cultural geography course, learning about sustainability and using the sustainability trip log for my own trips I have taken of the four week logged course it will forever change the way I travel. This project has saved my family, friends and I a lot of time and money in the long run." n=T19

Timothy made the following comments, "During my trip log II, I saw more time savings by planning ahead and using the traveling salesman method to save time and money. From trip log I to trip log II I have saved 125 minutes. I've saved 160 miles from trip log I to trip log II and I can see the savings in the gas tank…The affect the trip logs have had on my sustainability has had a far greater impact on me than I thought. The trip logs have showed me to be more aware of my travel habits and the cost of travel, whether it be time or money they are very important to me with work, kids, school, and a husband. The logs and DTP have given me an important took to take back my time and money." n=T20

Robert noted, "In the beginning I did not think I would pick that much from this exercise, but when I started plotting them out with the DTP maps, I saw how much taking extra deviations would cut into time and cost. I started trying to plan trips before school that were close to home and the highway entrance to cut down on time spent making trips and becoming a mini traveling salesman. Using one hub to get quick errands completed for the day, rather than one trip for the errand." n=T21

Kyle states, "The cost of travel shocked me at first. But then I remembered it's the little unnoticeable things that hurt the most. ..I did not save any money from Trip Log I to Trip Log II, only because I moved to a new home. If I had been in the same house, the savings would be very noticeable." n=T22

Question #4: Findings

The fourth essay asked each student, "Summarize the effect that this sustainability trip log exercise has had on your ability to make more efficient and sustainable travel."

Question #4: Segmenting and Reassembling Method

Eighty percent of the students responded that practicing the Traveling Salesman model would be a way to improve their travel sustainability, while sixteen percent thought that their ability to make more efficient and sustainable travel would include the use of public transit and carpooling. Additionally, seventy-two percent of the students responded that practicing the DTP, using a GPS, or prior planning and/or mapping would be helpful in attaining more efficient travel. Four percent of respondents reported that buying in bulk, what I refer to as the "Costco effect", would be helpful in meeting their sustainability travel desires. Additionally, up to eight percent of the students claimed that they were already efficient in their own routine, and that they could not improve on their ability to make more efficient travel at this time.

The difference between question 3 and 4 is rather subtle. Question 3 emphasizes the students' awareness of the true cost of travel, both time and money. Question 4 emphasizes their ability to make more efficient travel from what they have learned. In other words, the first question relates to awareness, while the second one is asking, quite frankly, whether each student thinks that they are going to be able to make a difference, and then change their own patterns of behavior in the future. Question 5 then asks exactly what changes will be made by each student. It asks the students to list such changes that would be necessary for a sustainable travel future and what their exact intentions are, once this college geography class has ended. Simply put, question 3 asks about awareness, question 4 asks about ability to implement sustainable changes, and question 5 asks exactly which techniques will be employed to achieve more efficient and sustainable travel in the future. Each question builds on the results of the prior question in an effort to exact from the students their knowledge, ability, and intentions with regard to sustainable travel improvements. Each step is necessary, each step is incremental, each step is additive.

Question #4: Scaling Method

Question four asked students to evaluate the exercise on their "ability" to make more effective and sustainable travel decisions. The Likert score for this question was a 1.446. According to student qualitative responses, this exercise has, once again, had a very positive impact in helping students to actually make better travel choices. Two hundred pages of student qualitative responses attested to these results and excerpts from student essays follow.

Question #4: Sample Student Responses

David noted, "However, this exercise makes you plan out where you are going, how long it took and how much gas you used…The effect has impacted my wallet; most of all I have been able to put off filling my tank up for two day and that means I am spending less gas and less money." n=T3

William said, "I was even able to study at the end of the day whereas before I felt restless. I believe this has to do with me exercising more during my travels so I ended up working out less because I was getting the exercise I needed in my daily trips along. This was me putting the principle of least effort to work and not even realizing it." n=T5

Michael commented, "Sustainability isn't a summer blockbuster movie with its quick pace, large budgets, and even larger box offices sales. It's a film full of slow character development, independent budget, and can often only be appreciated in hindsight. But Oscars aren't won by "Avengers" and "Mission Impossible," they are won by films that reveal a universal truth about the human condition, like "Schindler's List," and "The King's Speech." The universal truth that I've taken away from this project is that change is not only possible, but easy to digest in small quantities, and over time, can yield dramatic results." n=T6

Aaron noted, "The use of trip logs and DTPs improved my ability to travel efficiently, as evidenced by the calculations. By visualizing where I intend to go the next day and making a DTP, I was able to significantly reduce the time spent traveling, which greatly increased the efficiency with which I could complete school assignments and make progress on paper I intend to submit to a peer-reviewed marine biology journal." n=T7

Kaleena made the following observations, "The DTP proved to be the most meaningful aspect of the project because as I mentioned, I already considered myself fairly sustainable, being busy helps to facilitate trip-chaining activities but it was not until I physically sat down to think about where I needed to go that I saw there were ways I could better spend my time. It was planning out my day that I was able to consider alternatives to my travel and be more time efficient. I would bring my meals with me to work instead of going out, and would go straight to campus to study before my classes. This assignment helped to open my eyes to where my time was being spent and the maps helped me to streamline my trips into the least mileage (and for the most part fully adopting the traveling salesman method). While the logs were tedious to maintain, I do feel that it was a valuable tool." n=T8

Talina said the following, "this sustainability trip log has certainly affected my ability to make more efficient and sustainable travel in many ways. This project has undoubtedly made me more conscious of the value of my time and the cost that is required for my vehicular travel. I too am more aware now of the repercussions of extensive driving on my environment as far as contributing to the greenhouse gases and the use of non-reusable sources of energy. Knowing now that with everything I do I leave a carbon footprint behind me has made me feel a sense of responsibility and obligation to continue on and try to make more efficient and sustainable travel decisions in my future." n=T9

Rafael noted, "These trip logs have made a huge impact on how I prepare to travel somewhere. Before, I used to have a mentality that I have to drive and that wasting gas and time is inevitable. What I didn't realize is that I could continue doing what I do, but I can change how I do it…I also see everything as a profit; the less time and gas I use, the more profit I make; while as the more trips, gas and time I spend, the less profit I make out of a given situation or trip. Every trip is an investment of some sort. At $0.80 a mile, every time I drive to work, I spend about $2.40 on literal and rhetorical dollars. However, I end up earning much more at work-which makes my profit margin greater." n=T10

Zeinab commented, "The sustainability exercise has had a big change on my thinking but not much change in terms of saving money. Now that I have done the activity I am more cautious on how many trips I want to take, and the easiest way for me to save time and money. Even though I did not save a lot of money and time from my second log, this exercise made me see exactly how much money I spent on traveling alone. It is something I would have to make drastic changes to because the money I spend on traveling and what I am achieving are not adding up." n=T11

Douglas stated the following, "Along with these epiphanies of concerning myself with the environment and the physical world in which I live, I now have the tools at hand from the Trip Log exercises to put down in tangible form evidence to help bring down my cost of living. It has been an invaluable learning tool. The biggest learning lesson from the Trip Log exercise has been evidencing and documenting where my travel time and cost is spent. Instead of something that I don't think of at all, it has now become an actual step and review to see at the end of the week where I have gone, the cost of the trip and also doing a reflection of whether it was worth not only the cost of fuel, but my time and effort as well." n=T13

Jeff notes, "This trip exercise has allowed me to become more efficient with my daily trips through planning chain trips with the shortest route using the DTP. I had never really used services such as MapQuest of Google maps to find the shortest route between places. These services helped me find the most efficient paths to take to minimize my travel costs. The principle of chain trips has also led me to understand the unnecessary nature of having too many home-based trips. Before this sustainability exercise, I returned home frequently thinking I was 'saving' time in between classes and other activities. However, I found out that it actually costs me more time and money traveling back and forth throughout the day. Now I pack everything in my car before the day starts so that so that I do not have to rely on going back home to gather things such as a change of clothes, books, etc. Without planning the day in advance, I find that I was not making the most efficient use of my time and travels. Traveling to places based on feeling, such as going to the gym or finding a place to eat, has added unnecessary and inefficient trips." n=T14

Manuel said, "Despite the fact that I did not save that much time and money, I was however able to quantify my true costs of travel. This made me aware of how many miles I traveled and how much time and money I had spent just for travel." n=T16

Bumwoo made these comments, “This sustainability trip log has opened my eyes to traveling efficiently and in an organized fashion. With the evaluation of my trip log it shows that I would lose several bucks and mileage when all I had to do was a little rearranging. Before I pursue my day, this log [and DTP] helps me plan out my destination and the means to get there.” n=T18

Michael states, “If I would not have taken this course or participated in the sustainability project I would have never attempted to change the ways I was thinking about my travels. I believe courses like this should be incorporated in drivers’ training for those high school students learning to drive so that they can not only know how to properly drive a vehicle and the laws of the road, but it will also help them think about the way they should plan their trips out for the day to save more time and money for themselves. It would be better to learn these things early on in life and apply them while still young so that it is more of a habit as they grow older.” n=T19

Question #5: Findings

The fifth essay asked each student, “Will you be able to make any sustainable changes in your travel in the future because of this exercise? What are your intentions?”

Question #5: Segmenting and Reassembling Method

Fully seventy percent noted intent to practice some form of the Traveling Salesman model to improve travel efficiency, while fifty-eight percent planned to use some form of the DTP mapping, GPS or path analysis examinations before they undertake travel in the future. Sixteen percent said that they intended to explore public transportation and carpooling while thirty percent said that they would try to improve travel efficiency with some form of biking and/or walking. Ten percent mentioned that they intended to load supplies/food/clothes in the vehicle so as not to have to return home during the day, and yet a few others mentioned motorcycle as an option. Ten percent said they were already efficient and plan to make no changes in their present behavior.

Question #5: Scaling Method

The results, again, were very positive when students were asked if they will now be able to make sustainable changes in their future travel based on their experience with this travel log experiment. Sample quotations representative of the student essays are given below. The average Likert score was 1.482. According to student qualitative responses, this exercise has had a very strong impact on their ability to continue to make more efficient and sustainable travel well into the future, suggesting overwhelmingly that such training and geo ed applied to travel results in greatly improved and more sustainable travel efficiencies.

Question #5: Sample Student Responses

Danielle said the following, “Yes, I feel I will be able to make sustainable changes when making my future travel plans. I have already started to automatically think about what and where I’m going to see if I can reduce the amount of traveling necessary. I intend to bring my lunches more often to school and stop going home as much. I feel this has been a huge waste of time and money for a long time and I’m happy I’ve finally recognized what a waste this has been so I can make smarter choices in the future.” n=T1

David noted, “I will be able to make some sustainable changes in my travel like I have already been doing. I plan on riding my bike to work more often to get in shape and to also save more money on gas. I also plan on jogging/walking when not leaving the neighborhood to go do errands instead of using motor vehicle transportation. My intentions are to follow through with the exercise somewhat keep the numbers more in my head instead of writing down every last bit of information like we had to do with this exercise…but it is my intention to at least stick with the program for a little [while] until it no longer fits my needs. My intention is to begin using one other form of transportation once every two weeks and if it works out in my favor perhaps I may enhance the number of times I use a different form.” n=T3

Ralph made the following conclusions, “Also by diversifying options with sustainability approach in mind we can improve access, reduce the need to travel, protect social and economic needs. I strongly agree with the strategic directions of Urban Planning and Transportation Planning where they promote to concentrate urban sprawl that reduces the demand for automobile trips by moving destinations closer together. The sustainability exercise made me aware how much I could save when I plan ahead and when I applied the traveling salesman model to my daily trips. By planning ahead I get a better grasp of the value of my time and I feel that I add value to my daily travel and my future." n=T4

Aaron said, "In the future, I intend to maintain an awareness of travel sustainability and efficiency as I have noticed a marked increase in my productivity over the past two weeks. While I don't intend to make daily DTPs, I will make use of them when I take multi-day trips to areas such as Los Angeles and San Francisco as I feel they can be a genuine aid in travel." n=T7

Kaleena noted the following, "This exercise actually helped solidify for me that being more sustainable is something for which I want to continue to strive…This project helped me to see what I want in life and I am really happy to have had the opportunity to participate. Once I move to Davis, I intend on selling my car and using a bicycle for my main mode of transportation. Not only will I get the benefits from a more active lifestyle, but I am confident that the added amount of time it would take to bike instead of drive would cancel out the need to find a parking space, allowing me more time to study and hopefully a little free time as well. I look forward to moving and starting a more sustainable lifestyle this fall." n=T8

Talina commented, "Despite the fact that I loathed having to make my daily plan ahead of time, mainly due to the fact that the concept of it felt strange and awkward to me, it did make my day run significantly smoother and more efficiently. So my goal is to continue planning out my days ahead of time." n=T9

Jeff says the following, "I plan to continue sustainable travel all throughout my career of traveling around to places. I may not always make a detailed daily trip plan on paper or with maps [DTP], but I will certainly keep a mental plan every day and use MapQuest as a guide to pick the shortest route whenever possible. This [geo ed] exercise also helped me to have a better understanding of locations and how to arrive at those locations." n=T14

May said, "I believe I can make changes in my travels in the future. If I stick to planning and mapping out before taking my trips I will reduce the travel cost and time spent every day than what I usually do now. Taking less trips from home can save me a lot more time, for example, [I could] bring lunch or snacks instead of stopping at a fast good joint to grab food." n=T15

Kathleen observed, “I have seen how much time, money and energy I am wasting. I also see opportunity to walk to places close by, which will also help with my health. I intend to stick to planning my days carefully as a traveling salesman, along with saving as much money as I can.” n=T17

Michael notes that, “…my school roommate will be attending the same school that I will be transferring to, and we will set up our class schedules to fit each other so that we could carpool. It will save us both gas and help the environment by not burning as much fuel. I have been able to talk most of my family and friends into making these same changes so that we do our part in cutting down on our own time and fuel costs. After learning how to calculate my cost of my time, and how much my time is worth, while driving from place to place, I realize how to make better use of my time.” n=T19

Question #6: Findings

The sixth essay asked each student, “What would it take for you to become permanently more sustainable in your daily travel in the future?”

Question #6: Segmenting and Reassembling Method

While certain external factors were mentioned as being either an important or a necessary condition to practice travel sustainability, such as improved public transit efficiency and scheduling, or having the price of gas increase substantially, most of the necessary conditions for people to become more sustainable in their travel behavior, surprisingly, were internal factors, particular to the individual. For example, sixty percent of students reported that a more sustainable lifestyle required that they obtain a permanent job. Thus, a permanent job would be a necessary condition to practice the sustainability techniques employed in this exercise. Another fifty-eight percent mentioned their own personal sustainability awareness continuation, i.e., a personal diligence for improved travel, as part of their own attitude. In other words, they knew that they had learned a life-changing series of behaviors, but they had to have the desire and personal, continued, tenacity to make such changes. Such changes listed included, but were not limited to staying on campus between classes and not returning home; mapping trips ahead of time on the computer or with a GPS; purchasing a motorcycle; practicing carpooling; using public transportation; packing the car for the day, so I was not to return home unnecessarily; buying a more efficient automobile; and one student even included taking more semesters of human geography to practice the changes that were recommended during the geographic education component (also referred to as "treatment" phase of the experiment).

Question #6: Scaling Method

This question was not subjected to the Likert scale as students gave a varied range of nominal-type answers. Responses included options that they intended to explore, versus those that they thought possible in the future, depending on their job, their residential location, their school status, their marriage status, their car ownership, their level of income, etc. The results, again, were very positive regarding students' intentions and willingness to become permanently more sustainable and efficient in the future, based on the contributed essays outlining the necessary steps they actually intend to take.

Question #6: Sample Student Responses

Danielle noted, “Organizing my days’ travel plans before I start my day. Keeping snacks in my car which I’ve also been doing and not going home without running my errands first. Staying on campus and studying at the library, when I would prefer to go home between my classes. Trying as I always do to schedule my classes on the same days and around the same times and scheduling appointments in clusters so I don’t have to go home in between them.” n=T1

David concluded, “For me to be more sustainable in my daily travel I would need a more gas-efficient car, preferably not a truck…This exercise has opened my eyes and now I am able to plan more intelligent trips and it has provided me with the abilities to map out my itinerary for the day.” n=T3

Ralph made the following conclusions, “But what would it take for me to become permanently more sustainable in my daily travel in the future are better places to ride a bike and more accessible public transportation.” n=T4

William said, “The cost of my travels were of no surprise to me, but what did surprise me was how simple it is to reduce those costs and increase the quality of life altogether. This assignment has helped me understand how cost-effective it is and how much it would help out the Earth if everyone took ten minutes to review their own daily trips. From this assignment alone I have learned the importance of community and supporting it. Almost everything I need is within a walk or a short bike ride from my apartment. I feel like I now have all the tools I need to help reduce the carbon footprint, save time, save money, and exert the least amount of energy, including a major one: stress. Those tools for me are my legs, bicycle, moped, compact car and, most importantly, knowledge. My intentions are to keep up with these trip logs from time to time, review them to see if I can make my trip logs any more efficient than they already are.” n=T5

Aaron made the following claims, “Becoming more sustainable in future daily travel would require that I continue to follow the traveling salesman model, and [even] adapt it for overnight use. For example, if I plan on fishing in OB from 9pm-2am and then fishing from Point Loma the following morning, I can stay with a friend in the area that night instead of returning to the UCSD area late at night and waking up early to get to Point Loma. This is only one example, but it shows the usefulness of being a ‘traveling salesman and it is a model that I will definitely be following from now on to improve the sustainability of my daily travel.” n=T7

Talina commented, “I am no usually one who likes to plan every step of my day out. I would much rather go ‘where the wind takes me.’ However, because I do see the benefits in a more sustainable manner of travel I believe with more practice and real determination I know in time I will be able to use and apply all of these new skills with a greater efficiency. I figure if I stick with it long enough it will become second nature to me. I look forward to being able to fully reap all the benefits of this project. In order to become more fully sustainable in the future, I think it would take another semester of Geography 102 to get me to that comfortable place where decisions leaning toward economic sensibility would be a second-natured thing or the other hope is that I get older and wiser with age…”n=T9

Douglas said the following, “At this point, I may not go as far as documenting everyplace that I go, but I can now have the foresight as to whether I need to go, or be cognizant of the information needed to make these kinds of decisions. It is knowledge in the memory banks I can refer back to whenever it is needed. In order to become more fully sustainable in the future, I think it would take another semester of Geography 102 to get me to that comfortable place where decisions leaning towards economic sensibility would be a second-natured thing…” n=T13

Jeff notes, “In order to become more sustainable, I would probably have to switch in my vehicle for a hybrid or perhaps an electric car such as the Nissan Leaf. However, these vehicles generally cost more than their less eco-friendly counterparts and are difficult to maintain. Not all places have accommodations for electric charging cars which makes practical use a hassle. The only options I have are to keep up these sustainable measures in my daily trips and/or find other possible modes of travel such as public transit, bike or motorcycle. However, these also present challenges in their own ways. Riding a bike…does not allow me to travel far distances and it also takes up more time than a vehicle. Public transit seems possible but it does not allow me freedom to travel to specific locations and I also have to set my plan according to its schedule. Motorcycle is definitely worth it in terms of savings, but it is also more dangerous than a vehicle and it also would bring more costs into the equation such as insurance and maintenance. Hopefully in the future, the government provides more accommodations for other modes of travel as well as for hybrid and electric vehicles." n=T14

May writes, "This exercise has made me realize how much I spend in a week by just deducting trips and making stops at home before going to my needed destinations. In the future, will be a permanent sustainable traveler and save more." n=T15

Manuel said, "To become permanently more sustainable in my daily travel in the future, I have already taken my first step by riding a motorcycle, a very fuel-efficient vehicle. Through this exercise, I have learned how to calculate my costs and will continue to use these methods in the future. The best I can do is limiting my travel to trips that are actually necessary." n=T16

Kathleen drew these conclusions,” There is a plan to be more sustainable when I travel. The main goal first is to get the source of income I need. The second goal is moving to a location that has a walking distance to places I go on a daily basis. The third goal is using other modes of travel…final goal is to stop eating out and instead cooking more healthy meals at home. I will also plan daily where I go before I go. I will limit the amount of money to spend by making a list of the things I actually need, instead of want, [and] I will have savings…Personal savings is great for everyone because we are meant to enjoy life.” n=T17

Michael noted, “I was even skeptical about how all this was going to play out when the project was first introduced to my class. I believe I was probably more annoyed by the fact that I would have to log every single trip that I took in order to see the difference in how my travels would be affected. I was shocked to see how much time and money I was wasting my traveling from and to my home throughout the day or making needless stops or going out of my way for what I thought was a better deal. But looking at the big picture, when I realized how much gas I was wasting going to a store or gas station across town because of the price of an item, I ended up paying the same price if not more if I would have just stayed local or gotten the item when I was in the part of the city at that time. After calculating my price per mile, factoring that into the amount of time I spent on the road, how much gas was burned in the process of taking the trip to and from, in most cases, ended up being a huge waste of time and money.” n=T19

Timothy said, “To be more sustainable I would need to make better travel decisions and have a better understanding of the need to plan out my week to better prepare for my travel needs. For me to be completely sustainable I would need to start taking public transportation, walking to the shorter destinations and effectively using the traveling salesman method.” n=T20

Robert concluded, “To become more permanently sustainable, I would imagine I will have to make sure to have more hubs of commerce around where I need to go and live within a reasonable distance from work. If my commute to school will be substituted with work, then that is the one major change to my whole travel log. Finding an area in which my hub and spoke almost becomes a bubble in which I can travel in without having to venture off for miles just to do one simple task.” n=T21

Qualitative Findings Review

To briefly conclude, the researcher found that all six of the questions posed to the study population yielded positive results when analyzed qualitatively. Two individual analysis approaches were adopted to best interpret the relevance and significance of the essays, a segmenting and reassembling method (active coding) and a scaling method (Likert scale).

Using the segmenting and reassembling method, fully sixty percent of the respondents reported a reduction in both total travel time and the number of trips taken between Phase I and Phase II. Additionally, seventy-two percent of the respondents reported that the miles traveled actually declined in the second trip log, or Phase II. These two results alone suggest that the geo ed travel reduction experiment posed by this research was extremely successful!

The “treatment” phase of the research also proved highly effective, as approximately ninety-six percent of the students reported positive and helpful comments regarding the geographical education, instruction, power point slides and documentation concerning efficient travel making. This result is extremely encouraging since the main thesis of this dissertation was that geographical education could make a difference in people's travel behavior, environmental consciousness, and sustainable behavior.

Other key findings using the segmenting and reassembling method included that the students, by and large, reported an overwhelmingly increased awareness of the need for and method of sustainability of travel based on this simple exercise. Approximately eighty-eight percent reported a better awareness of the total cost of travel, while approximately eighty-two percent reported a greater awareness of time savings due to the sustainability exercise and conservation activities proposed in this study. Two-thirds of respondents reported saving both time and money.

Eighty percent of the students responded that practicing the Traveling Salesman model would be a way to improve their travel sustainability, while sixteen percent thought that their ability to make more efficient and sustainable travel would include the use of public transit and carpooling. Additionally, seventy-two percent of the students responded that practicing the DTP, using a GPS, or prior planning and/or mapping would be helpful in attaining more efficient travel.

Additional findings, using the segmenting and reassembling method, that lend credence to the relevant and timely nature of this vein of research are the following: fully seventy percent of respondents noted an intent to practice some form of the Traveling Salesman model to improve travel efficiency; fifty-eight percent planned to use some form of the DTP mapping, GPS or path analysis examinations before they undertake travel in the future; sixteen percent said that they intended to explore public transportation and carpooling; and thirty percent of respondents said that they would try to improve travel efficiency with some form of biking and/or walking.

In using the second qualitative approach, the scaling method, student responses to five of the six questions were analyzed and converted to a five-point Likert scale. The mean Likert score for the first five essays collectively was 1.54, with a 1 representing "very positive," and a 2 representing "positive." The sixth and final question was entirely subjective and garnered a broad range of responses from students. While the responses to this final question were not statistically analyzed, the results helped to illuminate and corroborate the students' responses to the first five essay questions that were subjected to statistical analysis.

Reviewing the totality of the qualitative responses, over 200 pages of written feedback from the sample population consisting of fifty-six students, the overwhelming sentiment is that while the mobility of cars is essential and of great value to most Americans, change is necessary, and with the proper education, it is possible. It is clear that respondents understand that in order to save energy and time, and to move toward sustainability, changes in individual behavior must occur. An overwhelming majority of students reported positive results, i.e., making moves toward sustainability throughout the semester, based on the provided geography education and the use of the DTP. Improved urban travel efficiencies can seemingly be achieved with enriched geographic education, simple a priori planning, and basic sketch techniques.

In order to bring about change in personal behavior, a learning process needs to occur. Therein lies the basic thesis of this research. Is it possible to increase transportation efficiency through geographical and spatial learning? The answer seemed obvious and rhetorical: Yes! The geography education training in the classroom that took place over a month's time did, in fact, help to facilitate changes in student attitude and behavior. Geography education in the classroom included discussions about travel efficiency, energy savings, sustainability, the principle of least effort, gravity models, the traveling salesman model, distance decay concepts, the value of a person's time, spatial analysis, and place utility.

During the geography education (treatment) between Phase I and Phase II, interactive discussions between student and researcher, and amongst students themselves, brought about lively discussion regarding energy efficiency, the environment, and sustainability. It was widely concluded that the transportation sector consumes massive amounts of energy, accounted for tens of thousands of deaths annually, affected human health and the well-being of the environment, and enabled urban sprawl. Students recognized that the United States, when compared to all other countries, has the highest rate of private vehicle ownerships, the highest level of daily miles traveled, and the lowest rates of trip making by modes other than the auto. After identifying the personal automobile as the primary source of some of the aforementioned problems, students wholly acknowledged that there was potential for change, and that it needed to start with behavior at the individual scale.

Reasons for Limited Non-Significant Qualitative Findings

While the qualitative contributions were overwhelmingly positive, not all written comments were praiseworthy. In an effort to present balanced research, I have included a section on student contingencies. Below are reasons that students presented as to why their findings weren't personally significant in some cases. In evaluating 200 pages of written student responses, the top ten specific contingencies included the following:

- Respondents started economizing on travel at the beginning of the semester, when they read the syllabus including an assignment entitled "Travel Sustainability Exercise;"
- Respondents were already very efficient and claimed to actually not be able to improve much;
- Respondents had an activity blip in Phase II, causing them to stray from their normal driving patterns, e.g., Mother's Day travel out of town, one student delivered 80 flower arrangements, etc.;
- Respondents didn't follow through with the assignment and did not keep close track of log entries or maps;
- Several students were sick and stayed home during the first trip log, and resumed normal travel for Phase II, resulting in higher VMT for round two.
- Delivered and picked up friend from LAX 4 times (504 miles);

- Respondent had sick pet and went to vet four times during Phase II;
- Respondent had sick wife and went to hospital three times during Phase II;
- Respondent found a job during Phase II;
- Respondent relocated to suburbia (El Cajon – 20 miles from school)

The following quotes address these contingencies using direct excerpts from student essays.

Nicole states, “None of my calculations were significantly different. I already employ the idea of putting forth the least amount of efforts to get the maximum result. I preplan my trips daily so as to save time and gas. If this exercise were not already a daily ritual for myself I believe the results of the trip log experiment would have varied greatly.” n=T2

Benjamin noted the following, “However, during both periods of record keeping, I had unusually busy weeks with a number of extra, entirely unexpected trips: During the first two week period, I had to ferry my wife to and from more than one medical procedure…had a very sick pet to needed trips to the vet, and also had two separate construction –type projects that required additional shopping. During the second week…due to a family emergency, transport to LAX the day before the trip logs began…which warranted another two 126-plus mile trips.” n=T12

Douglas said, “Interestingly, even during the second trip log, average home-based trips did not improve. I do not considering myself much of a traveling salesman, meaning I do not economize too consciously when I travel by car by looking for the shortest routes, but this is due to me being a frugal traveler to begin with, so there is less of a need. When I settle into a fulltime job or just a more predictable lifestyle, I see myself adopting the traveling salesman trip-chaining method of travel.” n=T13

Kathleen made these comments, “I have made exact documentation of time, distance traveled, and where I traveled for this project. We also calculated the differences between both trip logs. According to my calculations, there is a significant difference between both trip logs. During the first two weeks of this project I had all the time in the world with just school in mind. The second two weeks, I found a part-time job. The second part of my project also included personal family issues, which required me to visit more often.” n=T17

Robert summarized it this way, “I have not saved that much time or money, due to the fact that my trips are already low in number and I have no clear cut options to help cut down time and money…in the future I could see myself needing to know what was in the major district hubs near work and home thus eliminating the need for numerous trips. Going over all the data, I can’t really see much I can change to benefit me now, but plenty in the future.” n=T21

V. SUMMARY AND CONCLUSIONS

This study sought to determine whether there would be measurable changes to transportation efficiency as a result of supplementary geography education. The following research question guided the research methods selected for this study:

- Can improved spatial awareness of the urban environment, coupled with energy conservation training, together referred to as geography education, evoke a measurable increase in travel efficiency?

Qualitative Recap

With regard to the qualitative results of this study, all six of the questions posed to the study population yielded positive results. Due to the large volume of data to process, an exhaustive effort to determine if the research questions were answered was needed. Toward this end, two distinct analysis approaches were adopted to best interpret the relevance and significance of the essays, a segmenting and reassembling method (active coding) and a scaling method (Likert scale).

Using the segmenting and reassembling method, fully sixty percent of the respondents reported a reduction in both total travel time and the number of trips taken between Phase I and Phase II. Additionally, seventy-two percent of the respondents reported that the miles traveled actually declined in the second trip log, or Phase II. These two results alone suggest that the geo ed travel reduction experiment posed by this research was extremely successful!

The “treatment” phase of the research also proved highly effective, as approximately ninety-six percent of the students reported positive and helpful comments regarding the geographical education, instruction, power point slides and documentation concerning efficient travel making. This result is extremely encouraging since the main thesis of this dissertation was that geographical education could make a difference in people's travel behavior, environmental consciousness, and sustainable behavior.

Other key findings using the segmenting and reassembling method included that the students, by and large, reported an overwhelmingly increased awareness of the need for and method of sustainability of travel based on this simple exercise. Approximately eighty-eight percent reported a better awareness of the total cost of travel, while approximately eighty-two percent reported a greater awareness of time savings due to the sustainability exercise and conservation activities proposed in this study. Two-thirds of respondents reported saving both time and money.

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Additional findings, using the segmenting and reassembling method, that lend credence to the relevant and timely nature of this vein of research are the following: fully seventy percent of respondents noted an intent to practice some form of the Traveling

Salesman model to improve travel efficiency; fifty-eight percent planned to use some form of the DTP mapping, GPS or path analysis examinations before they undertake travel in the future; sixteen percent said that they intended to explore public transportation and carpooling; and thirty percent of respondents said that they would try to improve travel efficiency with some form of biking and/or walking.

While certain external factors were mentioned as being either important or a necessary condition to practice travel sustainability, such as improved public transit efficiency and scheduling, or having the price of gas increase substantially, most of the necessary conditions for people to become more sustainable in their travel behavior, surprisingly, were internal factors, particular to the individual. For example, sixty percent of students reported that a more sustainable lifestyle required that they obtain a permanent job. Thus, a permanent job would be a necessary condition to practice the sustainability techniques employed in this exercise. Another fifty-eight percent mentioned their own personal sustainability awareness continuation, i.e., a personal diligence for improved travel, as part of their own attitude. In other words, they knew that they had learned a life-changing series of behaviors, but they had to have the desire and personal, continued, tenacity to make such changes. Such changes listed included, but were not limited to staying on campus between classes and not returning home; mapping trips ahead of time on the computer or with a GPS; purchasing a motorcycle; practicing carpooling; using public transportation; packing the car for the day, so I was not to return home unnecessarily; buying a more efficient automobile; and one student even included taking more semesters of human geography to practice the changes that were recommended during the geographic education component (also referred to as the "treatment" phase of the experiment).

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Reviewing the totality of the qualitative responses, in excess of 200 pages of written feedback from the sample population consisting of fifty-six students, the overwhelming sentiment is that while the mobility of cars is essential and of great value to most Americans, change is necessary, and with the proper education, it is possible. It is clear that respondents understand that in order to save energy and time, and to move toward sustainability, changes in individual behavior must occur. An overwhelming majority of students reported positive results, i.e., making moves toward sustainability throughout the semester, based on the provided geography education and the use of the DTP. Improved urban travel efficiencies can seemingly be achieved with enriched geographic education, simple a priori planning, and basic sketch techniques.

In order to bring about change in personal behavior, a learning process needs to occur. Therein lies the basic thesis of this research. Is it possible to increase transportation efficiency through geographical and spatial learning? The answer seemed obvious and rhetorical: Yes! The geography education training in the classroom that took place over a month's time did, in fact, help to facilitate changes in student attitude and behavior. Geography education in the classroom included discussions about travel efficiency, energy savings, sustainability, the principle of least effort, gravity models, the traveling salesman model, distance decay concepts, the value of a person's time, spatial analysis, and place utility.

During the geography education (treatment) between Phase I and Phase II, interactive discussions between student and researcher, and amongst students themselves, brought about lively discussion regarding energy efficiency, the environment, and sustainability. It was widely concluded that the transportation sector consumes massive amounts of energy, accounted for tens of thousands of deaths annually, affected human health and the well-being of the environment, and enabled urban sprawl. Students recognized that the United States, when compared to all other countries, has the highest rate of private vehicle ownerships, the highest level of daily miles traveled, and the lowest rates of trip making by modes other than the auto. After identifying the personal automobile as the primary source of some of the aforementioned problems, students wholly acknowledged that there was potential for change, and that it needed to start with behavior at the individual level.

Quantitative Recap

Research employed a mixed methodology, using both quantitative and qualitative approaches. The trip log survey instrument, used to generate the quantitative data, included variables for each trip taken, such as origin, destination, departure and arrival time, distance from origin to destination, travel mode for each trip taken for each day, etc. For the Phase II travel diary, conducted four weeks later in the semester, students used the sketch-map concept, in which they used a base map of the San Diego region, and marked where they intended to travel over the network, at the outset of each day (or the night before).

In addition to collecting quantifiable trip log data, students were required to submit the sketch map for each day of the second iteration of the trip logs (Phase II). This is what I call the daily trip plan (DTP). The sketch map was drawn daily, just prior to that same day's travel diary in an effort to help students plan an efficient day of trip-making. As mentioned previously, students also wrote an in-depth qualitative analysis of their experience, including documenting their trip logs and mapping exercises, and the degree to which geographical training that they received in a classroom affected their "after" travel.

Four of eleven quantitative questions seeking to measure dependent variables yielded results that were statistically significant using a one-tailed paired *t*-test, and six of the remaining seven hypotheses achieved the desired outcome in terms of direction of change. From this analysis, it is apparent that geography education had a measurable effect in reducing trip-making for the average student.

The four hypotheses that were significant related to the most notable indicators of whether the conducted research was meaningful – the total number and total duration of trips. The first hypothesis claimed that a statistically significant reduction in total number of trips would occur, and the findings were significant. Students reduced their travel by approximately 5.3 trips apiece for Phase II, dropping from an average of approximately 53 trips taken per student in Phase I, to an average of approximately 48 trips taken per student in Phase II. This equates to an overall reduction in travel by ten percent. Hypothesis three claimed that there would be a statistically significant reduction in total trip time duration, and the findings were statistically significant. Students traveled, on average, 97 minutes less during Phase II. The number of trips taken per day, hypothesis seven, was also statistically significant, as students reduced their travel from 3.9 to 3.5 trips per day, an approximate ten percent reduction of travel on a daily basis. Hypothesis eight, duration of all trips per day, was also statistically significant, and students reduced their travel by seven minutes per day.

Though the other seven hypotheses were not statistically significant, six of the remaining factors tested achieved the desired outcome i.e., vehicle miles traveled dropped (hypothesis two), average trip duration decreased (hypothesis five), miles traveled per day was reduced (hypothesis six), proportion of trips taken by auto declined (hypothesis nine), proportion of trips taken by modes other than auto increased (hypothesis ten), and percent trip-chaining increased (hypothesis eleven). Only one of the eleven tested hypotheses did not observe the desired direction of change. The only hypothesis that did not observe the desired outcome in terms of direction of change was hypothesis number four, which tested to see whether there would be a significant reduction in average trip length. Average trip length increased from 8.8 miles per trip in Phase I to 9.0 miles per trip in Phase II. In any case, the number of miles per trip is not as critical a factor, as long as the overall trip-making and total vehicle miles traveled drop, both of which occurred.

No extension of average results can necessarily be made to the overall population in San Diego or in the United States. Students were able to reduce travel by approximately one-half trip per day, which translated to a reduction of about 4.4 miles per day per person or 31 miles per week. This amounted to an average time savings of seven minutes per day, or roughly one hour per week. These results translate to an average savings in gas of $320.00 per year, based on $4.00 per gallon (and a fuel economy of 20 mpg); and an average savings of $1,250.00 per year based on $25.00 per hour of travel time (one hour per week times fifty-two weeks equals approximately 50 hours).

If we extrapolate these results to the general population, a significant savings in fuel as well as travel time, not to mention the conservation of environmental quality may occur. The number of vehicle miles traveled annually by age group varies dramatically, as one might expect. College-aged Americans between the ages of 20-24 drive approximately 170 million miles annually, while persons between 40-44 years of age, presumably well-entrenched in the work force, drive approximately 290 million miles annually (U.S. Federal Highway Administration 2007). Middle-aged Americans drive 40% more miles than your traditional college-aged American, many of whom are students. Considering that students are not typical trip-makers, but have fewer and shorter trips than the other segments of the population, I expect that such time and cost savings due to geo ed training would be close to double for the general population compared to my subject population of students.

Students had a difficult time understanding the value of their time in travel. My first example was the construction of freeways in San Diego County. I had served in the position of transportation planner for eight years prior to my fourteen years of teaching at San Diego City Colleges. In order to justify the construction of new freeways, the value of a person's time in commuting and personal travel must be calculated. The California Department of Transportation, or CALTRANS, uses 50% of a person's wage and salary per hour as a means of determining value of a commuter's time (1999). To elaborate, all of the trips (not including travel time to work), is calculated at twenty-five percent of a person's hourly income.

To translate this to student values of time, one must relate their value to two aspects of their life meaning. The first aspect is the value of wages or salaries that they are receiving from a job that they presently occupy. I tried to relate the value of time in travel to the exact value that they're being paid. Additionally, for those people working, and even for those who are not working, another aspect related to the value of time related to their future earning potential based on their educational level. By calculating their net present value of their future earning potential, and including the amount of college credits and study time in pursuit of those credits, the value of time rapidly escalates for each student.

Therefore, when demonstrating to students the true value of their time, based on their future earning potential, with and without their respective degrees, it became easy to show their true value of time. While value of time was not calculated in the course of this study, I showed that, for example, over a forty-year useful working life, times the actuary published difference (in earnings based on earning a four-year degree versus no earned degree) equals pay, divided by their time, cost of study and efforts toward course completion at the college level, resulted in a true value of time between $100.00-$300.00 per hour. Since attraction to social networking, video games, and the beach always a consideration, my slogan for students is, “pay now, play later.”

Another, never-before-used component, used to supplement the geography education, was the sketch-map concept. Students were required to use a base map of the San Diego region, and mark where they intended to travel over the network, at the outset of each day (or the night before). In addition to collecting quantifiable trip log data, students were required to submit the sketch map for each day of the second iteration of the trip logs. This is what I called the daily trip plan (DTP), a term coined within the context of my research. The sketch map was drawn daily, prior to that same day’s travel diary. Only three students of 55 did not complete two full weeks’ of sketch maps, therefore, 728 individual DTPs were submitted at the end of trip log II.

In their qualitative responses, many respondents indicated that the implementation of a DTP, created the night before, greatly aided their route choice the following day, especially when they were required to travel to more than one non-home destination. In the absence of GPS technology as part of this study methodology, students were encouraged to use MapQuest and Google Earth to assist with making their DTP, and found this tool helpful when seeking the shortest route between trips.

Perhaps one of the most common themes reiterated by the respondents in the qualitative essays, was the recognition that change in personal mobility is both possible and necessary. Questions eleven and twelve (of the qualitative essays) asked students how they might incorporate sustainable transport approaches and their implementation on a personal level. A significant number of respondents concluded that they were able to implement some strategies right away, whether it be carpooling, increasing their use of transit, or walking more often when circumstances warranted. A small percentage of respondents considered relocating to a higher density, more compact neighborhood in order to improve their commuting efficiency and enhance their walking possibilities.

New Urbanism is an urban design movement that touts walkable communities above all else, and embraces principles from urban planning, architecture and sustainable practices. Since the Congress for New Urbanism was founded in 1993, the concept is not new. European cities built prior to the automobile have, by default, adopted a smart growth model, where mixed use residential, commercial, industrial cluster near a Central Business District that has been built "up" instead of "out." Creating livable, sustainable communities seems like an obvious and necessary choice as we face a warming planet, large pockets of exponential population growth, an unparalleled global drawdown on resources, never-before-seen levels of waste generation, and an increasingly shared geography through globalization.

Charron (2007) introduced groundbreaking research to the literature (that embraces compaction) by suggesting that theoretical minimum and maximum commutes were not likely outcomes of the statistical distribution of commuting possibilities, but suggested that they were numerous commuting possibilities for different types of urban form. He called this approach, the “commuting possibilities framework”. Yet another method proposed to evaluate the commuting efficiency of a city was proposed by O’Kelly and Niedzielski (2008, 2009), who explained urban form in terms of entropy, or degree of disorder in a system. Long commutes across the city resulted in “high entropy” measures, while short journeys-to-work resulted in “low entropy”. Short journeys-to-work are optimal on a person level, and conform to the need for a more sustainable, environmentally-friendly, energy-saving approach toward travel.

One company which bases its travel efficiency on trip-chaining is UPS. In 2004, UPS announced a new policy for its drivers: the right way to get to any destination was to avoid left-hand turns. When better tracking systems were introduced in 2001, primarily using electronic GPS real-time information, the package delivery service reevaluated how trucks performed when making deliveries. As a logistics company with almost 100,000 trucks and several hundred aircraft, much of UPS's business equates to a series of optimization problems around reducing the amount of fuel used, saving time, and using space more efficiently. UPS engineers found that left-hand turns were a major strain on efficiency. Turning against traffic resulted in long waits in left-hand turn lanes wasted both time and fuel, and it also led to some additional accidents. By mapping out routes that involved "a series of right-hand loops," UPS improved both their profits and safety. As of 2012, the right turn rule saved around ten million gallons of gas and reduced emissions by the equivalent of taking 5,300 cars of the road for a year (United Parcel Service 2014).

Future Research

As the demographics of population pyramids and age-structures of more developed countries show, large elderly populations are emerging. A radio broadcast from National Public Radio in the first quarter of 2014, reported that in the United States, 10,000 people turn sixty-five years- old every single day. While my dissertation research focuses on the college-aged segment of travelers, more trip-chaining research will likely be necessary as the "baby boomers" retire and inevitably give way to challenges for transport policy. A recent study of trip-chaining among older age groups had important findings including: 1) the complexity of trip-chaining does not increase, unless one has severe mobility problems; 2) recent retirees are often as mobile as those younger than age 65; 3) number of trip chains (or tour complexity) will increase as mobile phone use increases; 4) tour adjustment after one has left home spans all age brackets; and 5) day of week influences trip chaining patterns, with Mondays being the most complex (Schmocker et al. 2010).

Today, technology is facilitating the potential for change at the personal level more than ever before. Students who participated in this study used sketch maps and the DTP to help govern smart route choice, and recorded their movements using a travel diary, a paper log that included numerous attributes about their daily trips. An ever-increasing and impressive set of groundbreaking technologies are available to assist with route choice, which is often difficult to observe using conventional methods of data collection. Conventional trip logs kept on paper ledgers may soon be replaced by an all-digital approach of data collection.

Recently, the Global Positioning System (GPS) has proven to be an effective tool for collecting travel data because it offers a spectrum of information both for and about the traveler such as shortest path, precise route selected by traveler, and speed of travel. A Geographic Information System (GIS) can then be paired with the GPS data to generate alternatives for route choice using an expanded set of variables including, but not limited to travel time, trip speeds, route distance, number of intersections, signalization, shortest path, etc. (Papinski and Scott 2011).

The use of GPS paired with a GIS such as ArcGIS can increasingly help examine the efficiency of observed routes, something that people can't easily do without the assistance of technology. Historically, travelers make their decisions based on the three most studied route choice attributes: shortest distance, shortest travel time, or familiarity/perceived reliability of a route (Lam and Small 2001). Future research on this topic will most certainly necessitate the use of GPS receivers for tracking people and vehicles, due to its widespread availability.

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APPENDIX SECTION

APPENDIX A

IRB EXEMPTION

TEXAS STATE UNIVERSITY

The rising STAR of Texas

Certification of Exempt Status

Institutional Review Board Application

Transportation efficiency through geographical and spatial learning

Applicant: Christa Stutz

Application Number: EXP2012N3928

Exemption granted: 05/09/2012

Project is exempt from full or expedited review by the Texas State Institutional Review Board

Szende Szabo

Dr. Michael Blanda
Assistant Vice President for Research and Federal Relations

Dr. Jon Lasser
Chair, Institutional Review Board

This is a digital certificate issued by Research Integrity & Compliance
Office of the Associate Vice President of Research and Federal Relations
Texas State University
JCK 489 512-245-2314

APPENDIX B

COURSE SYLLABUS

Geography 102- Cultural Geography

Mesa College, Spring 2012

Instructor: Christa Farano, MA
Section: 56571
Units: 3
Required Text: ***An Introduction to Human Geography: The Cultural Landscape, 10th Edition***
Mailbox: H302
Email: cfarano@sdccd.edu
Website: http://homework.sdmesa.edu/cfarano
Office Hours: Thursday 5:30-6:30 pm; H313. I'll also be able to meet after our class or during the break.

Course Description:
This course is an introduction to the economic, social, and political elements of geography and a survey of major world urban and industrial patterns. Emphasis will be placed on the introduction and distribution of human cultures and their effects on the earth's surface. Students successfully completing Geography 102 will satisfy the social science requirement at most four-year colleges.

Learning Outcomes:

a. The student will demonstrate an appreciation of the many examples of interactions between the physical environment and man's culture involving religion, political order, migration, settlements, resources, technology, and economic development.
b. The student will understand that no single factor such as race or environment can explain the differences behind the various patterns of human habitation.
c. The student will acquire knowledge of the role of innovation in cultural development; animal and plant domestication, deforestation, industrialization, urbanization, transportation and trade and related settlement patterns.
d. The student will describe a systematic way of looking at the world and will perceive some patterns regarding the human habitation of the earth.
e. The student will begin to recognize how the environment has shaped human behavior, and, how human behavior has shaped the environment.

Materials:
Required: ***An Introduction to Human Geography: A Cultural Landscape, 10h Ed***. Rubenstein; Prentice Hall Inc. Other reading materials may be in-class handouts. Slides and videos will be presented in class, and represented on all tests.

Prerequisites:
You are expected to be able to read and write at the college level. I highly recommend that you satisfy the minimum transfer requirements in English prior to taking this class. Most exams will have a writing component, and there will be several writing assignments.

NOTE: Important Dates for Spring 2012 Academic Semester

February 3	Last day to pay for add code; deadline to drop with no "W" recorded.
February 6	Deadline to drop and be eligible for refund.
February 27	Last day to file Pass/No Pass (Credit/No Credit).
March 30	Withdrawal deadline. No drops after this date.

Grading Policy:
All students will receive a letter grade unless prior arrangements for credit/no credit have been made. There will be no "incompletes." Grading will be based on a point system as described below:

Total possible points equal 250. Final letter grades will be assigned as follows:

90% of total points = A
80-89% of total points = B
70-79% of total points = C
66-69% of total points = D
Less than 60% of total points = F

METHODS OF EVALUATION

Exams: up to 195 points
There will be four (4) examinations worth 65 points each. The lowest test score will be dropped, and will not be factored into the final grade. Tests will use a combination of objective, short answer formats, map identification and short essay formats. Exam questions may be drawn from readings in the textbook, lecture materials (including handouts or other supplements), homework assignments, slides, in-class activities, and films. THERE WILL BE NO TEST MAKE-UPS. If you miss an exam due to an emergency and/or planned absence, I will automatically drop the missed exam for you. The purpose of dropping one exam is to accommodate those who are victims of an unexpected emergency/absence. Most students take all four exams and drop the lowest of the four exams they prepared for and completed on test days.

Homework Assignments: up to 55 points
1. Map packet – up to 15 points - Due Monday, March 12, 2012 – this is a required assignment. Completion of a map packet which includes features from every world region covered in class. There are **FOUR** map sets to download on my website (13 pages in total) and include all the world regions with 300 features to identify in total. Two points for each class period it is late.

2. Travel Patterns/Energy Sustainability– Trip Logs: up to 40 points- Logs collected four times: April 9, April 16, May 7, and May 14. Detailed explanation of assignment to occur in class after Exam 2.

Students will record daily trip-making on a provided simple trip log template for a period of 14 days. Origin and destination of each trip and trip distances will be recorded. Several weeks later after geographical education and sustainability awareness learning has taken place in the classroom, a second trip log will be recorded with the additional requirement that a daily trip plan map (DTP) be used before travel is initiated for each day. The DTP map will be used to plot out the daily trips both beginning and ending at home, much as a pilot submits a trip plan before each flight day. Simple calculations will be made regarding any attempt to reduce travel distance, energy/resources, and travel time by applying the a priori DTP map (an exercise to reduce travel and make energy more efficient). A 2-page MINIMUM paper also due on the last day of class is required describing the trip log exercise (14-days "before" logs versus "14-days after" geographical learning). Discussion will include the degree to which travel efficiencies and a priori planning for each day's trips using the DTP have been useful and successful with regard to energy efficiency and travel sustainability. **No late assignments accepted.**

Extra Credit

You may do *up to 15 points* of extra credit due Monday, May 14, 2012 (last day of class).

1. Community-Based Lecture- up to 5 points
You may attend a community-based lecture that is related to this course. Lectures are offered periodically at the Natural History Museum and Museum of Man in Balboa Park. You may also want to attend a monthly meeting of a local community group, town council, business improvement district, regional economic development council, gay and lesbian group, cross-border development group, or an environmental organization. Please advise me of what you plan to attend before doing so if you have any questions about whether it relates to this class or not. Plus, if it's a good candidate, then I can share it with the class. To receive extra credit, you must turn in a two-page, typed, double -spaced summary of the lecture/exhibit, along with your ticket stub or program flyer (handwritten summaries will not be accepted).

2. Attend a Religious [or Cultural] Function– up to 5 points
The Southern California area has tens of thousands of places of worship. The task is to expose yourself to a faith group that is unfamiliar to you (or one that you want to know more about). In doing so, you will attend a formal or informal function hosted by a declared religious or cultural group. If you haven't visited a Jewish, Baha'i or Buddhist temple, or an Islamic mosque, now is the time. If you haven't attended a service at a Christian, Catholic or Mormon church, here's your chance. Get to know more about Native American Kumeyaay worship forms. The two most distinctive traits that help us paint a picture of one's cultural geography are religion and language. Please submit a two-page, double-spaced summary of your experience and how it has expanded your knowledge of cultural geography. Include the name of the event (i.e. Sunday mass) and location name (i.e. Mormon temple in La Jolla), the address, and some documentation (i.e. a church bulletin or other handout, or a picture of you at the site, etc.)

3 . Tour of Central Business District – up to 5 points
Contact Centre City Development Corporation, the redevelopment arm of the City of San Diego, and sign up for a downtown walking tour (hosted by the Gaslamp Quarter Historical Foundation). The contact info is 619.233.4692. This tour will open your eyes to the history of the economic development of vibrant downtown San Diego and illuminate patterns of urban land use and design that we will discuss in this class. You will learn about the different neighborhoods and enclaves that exist within the central business district and how they have been shaped by a hundred and fifty years of various human activities.

Cheating/Plagiarism:
Students are expected to be honest and ethical at all times in their pursuit of academic goals.   Students who are found in violation of district *Procedure 3100.3*, *Honest Academic Conduct*, will receive an F grade on the assignment in question and may be referred for disciplinary action in accordance with *Procedure 3100.2, Student Disciplinary Procedures.*

Attendance Policy/ Adding and Dropping:
Class attendance is strongly advised; therefore attendance will be taken daily. District policy states that you may be dropped from the class if you miss the first day and your seat given away to another student. If you miss class, make arrangements with a classmate to keep you informed on lecture topics, handouts, and assignments. It is the student's responsibility to drop all classes in which he/she is no longer attending. It is the instructor's discretion to withdraw a student after the add/drop deadline (September 3) due to excessive absences. Students who remain enrolled in a class beyond the published withdrawal deadline, as stated in the class schedule, will receive an evaluative letter grade in this class.

Accommodation:

Students with physical or learning disabilities will be accommodated with lecture/test materials by mutual agreement between individual students and the instructor. Please present any relevant paperwork at the beginning of the course.

Statement of Retention:
It is Mesa College's policy to encourage learning through student retention. Therefore, if you are considering dropping this course after you have invested some time in it, please consult with me after class or make and appointment to see me.

Tentative Lecture Schedule and Related Reading Assignments from Rubenstein

TOPIC	**CHAPTER(S)**
UNIT 1	
Thinking Geographically	1
Population	2
Migration	3
TEST 1 Monday, February 13	
UNIT 2	
Folk and Pop Culture	4
Language	5
Religion	6
Ethnicity	7
TEST 2 – Monday, March 12	
UNIT 3	
Political Geography	8
Development	9
Agriculture	10
TEST 3 – Monday, April 16	
UNIT 4	
Industry	11
Services	12
Urban Patterns	13
Resources and Sustainability	14
FINAL EXAM on Monday, May 14	

Holiday for this class: Monday, February 20 and Monday, April 2

NOTE: This is a tentative syllabus; the content is subject to change by the instructor as the course progresses, and as is necessary and appropriate. Test days may fluctuate (this is unlikely). Each student is expected to attend every class in order to maximize their preparedness for each class period and activities during each meeting.

APPENDIX C

QUANTITATIVE SURVEY INSTRUMENT

Trip Purpose: Home -1; Work -2; School -3; Shop -4; Recreation -5; Personal Business -6; Social -7; Eat out -8; go for ride -9; Serve passenger -10
Trip Mode: Car - 1; Motorcycle - 2; Bus - 3; Trolley - 4; Bike - 5; Walk - 6; Other - 7

DATE	Trip #	Place of Origin	Place of Destination	Odometer @ Origin	Odometer @ Dest.	VMT	Time of Depart	Time of Arrival	Mins Trip Duration	Purpose Origin	Purpose Dest.	Mode

APPENDIX D

POWERPOINT SLIDES PRESENTED DURING TREATMENT PHASE

Sustainable Transport

Presented by Christa Farano
San Diego Mesa College

M.A., SDSU
Ph.D. candidate, Texas State University – San Marcos

April 16, 2012

sustainable transport

An approach to transportation that meets the needs of all segments of society while minimizing environmental, societal, and economic costs. At the heart of the sustainable transportation challenge is the dominance of petroleum-powered automobiles as a mode of daily travel in the U.S and the fact that more people are driving more miles than ever before…

UC Davis Sustainable Transportation Center

Accessibility vs. Mobility

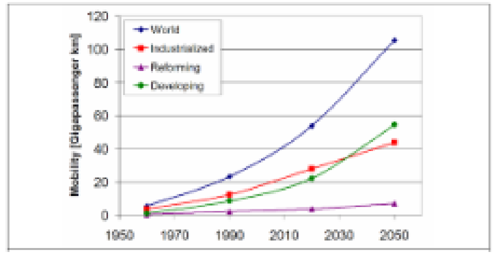
- Access to people, places, goods and services is important to the social and economic well being of communities.
- Transportation is a key means, but not the only means, through which access can be achieved.
- People are entitled to reasonable access to other people, places, goods and services.

Accessibility vs. Mobility

Accessibility is the ability to REACH opportunities that are beneficial, not movement itself. In remote rural contexts gaining access to services, goods often requires a lot of mobility. In urban contexts accessibility might involve very short trips. In suburban USA, policies to enhance accessibility might require that we reduce traffic or even reduce the need to travel (or reduce mobility).

Mobility is the efficient movement of people and goods. It puts a high priority on collective modes of transport (eg buses, rail).

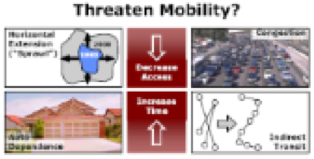
Accessibility vs. Mobility



Schafer A, Victor D. The future mobility of the world population. Transportation Research Part A 2000;34:171-205.
Graphic courtesy of: John Thomson,

Accessibility vs. Mobility

What Practices Threaten Mobility?



Mobility is not just threatened by freeway congestion. It is also threatened by sprawl, auto-dependence, and suboptimal transit.

In car-oriented cities, activities tend to spread out. This forces people to travel further and further for the same level of accessibility as before.

Accessibility vs. Mobility

Strategic Directions

Demand Management

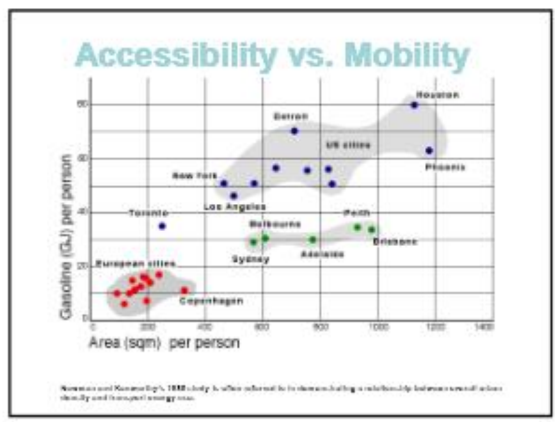
- Reduce the need for travel while protecting social and economic needs for access by changing urban form to minimize sprawl, promote new communications technologies (e-work, telecommuting) and implement smart growth (TOD, urban infill).

Diversifying Options

- Improve access by diversifying transportation options, giving people more choices as to how they meet their access needs.


Accessibility vs. Mobility
PEDESTRIANS
BICYCLES
PUBLIC TRANSIT
COMMERCIAL VEHICLES
TAXIS
HIGH OCCUPANCY VEHICLES


SDSU LRT
Provides transit connections; alternatives

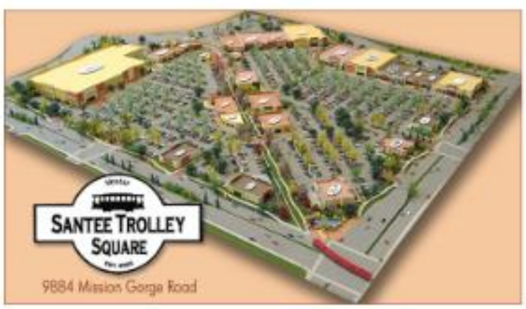

Accessibility vs. Mobility
Houston
Detroit
US cities
Phoenix
New York
Los Angeles
Toronto
Melbourne
Perth
Brisbane
Sydney
Adelaide
European cities
Copenhagen
Gasoline (GJ) per person
Area (sqm) per person

Accessibility vs. Mobility

Accessibility vs. Mobility

Development in these villages will be clustered around a "core" area within the village reflecting varying design character and densities. The plan will create tree-lined streets, and pedestrian plazas and buildings to complement human, rather than automotive activity. The plan provides a range of transportation alternatives to the automobile, most notably transit and pedestrian-oriented activities. Many of these villages will be connected by the future extension of the San Diego Trolley LRT. The plan also proposes a high-density "urban" center, which will contain a variety of office, regional commercial and multi-family residential uses. In all, this cooperative planning effort has resulted in a comprehensive plan which promotes a new livable community, and supports the need for smart growth living.

Accessibility vs. Mobility



Cost: Time and Money

- US work commutes are longer than they have ever been historically (reflecting increased mobility and urban sprawl).
- College-aged Americans spend an average of 58 minutes driving daily.
- Average monthly costs to own and operate a mid-sized vehicle are $250.00
- American families spend about 20% of their annual income on transportation.

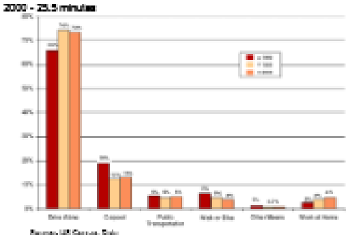
Cost: Time and Money

Travel Characteristics

The majority of people 16 and older choose to commute alone. This trend does not appear to be diminishing. As a matter of fact, the number of workers choosing to carpool dropped from 19 percent in 1980 to 13 percent in 2000. Less people are using non-motorized means to get to work and public transportation as a commute choice is holding constant. There has been a slight increase in the number of people choosing to work from home.

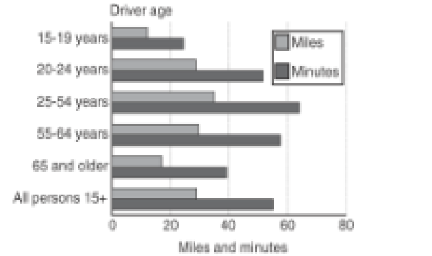
Average travel time to work

1980 - 21.0 minutes
1990 - 22.0 minutes
2000 - 25.5 minutes



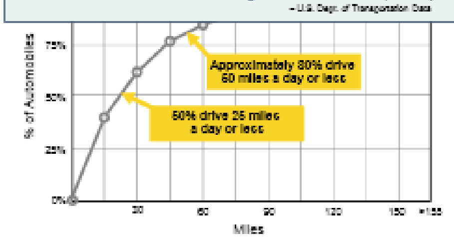
Cost: Time and Money

Mean Minutes and Miles Spent Driving by Driver Age



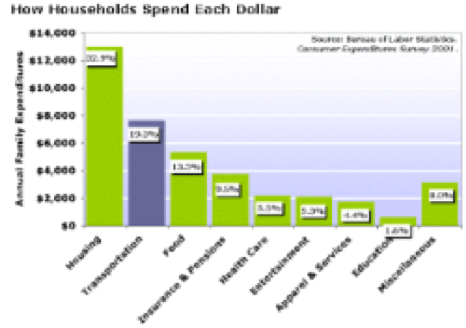
Cost: Time and Money

Drivers in the United States average 25 miles or less per day.
– U.S. Dept. of Transportation Data



Cost: Time and Money

How Households Spend Each Dollar



Cost: Time and Money

Weekly Operating Costs

Small-car = $111

SUV/4WD = $380

Royal Automobile Club of Victoria; 2009

Cost: Time and Money

Strategic Directions

Urban Planning and Transportation Planning

- Concentrate urban growth, limit sprawl and provide for more mixed land use through urban structure and land use policies. This would reduce demand (especially for automobile trips) by moving origins and destinations closer together and also help reduce habitat destruction and loss of agricultural and recreational lands.
- Give priority to less polluting, lower impact modes of transportation in the design of transportation systems and urban areas. Pedestrian and cycling paths should be provided as attractive and safe alternatives.
- Maintain and enhance the health and viability of urban public transit systems.
- Integrate transport modes, whether for passengers or goods, in order to provide more efficient goods movement, and to increase the availability of lower impact transportation options such as public transit.
- Protect historical sites and archaeological resources, reduce noise pollution, and consider aesthetics in the planning, design and construction of transportation systems.

- The U.S. DOT uses the following travel time values for evaluating transportation projects (1997 U.S. dollars): in-vehicle time, $8.90/person-hour; out-of-vehicle time (e.g. waiting for a bus), $17.00/person-hour; commercial truck, $16.50/person-hour.[34] Table 5.2.7-2 indicates US DOT recommended travel time factors.

Table 5.2.7-2 **Recommended Value of Travel Time**[35]

Time Component	Reference	Value
In-Vehicle Personal (local)	Of wages	50%
In-Vehicle Personal (intercity)	Of wages	70%
In-Vehicle Business	Of total compensation	100%
Excess (waiting, walking, or transfer time) Personal	Of wages	100%
Excess (waiting, walking, or transfer time) Business	Of total compensation	100%

This table summarizes USDOT recommended travel time values. For business travel costs are estimated to average 120% of wages to reflect total compensation, including non-wage benefits.

Transportation Cost and Benefit Analysis II – Travel Time Costs
Victoria Transport Policy Institute (www.vtpi.org)

Calculate Total personal driving costs at:
http://www.commutesolutions.org/calc.htm

Cost of Travel

Operating Cost

1. SUV 16mph $4.00/16 = $0.25 x 2 = $0.50/mi
2. Mid 24mph $4.00/24 = $0.167 x 2 = $0.33/mi
3. Compact 32mph $4.00/32 = $0.125 x 2 = $0.25/mi

(estimates are multiplied by 2 to include depreciation, maintenance, insurance)

Time Cost (CALTRANS uses 50% pay rate, ave speed 30 mph)

1. $10/hr $5/hr 5/30 = $0.16/mi
2. $20/hr $10/hr 10/30 = $0.33/mi
3. $30/hr $15/hr 15/30 = $0.50/mi

Examples

1 + 3 (SUV, $30/hr) $0.50 + $0.50 = $1.00/mi
3 + 1 (compact, $10/hr) $0.25 + $0.16 = $0.41/mi
2 + 2 (mid, $20/hr) $0.33 + $0.33 = $0.66/mi

Theoretical Models – Distance Decay Model

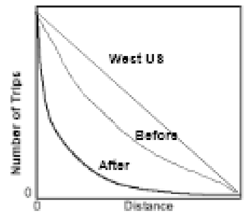


Figure 4.3. Distance decay curve showing decreasing interaction as distance increases.

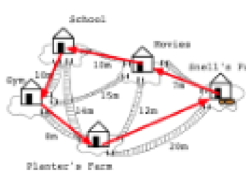
People are likely to have more complete perceptions of nearer places than of farther ones, which confirms the notion that the intensity of human activity, process, or function declines as distance from its source increases (Source: AP Exam in Geography, Review website)

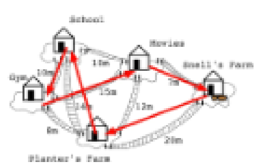
Theoretical Models – Principle of Least Effort

"In simple terms, the Principle of Least Effort means that a person in solving his immediate problems will view these against the background of his future problems *as estimated by himself*. Moreover, he will strive to solve his problems in such a way as to minimize the *total work* that he must expend in solving *both* his immediate problems and his probable future problems. That in turn means that the person will strive to minimize the *probable average rate of his work-expenditure* (travel) . And in so doing he will be minimizing his *effort*. . . . Least effort, therefore, is a variant of least work."

(George Kingsley Zipf, *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology*. Addison-Wesley Press, 1949)

Theoretical Models – Traveling Salesman



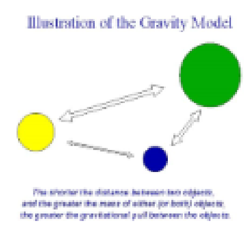


55 total meters

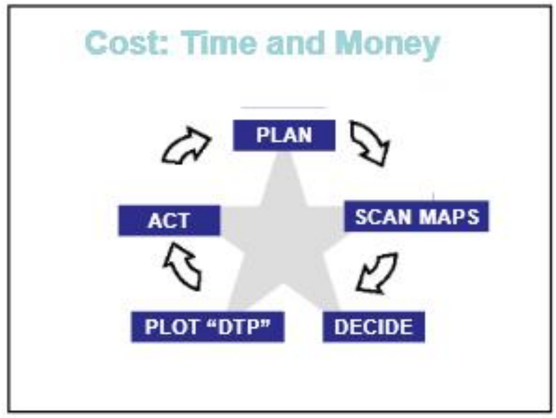
68 total meters

Given a list of destinations and their pairwise distances, the task is to find the shortest possible route that visits each destination exactly once and returns to th origin (Source: Computational Fairly Tales: Traveling Salesman Problem)

Theoretical Models – Gravity Model



The interaction between two locations declines with increasing (distance, time, and cost) between them, but is positively associated with the amount of activity at each location (Isard, 1956. *Location and Space-economy; a General Theory Relating to Industrial Location, Market Areas, Land Use, Trade, and Urban Structure*).



Cost: Time and Money

Strategic Directions

Decision Making Processes

Private

- Make informed decisions about travel patterns through geographical and spatial education; keep trip diaries; construct physical trip plan maps (DTP); create cognitive maps; greatly reduce primary trips and emphasize linked trips.

Public

- Ensure public and private sector stakeholders coordinate their transportation planning, development and delivery activities.
- Make transportation-related decisions in an open and inclusive process.
- Anticipate environmental or social impacts of transportation-related decisions rather than trying to react to them after they have occurred.

Strategic Directions

Decision Making Processes Using Trip Planning

http://www.sdcommute.com/#

http://www.sangis.org/

http://www.mapquest.com/

http://www.esri.com

http://www.sandag.cog.ca.us/

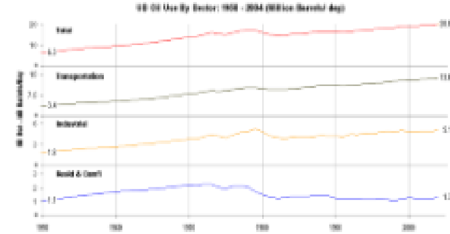
Resource Use

Auto habits have caused increasing dependency on oil imports, much of it coming from unstable parts of the world.

Today, we import more than 54 percent of our petroleum needs, and over 60% percent by 2010.

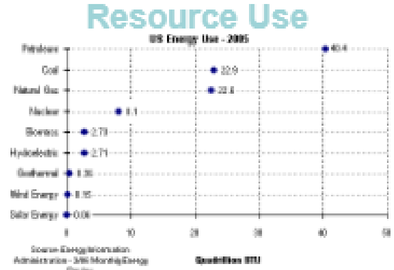
The cost of oil imports to U.S. consumers totals some $50 billion annually. We must also include the cost of productivity loss, and the cost of congestion, and social costs of transportation, such as traffic deaths and injuries, and pollution (Smart Communities Network, 3/09)

Resource Use



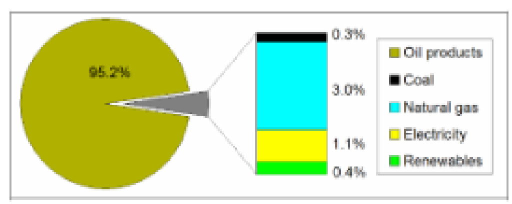
Petroleum (oil) is the single largest component of the US energy mix, accounting for over 40% of all energy use. Transportation accounts for 68% of all oil use.

Resource Use

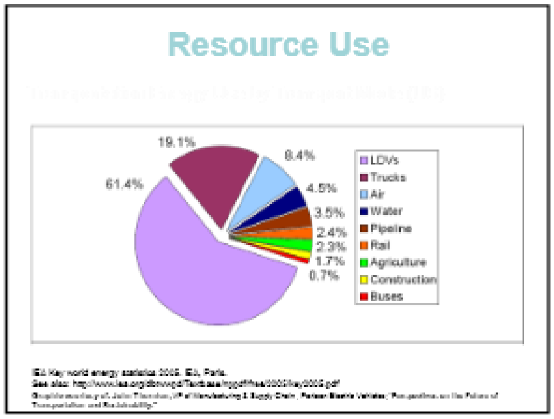


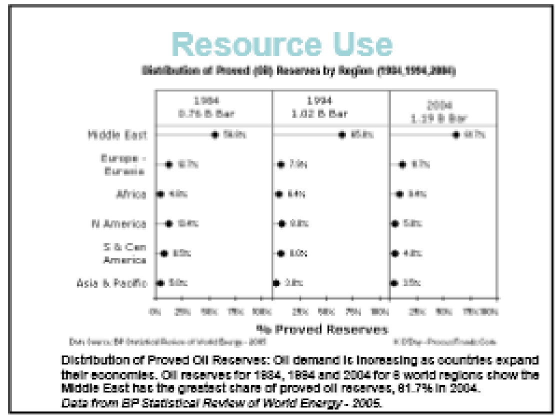
US Energy Use By Source - 2006: US uses nine (9) sources of energy: 3 majors (petroleum, coal, natural gas); nuclear; biomass, hydroelectric, geothermal, wind and solar. This chart shows the equivalent energy use of these sources in quadrillion BTUs for 2006, as estimated by the US Energy Information Administration.

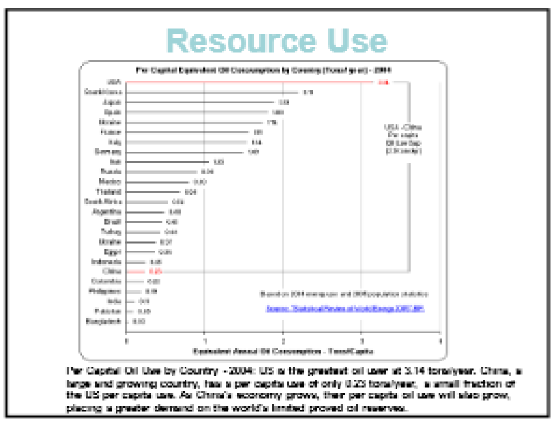
Resource Use

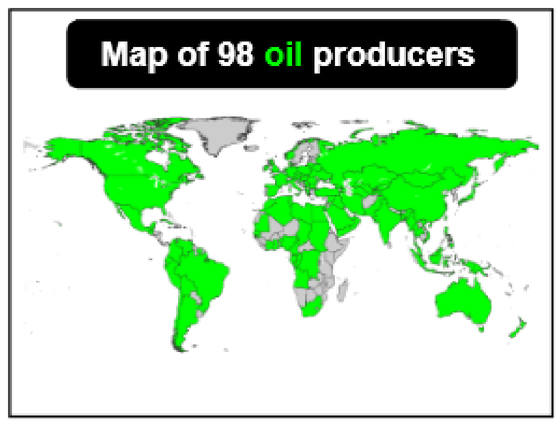


IEA Key world energy statistics 2006. IEA, Paris. See also:

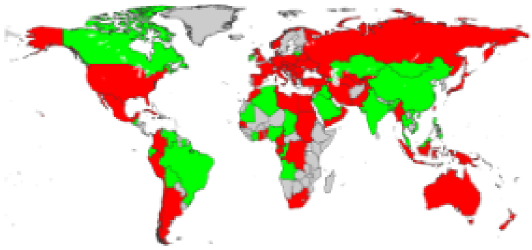

Resource Use
19.1%
8.4%
61.4%
4.5%
3.5%
2.4%
2.3%
1.7%
0.7%
LDVs
Trucks
Air
Water
Pipeline
Rail
Agriculture
Construction
Buses
IEA Key world energy statistics 2006. IEA, Paris.

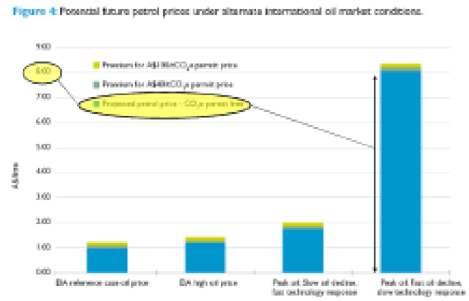

Resource Use
Middle East
Europe - Eurasia
Africa
N America
S & Cen America
Asia & Pacific
% Proved Reserves
Distribution of Proved Oil Reserves: Oil demand is increasing as countries expand their economies. Oil reserves for 1984, 1994 and 2004 for 6 world regions show the Middle East has the greatest share of proved oil reserves, 61.7% in 2004.
Data from BP Statistical Review of World Energy - 2005.


Resource Use
0
1
2
3
4
Per Capital Oil Use by Country - 2004: US is the greatest oil user at 3.14 tons/year. China, a large and growing country, has a per capita use of only 0.23 tons/year, a small fraction of the US per capita use. As China's economy grows, their per capita oil use will also grow, placing a greater demand on the world's limited proved oil reserves.


Map of 98 oil producers

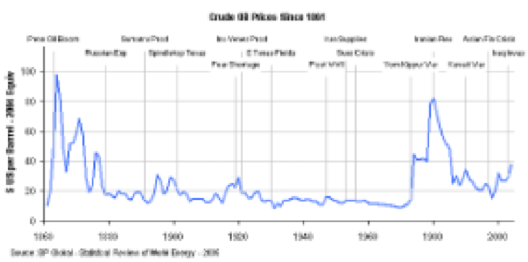
64 oil producers have past their peak





CSIRO predictions of $8 per litre fuel by 2018

Resource Use



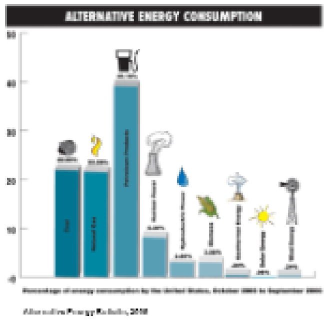
Trend in Crude Oil Prices ($2004) since 1861: Oil prices have fluctuated over the years. This chart shows the equivalent cost in US dollars per barrel in 2004. Oil discoveries and world wars contribute to the trends shown.

Resource Use

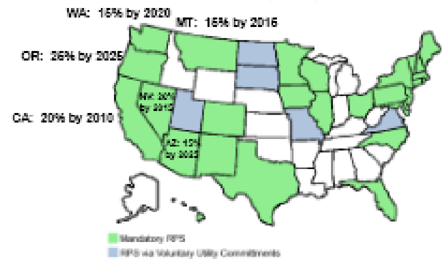
Strategic Directions

- Reduce fossil fuel consumption and emissions through efficiencies and demand management.
- Promote the use of alternative and renewable energy.

Resource Use

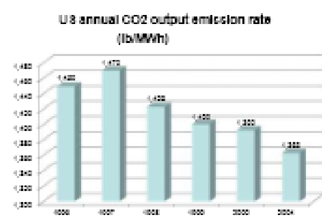


Resource Use



Source: Pew Center for Global Climate Change (September 2008)

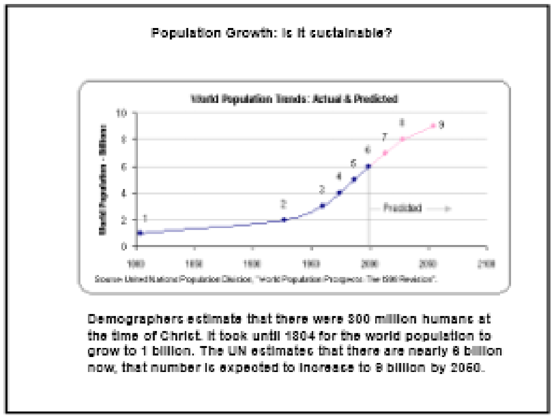
Resource Use

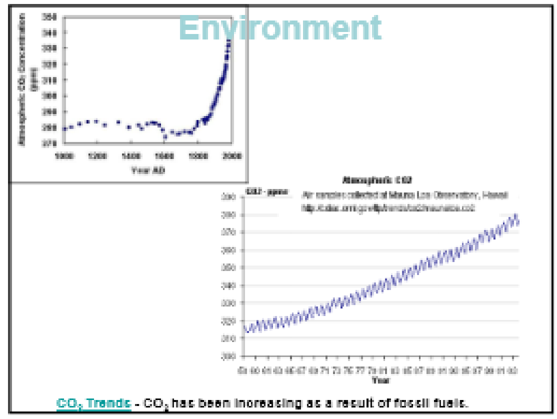


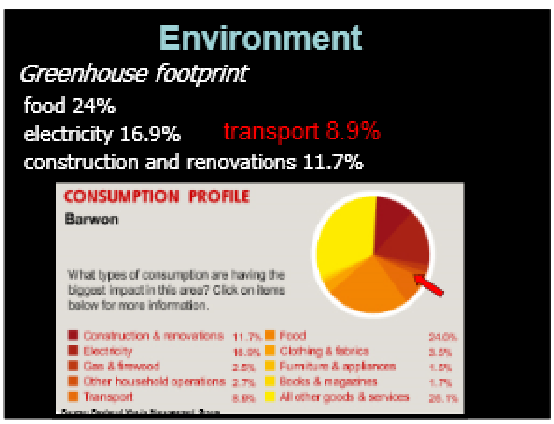
Source: U.S. Environmental Protection Agency eGRID Version 2.1 (updated April 2007 and based on 2004 data)

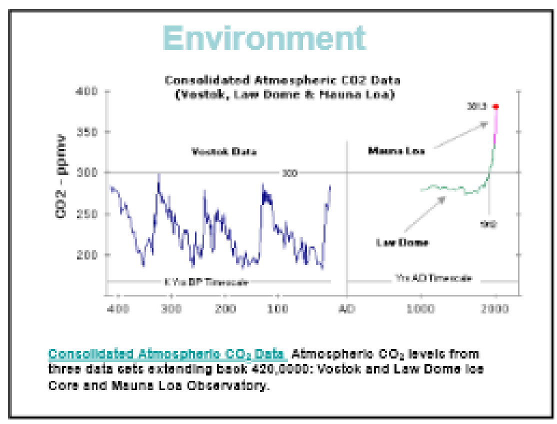
Environment

When pavement is laid, more vehicles come. With more vehicles, comes more smog. Autos are a major contributor to global warming. Their pollution also causes severe health problems for many. Traffic congestion, already costing us an estimated $168 billion annually in lost productivity, is expected to triple in coming years, wasting more productivity and fuel and worsening our air quality (Smart Communities Network, 3/2009).

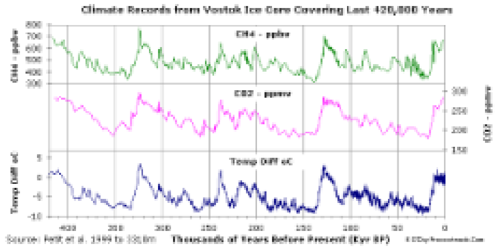

Population Growth: Is it sustainable?
World Population Trends: Actual & Predicted
Predicted
Demographers estimate that there were 300 million humans at the time of Christ. It took until 1804 for the world population to grow to 1 billion. The UN estimates that there are nearly 6 billion now, that number is expected to increase to 9 billion by 2060.


Environment
Year AD
Atmospheric CO2
Year
CO₂ Trends - CO₂ has been increasing as a result of fossil fuels.


Environment
Greenhouse footprint
food 24%
electricity 16.9%
transport 8.9%
construction and renovations 11.7%
CONSUMPTION PROFILE
Barwon
What types of consumption are having the biggest impact in this area? Click on items below for more information.
Construction & renovations 11.7%
Electricity
Gas & firewood
Other household operations
Transport
Food
Clothing & fabrics
Furniture & appliances
Books & magazines
All other goods & services

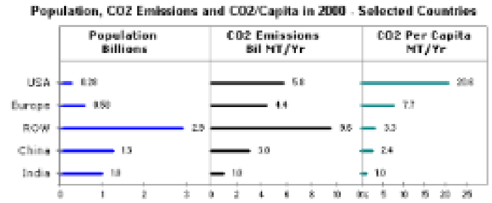

Environment
Consolidated Atmospheric CO2 Data
(Vostok, Law Dome & Mauna Loa)
CO2 - ppmv
Vostok Data
Mauna Loa
Law Dome
400
350
300
250
200
100
AD
1000
2000
Consolidated Atmospheric CO₂ Data Atmospheric CO₂ levels from three data sets extending back 420,0000: Vostok and Law Dome Ice Core and Mauna Loa Observatory.

Environment



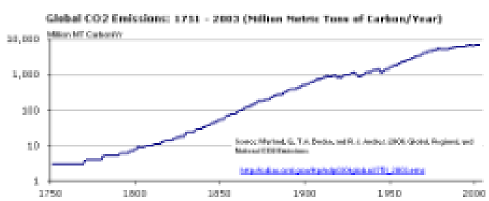
Vostok , Antarctica Ice Core paleoclimate CO2, CH4 and temperature data extending back approximately 420,0000 ybp.

Environment



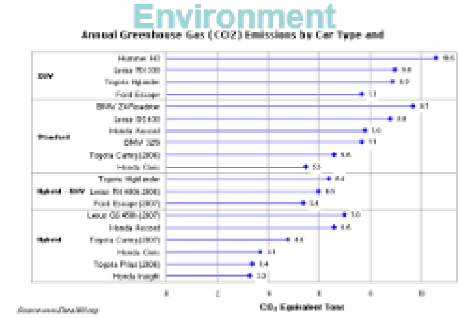
CO_2 Emissions By Country Dot plot above compares the population, CO_2 emissions and CO_2 emission per capita for the USA, Europe, China, India, and the rest of the world (ROW) in 2000.

Environment



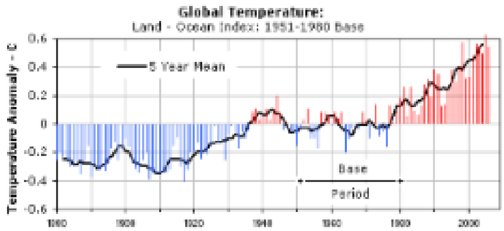
CO_2 Emission Trends - Global CO_2 emissions have increased from an estimated 3 million metric tons per year in 1761 to nearly 7,300 million metric tons per year in 2003, a 2,433 fold increase.

Environment



CO_2 Auto Emissions by Vehicle - EPA estimates that automobiles discharge 19.4 pounds of CO_2 for each gallon of gasoline used. That's why vehicle fuel efficiency plays an important part in CO_2 trends and global warming.
Source: Data360.org

Environment



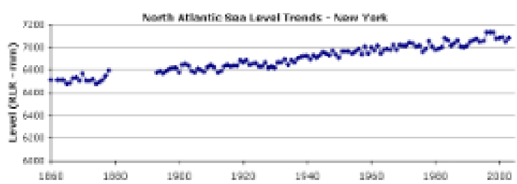
Global Temperature Trend - NASA's Goddard Institute for Space Studies (GISS) data shows the annual global temperature anomalies for the period 1880 - 2008. GISS uses the 1951-1980 period mean to establish the baseline value and calculates individual year anomalies by subtracting the baseline value from the year's mean temperature.

Strategic Directions – Environment

Environmental Protection and Waste Reduction

- Minimize transportation-related air emissions and discharges of contaminants to surface (fresh and salt water) and ground water.
- Minimize the generation of waste through each phase of the life-cycle of transportation vehicles, vessels and infrastructure. Reduce, reuse and recycle.
- Ensure that the rate of use of renewable resources does not exceed rates of regeneration, and non-renewable resource use is minimized.

Environment



Sea Level Changes - The United Nations Environment Programme reports that mean sea levels have risen 10 to 25 cm over the past 100 years. This sea level increase is caused by thermal expansion of warmer water, retreat of glaciers and ice caps and a net positive contribution from the huge ice sheets of Greenland and Antarctica.


http://www.smartcommunities.ncat.org/transpt/
http://its.ucdavis.edu/
www.processtrends.com/toc_global_trends.htm
http://en.wikipedia.org/wiki/Sustainable_transport
http://www.gdrc.org/uem/sustran/sustran-principles.html
Alternative Energy Bulletin, 2009
http://www.geocities.com/alternative_energy_bulletin/index.html
Eco-Casuarina Surf Coast Shire Project
Ontario Ministry of Transportation (logo)
Porteon Electric Vehicles, Thornton, J. "Perspectives on the Future of Transportation and Sustainability."
The Mission Group
U.S. Department of Transportation
Environmental Protection Agency
U.S. Census Bureau
Data360.org
Worldwatch Institute
Barwon Regional Waste Management Group, Victoria, Australia
Commonwealth Scientific and Industrial Research Organization
Victoria Transport Policy Institute, www.vtpi.org
AP Geography Review website; https://kihsaphuge3.wikispaces.com/
http://computationaltales.blogspot.com/2011/06/traveling-salesmans-problem-part-4-of.html
(George Kingsley Zipf, *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology*. Addison-Wesley Press, 1949)
(Isard, 1956. *Location and Space-economy; a General Theory Relating to Industrial Location, Market Areas, Land Use, Trade, and Urban Structure*).

APPENDIX E

CALCULATION SHEET/

QUALITATIVE INSTRUMENT

CALCULATION SHEET AND ESSAY QUESTIONS

MESA COLLEGE SUSTAINABILITY TRIP LOG PROJECT: GEOGRAPHY 102

You are required to calculate the following answers for both TRIP LOGS I AND II, 14 days each, and report them on this sheet.

TRIP LOGS I AND II, the 14 maps from TRIP LOG II, and the written essays are due at the next AND FINAL class period. Check your calculations twice; I will check them and remove points for incorrect answers. Below are also the questions to answer in your TRIP LOGS write up per the course syllabus.

To get full credit for this class project, all TRIP LOGS and maps, all calculations and write ups must be completed to the best of your ability, and turned in on May 14th to Professor Farano.

TRIP LOG I-- 2 WEEK CALCULATIONS:

1. Total no. of trips taken (no. of lines on 2-week trip log) __________.
2. Total no. of vehicle miles traveled, all trips (add "VMT" for all lines) __________
3. Total trip time duration, all trips,(add "mins trip duration" for all lines) ___________
4. Average no. miles per trip (divide # 2 by # 1) ___________
5. Average no. minutes of duration, per trip (divide # 3 by # 1) ____________
6. Average no. of miles traveled per day (# 2 divided by 14) _____________
7. Average no. of trips taken per day (#1 divided by 14) _____________
8. Average time duration of all trips per day (divide #3 by 14) _____________
9. Average auto trips (No. of auto trips (mode "1") divided by no. #1) ______________
10.Average # of trips taken by modes other than auto (#of non auto trips divided by # 1)_______ __________
11. Ave. trip chaining (No of trips w/o a "1" (home) at origin or destination purpose (in 2nd and 3rd last columns) divided # 1__________
12. Ave home-based trips (No of trips with a "1" (home) in origin or dest purpose (in 2nd or 3rd last cols) divided by # 1) ___________
13. What is your value of time? (what is the least you would be willing to accept to give up one hour between 7-8 pm on Wed? (i.e.it is related to your pay rate, the no. of college hours you are taking and the no. of kids you have--how busy you are, etc.)____________

TRIP LOG II-- 2 WEEK CALCULATIONS:

1. Total no. of trips taken (no. of lines on 2-week trip log) __________.
 LOG I MINUS LOG II___________
2. Total no. of vehicle miles traveled, all trips (add "VMT" for all lines) __________
LOG I MINUS LOG II_____________
3. Total trip time duration, all trips,(add "mins trip duration" for all lines) ___________
LOG I MINUS LOG II______________
4. Average no. miles per trip (divide # 2 by # 1) ___________

LOG I MINUS LOG II _________
5. Average no. minutes of duration, per trip (divide # 3 by # 1) ____________
LOG I MINUS LOG II __________
6. Average no. of miles traveled per day (# 2 divided by 14) _____________
LOG I MINUS LOG II ___________
7. Average no. of trips taken per day (#1 divided by 14) _____________
LOG I MINUS LOG II ______________
8. Average time duration of all trips per day (divide #3 by 14) _____________
LOG I MINUS LOG II _______________
9. Average auto trips (No. of auto trips (mode "1") divided by no. #1) ______________
LOG I MINUS LOG II _____________
10.Average # of trips taken by modes other than auto (#of non-auto trips divided by # 1) __________
LOG I MINUS LOOG II __________
11. Ave. trip chaining (No of trips w/o a "1" (home) at origin or destination purpose (in 2nd and 3rd last cols) divided # 1__________
LOG I - LOG II ____________
12. Ave home-based trips (No of trips with a "1" (home) in origin or destination purpose (in 2nd or 3ed last cols) divided by # 1) ___________
LOG I - LOG II _______________

ESSAY: TRIP LOG I AND TRIP LOG II WRITE UP QUESTIONS

1. Were any of your 12 calculations significantly different from TRIP LOG I TO TRIP LOG II? Summarize your numerical calculations.
2. Please evaluate, to the best of your abilities, the 60 sustainability SLIDES and instruction given in class and on the e-mail, which included models of efficient travel behavior such as the traveling salesman trip chaining, carbon footprint, value of time, the principle of least effort, etc.
3. Summarize the effect that this sustainability exercise has had on your awareness of the true costs of travel? * Describe value of time savings.* Have you saved any time? Any money?
4. Summarize the effect that this SUSTAINABILITY TRIP LOG exercise has had on your ability to make more efficient and sustainable travel.
5. Will you be able to make any sustainable changes in your travel in the future because of this exercise? What are your intentions?
6. What would it take for you to become permanently more sustainable in your daily travel in the future?

APPENDIX F

QUALITATIVE CODING TOOL

QUESTION 1 – IS THERE A DIFFERENCE?

Case#__________________

Travel Time	*Number of Trips*
1 = YES	1 = YES, reduced
2= NO	2= NO reduction/more trips Log 2
3= NO MENTION	3= NO MENTION
4=ALREADY EFFICIENT/NO CHANGE	4=ALREADY EFFICIENT/NO CHANGE

QUESTION 2 – EVALUATE SLIDES AND GEO ED (INSTRUCTION)

1 = HELPFUL

2= NOT HELPFUL

3= DIDN'T MENTION

QUESTION 3 – SUMMARIZE AWARENESS OF SUSTAINABILITY BASED ON EXERCISE

Awareness of Travel Cost	*Awareness of Time Savings*
1 = YES, better awareness	1 = YES, better awareness or had time savings
2= NO better awareness	2= NO understanding, didn't have savings
3= DIDN'T MENTION	3= DIDN'T MENTION

QUESTION 4 – ABILITY TO MAKE SUSTAINABLE TRAVEL BASED ON EXERCISE

Practice traveling salesman *Supplies in Car*	*Use Public Transit*	*Load Daily*
1 = YES	1 = YES	1 = YES
2= NO	2= NO	2= NO
3= DIDN'T MENTION MENTION	3= DIDN'T MENTION	3= DIDN'T
4=ALREADY EFFICIENT/NO CHANGE EFFICIENT/NO CHANGE	4=ALREADY EFFICIENT/NO CHANGE	4=ALREADY
Practice DTP	*Walking/Biking*	*New Category*
1 = YES	1 = YES	1 = YES
2= NO	2= NO	2= NO
3= DIDN'T MENTION MENTION	3= DIDN'T MENTION	3= DIDN'T
4=ALREADY EFFICIENT/NO CHANGE EFFICIENT/NO CHANGE	4=ALREADY EFFICIENT/NO CHANGE	4=ALREADY

QUESTION 5 – ANY SUSTAINABLE CHANGES FORTHCOMING AS A RESULT OF EXERCISE?

Practice traveling salesman *Supplies in Car*	*Use Public Transit*	*Load Daily*
1 = YES	1 = YES	1 = YES
2= NO	2= NO	2= NO
3= DIDN'T MENTION MENTION	3= DIDN'T MENTION	3= DIDN'T
4=ALREADY EFFICIENT/NO CHANGE EFFICIENT/NO CHANGE	4=ALREADY EFFICIENT/NO CHANGE	4=ALREADY
Practice DTP	*Walking/Biking*	*New Category*
1 = YES	1 = YES	1 = YES
2= NO	2= NO	2= NO
3= DIDN'T MENTION MENTION	3= DIDN'T MENTION	3= DIDN'T
4=ALREADY EFFICIENT/NO CHANGE EFFICIENT/NO CHANGE	4=ALREADY EFFICIENT/NO CHANGE	4=ALREADY

QUESTION 6 – NECESSARY CONDITIONS TO PRACTICE SUSTAINABILITY

1 = More stable lifestyle

2 = Increase their residential location accessibility

3 = Improve public transit efficiency/scheduling

4 = Personal Sustained Awareness/Diligence for such travel

5 = More Efficient Auto

APPENDIX G

LIKERT SCALE

OF

QUALITATIVE FINDINGS

LIKERT SCALE RANKINGS

Question	1 Any Difference	2 Evaluate Training	3 Evaluate Cost of Travel/ Time	4 Evaluate Trip Log for Sus. Travel	5 Will you Change Travel?	6 Permanently, What will It take?
1	2	2	1	1	1	Organize day, stay on campus
2	3	1	2	2	2	
3	2	2	2	2	2	
4	2	1	1	1	2	
5	1	1	2	1	1	Bike, walk
6	1	1	2	2	2	Chaining trips
7	2	1	1	2	2	Ask for rides
8	1	2	1	1	1	Bike, move to sustainable city, Davis, CA
9	1	1	1	1	1	Work, more determination
10	2	1	1	2	1	
11	2	2	2	2	2	
12	2	2	2	2	1	
13	2	1	1	2	2	
14	1	1	1	1	1	Switch modes
15	4	1	2	2	2	
16	2	1	2	1	1	
17	4	1	2	2	1	
18	2	1	1	1	1	
19	1	2	1	2	2	
20	1	2	1	1	2	
21	2	1	2	2	2	
22	2	1	1	2	1	
23	2	1	3	1	1	
24	1	1	1	1	2	
25	2	1	1	2	1	
26	2	1	1	1	2	
27	1	2	1	1	1	
28	2	1	2	2	3	
29	1	1	1	1	2	
30	1	1	1	1	1	
31	2	1	1	1	2	
32	1	1	1	2	2	
33	1	2	2	1	1	
34	2	2	2	1	2	
35	3	1	2	1	1	
36	2	1	1	2	2	

Question	1 Any Difference	2 Evaluate Training	3 Evaluate Cost of Travel/ Time	4 Evaluate Trip Log for Sus. Travel	5 Will you Change Travel?	6 Permanently, What will It take?
37	1	1	1	1	2	
38	2	1	1	1	2	
39	2	2	3	2	1	
40	2	2	2	1	2	
41	3	1	3	2	1	
42	1	2	1	1	2	
43	4	1	2	2	2	
44	2	2	1	2	2	
45	1	1	2	1	1	
46	2	1	2	1	2	
47	2	1	1	1	1	
48	1	1	1	1	1	
49	3	2	2	2	1	
50	2	1	1	2	1	
51	2	1	1	1	1	
52	2	3	1	1	1	
53	1	1	2	2	1	
54	2	2	3	2	1	
55	4	1	3	1	1	
56	2	2	1	1	1	
Average Likert Score	**1.893**	**1.339**	**1.536**	**1.446**	**1.482**	

Responses to the five essay questions were ranked using a five-point Likert scale where 1=very positive; 2=positive; 3=neutral; 4=negative; and 5=very negative.

APPENDIX H

SAMPLE DATA

DTPs (one set included)

COMPLETED ESSAYS (two included)

Google

4/30 M

Get Google Maps on your phone
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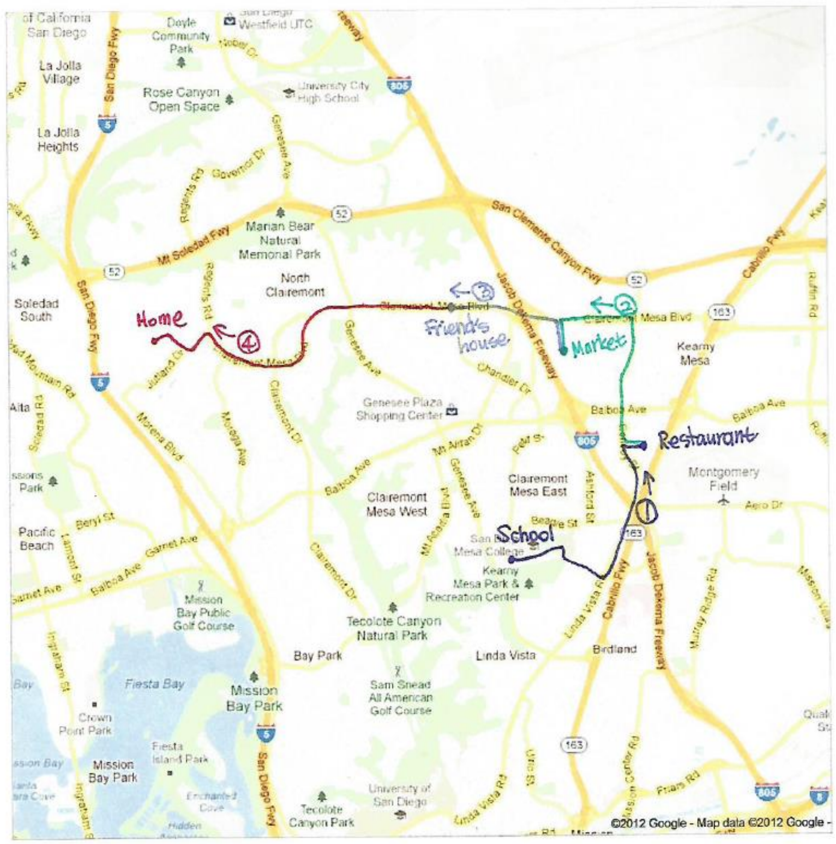

DTP Phase II-Week 1 Case#M8

Source: Google Maps

Base map printed with permission from Google

Google Maps 페이지 1 / 1

Google

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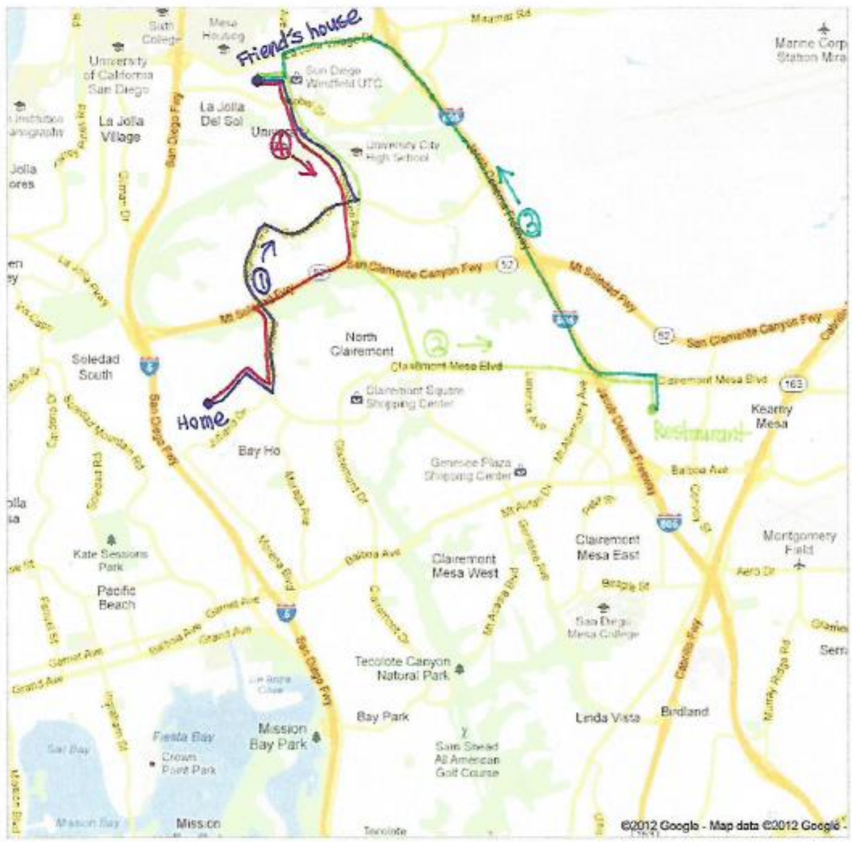

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Case#M8

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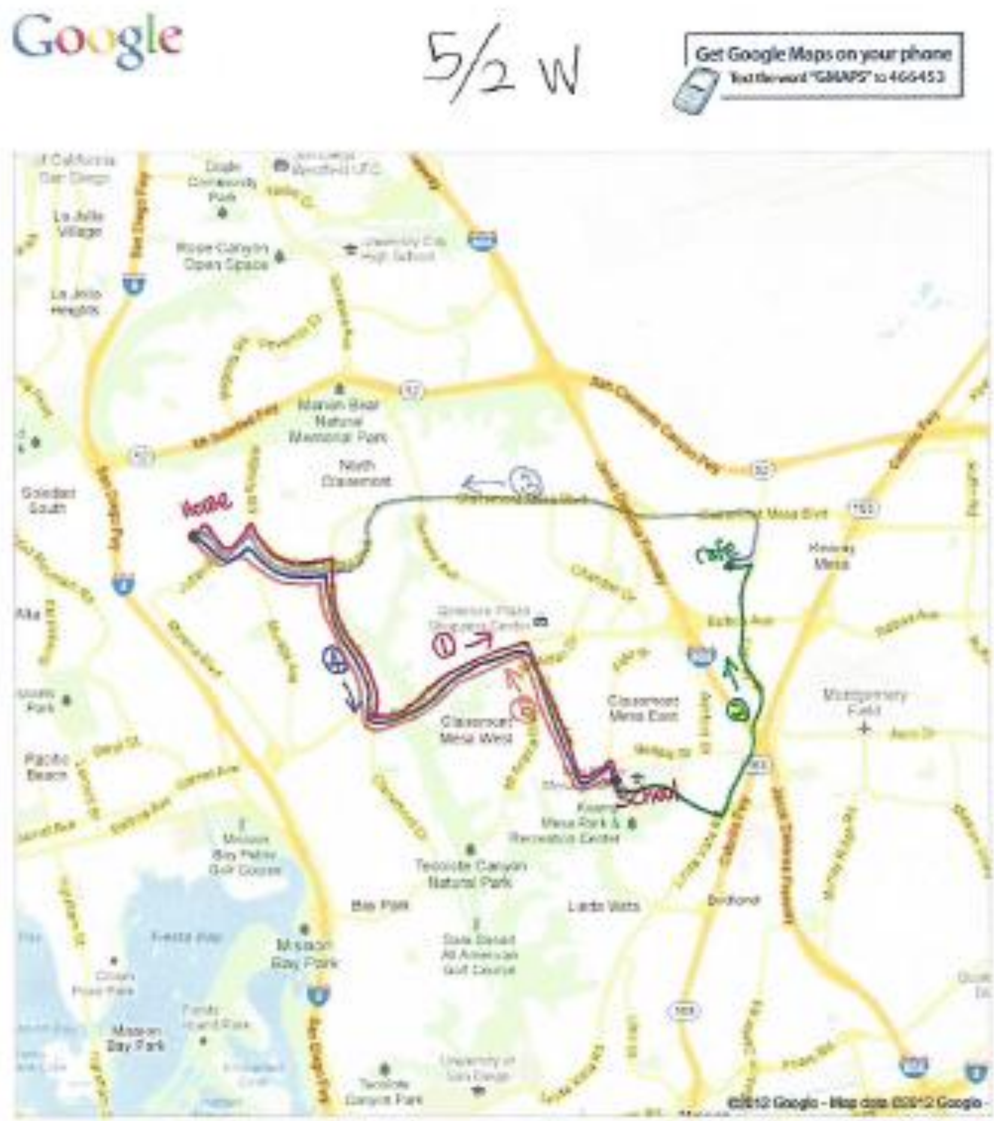

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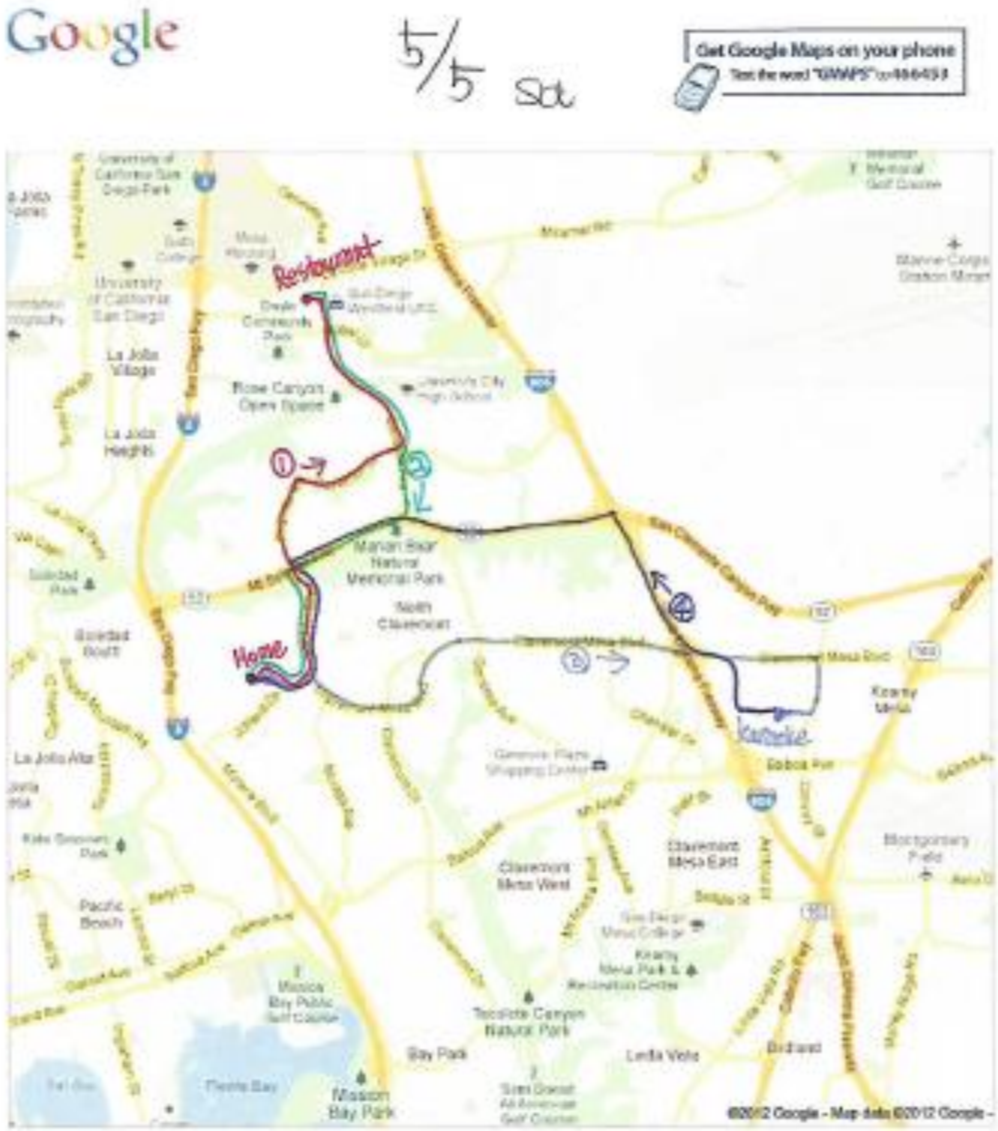

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Source: Google Maps

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Google

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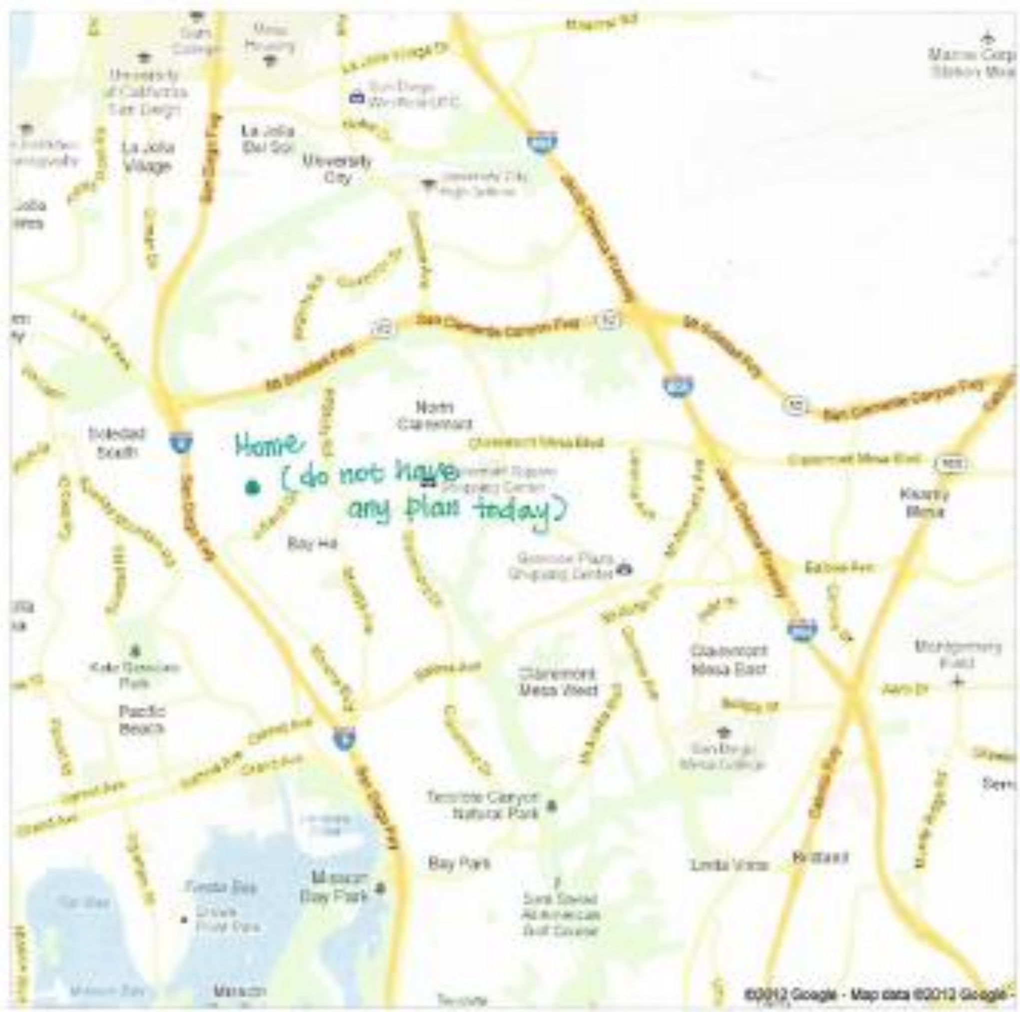

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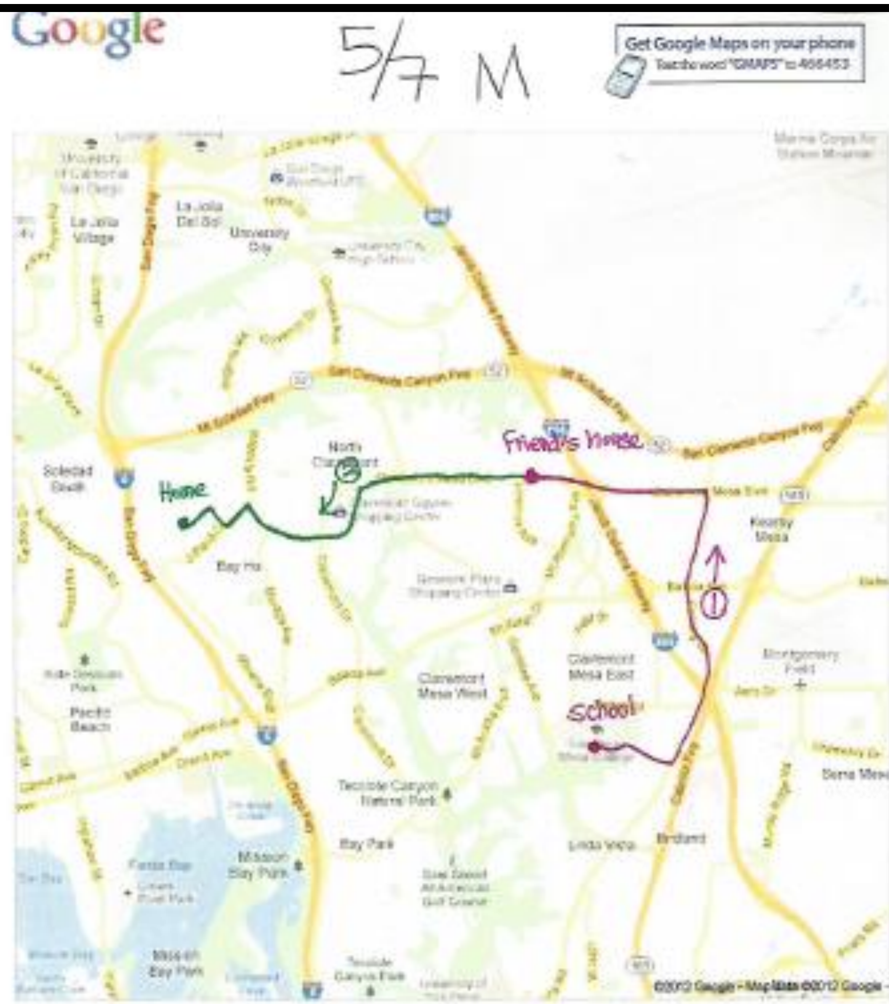

DTP Phase II- Week 2   Case#M8

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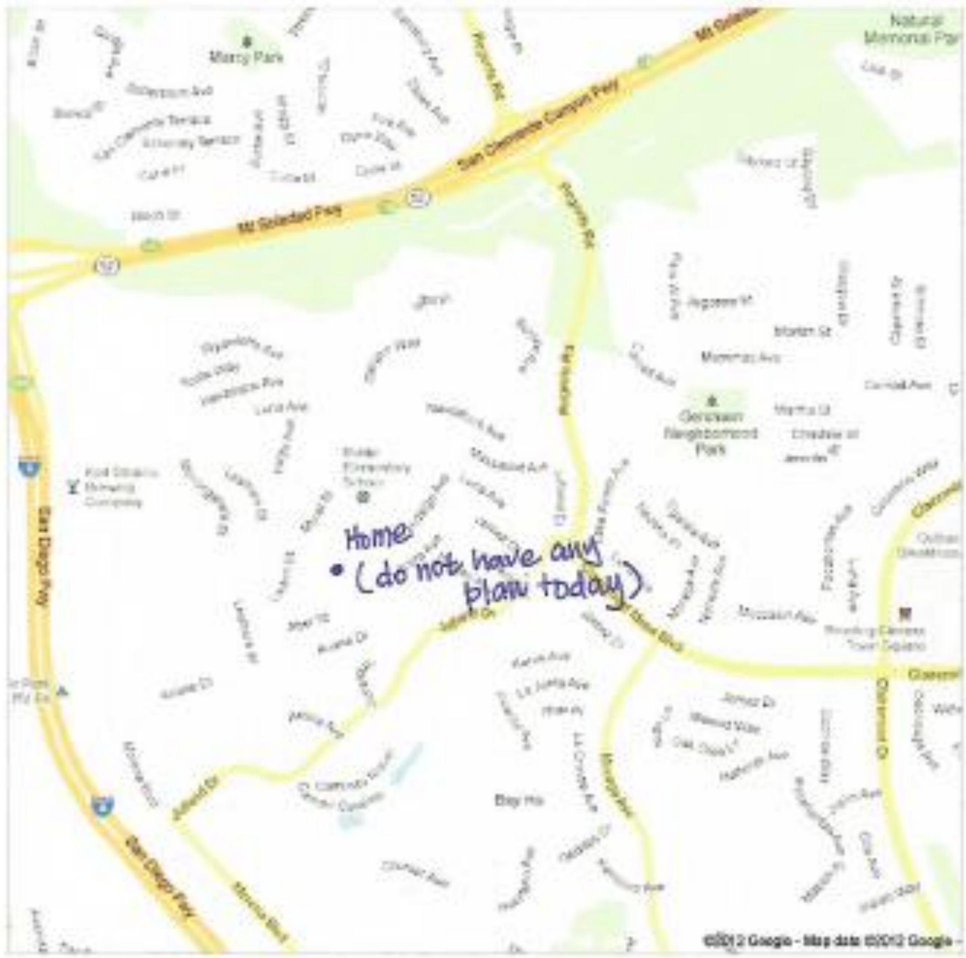

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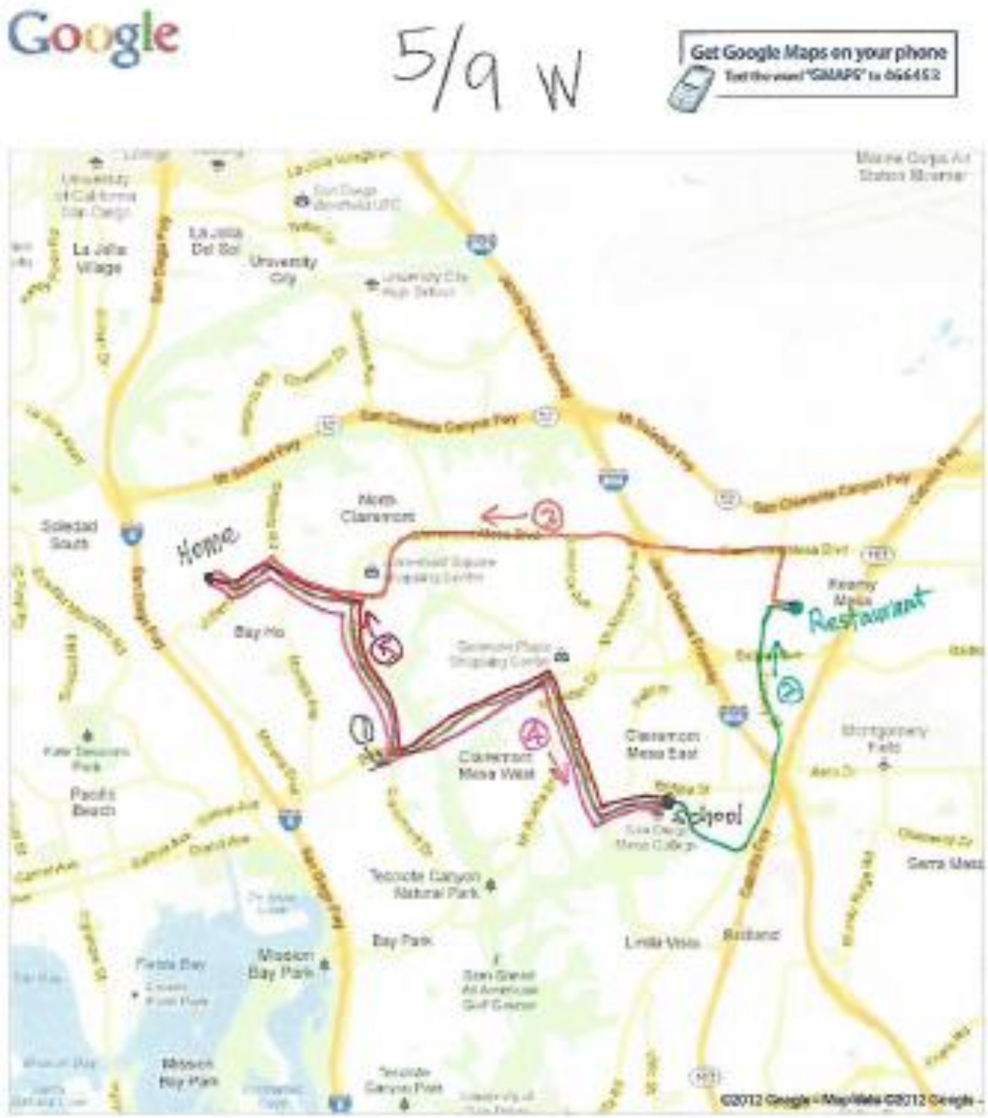

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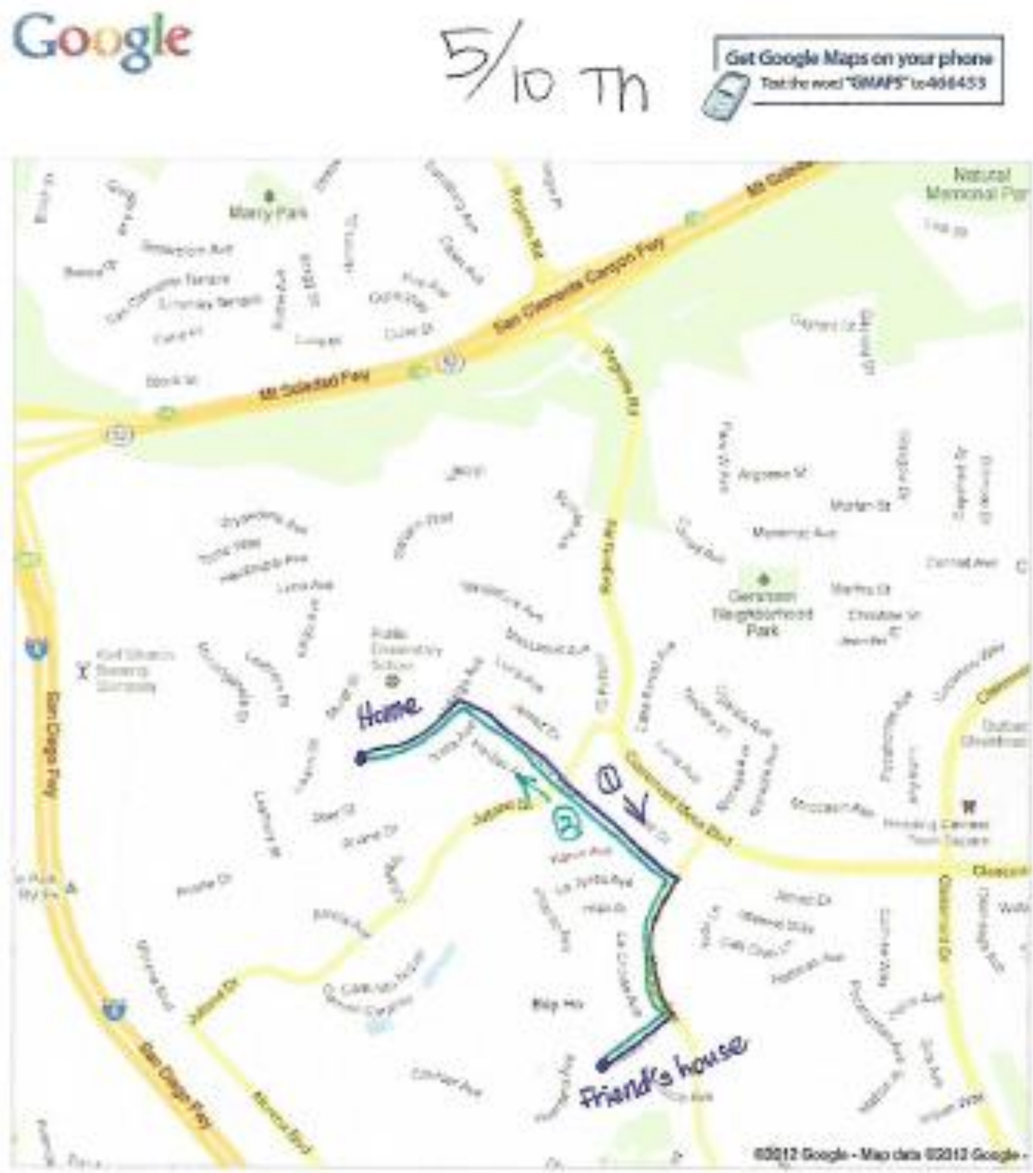

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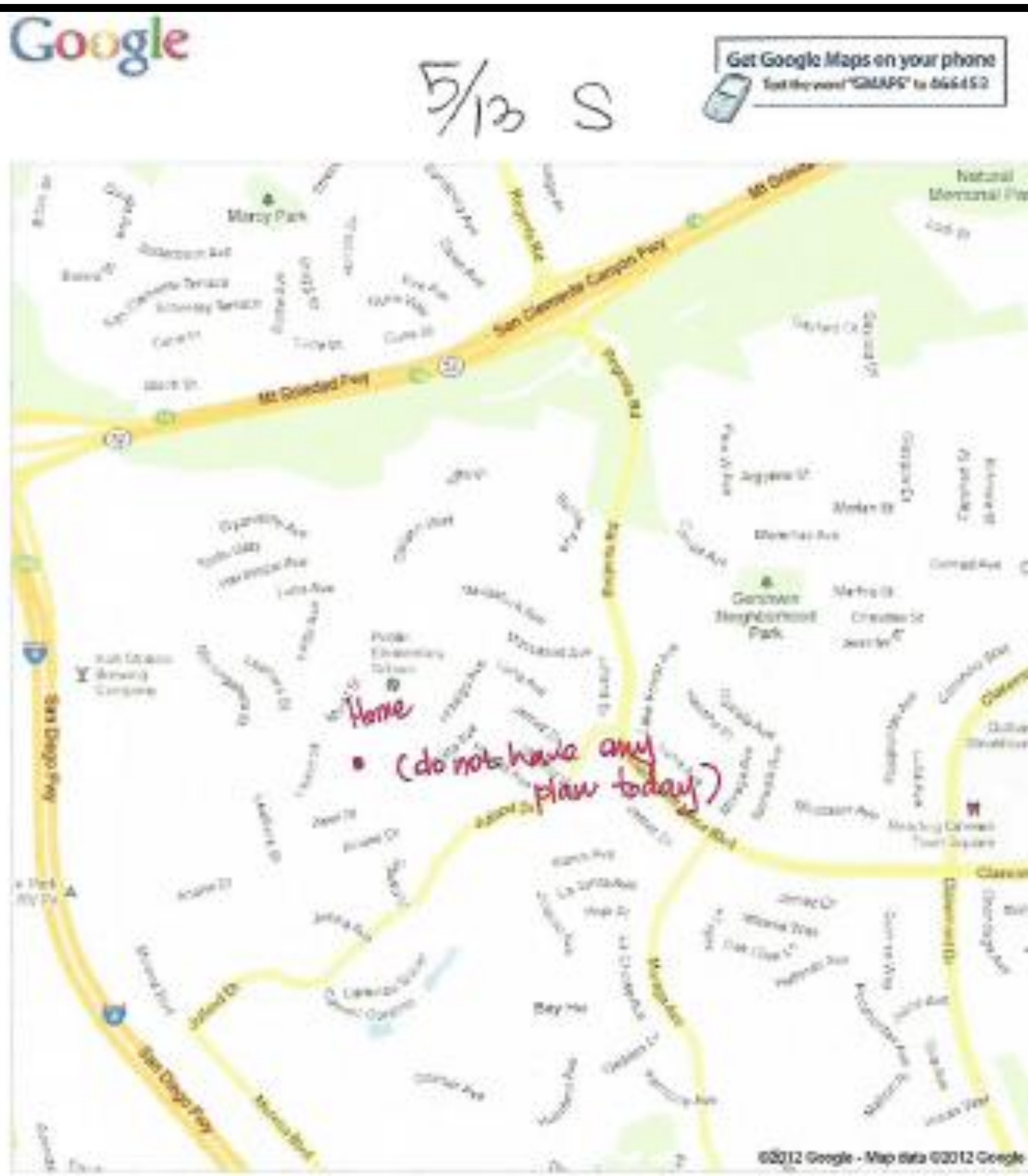

DTP Phase II- Week 2 Case#M8

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Trip Log Comparison

In the comparison of the two trip logs, I have found that I have made tremendous advantages to my efficiency in travel. I have found that by analyzing trip models and charts, I was able to comprise a trip log with success and methodical travel. Some of the charts were more helpful than others, but in general they all gave me an idea of how sensible travel should be done. Through the use of the Trip Distribution Model, I was able to track my trips by category and find out which type of trips I take the most and to where. This was helpful in comprising a plan to know which places were closest and which tasks I needed to complete in which day. Though creating a Utility Profile Model, I was able to see the changes in positive and negative utility and recognize that my time is worth way more than I had pictured. I have found out that my days and minutes spent during those days are extremely important if I have things that need to get done. When my positive utility was not too high, I was able to recognize the days that I had more time to kill and where my time was not as valuable. This has increased my efficiency in my travels and decreased my negative utility since I had more time to get to certain places by linking trips together.

Through creating a plan of strategic directions, I was able to get to my desired location with the least amount of travel as possible. In the lectures on Blackboard, I was able to learn that by cutting down on my trips or by using different modes of transportation, I can be efficient in all ways of travel. Also, by learning about Cost: Time and Money, I realized that I am one of those college kids that spends at LEAST fifty eight minutes driving daily. This has made me be wiser in the decisions I make to drive and link more trips together. By acknowledging how much the average weekly costs are to travel with a large vehicle, I have found ways that I will be saving money that I thought I did not have. This has increased my attitude about life since I have more money in my pocket. By cutting down on daily trips, I have learned that it dramatically effects the use of materials such as oil and creates less pollution. This has driven me to be more mindful when planning trips since it effects not just me, but the population surrounding me. By reading through the powerpoints by Christa, I have really taken into account the use of oil in the country and which country are more mindful on there consumption. Without a doubt, the United States needs to cut down on there daily trips and become more efficient in not just planning trips and linking trips together, but by becoming efficient in the fossil fuels and resources that we use. These impacts directly effects our lives and we are just going to make it more difficult to fix the problem we as human beings have put ourselves into. Through the use of alternative fuels and by the population controlling their use of vehicles, we can make good changes in the world and set a standard for people to live by. The United States is the most powerful nation in the world and if we want to remain near the top, we must create a new way to create less pollution and generate better products to power our utilities and vehicles with. Through the tactic of simply changing our ways, others will catch on and we can create sustainable energy at the lowest possible cost for all to enjoy with ease.

The behavioral changes that I went through between trip log one and trip log two was very extensive. I changed my model of transportation from the Hub and Spoke method talked about in class to the traveling salesman method. I found that I was able to be more efficient in my daily tasks while using as little of fixed cost a possible with still completing the things that I had to do. Some of the behavioral changes that I went through were trips to the gym, where I traveled straight from school to the gym where I previous did not. Previously, I went back home to change, and then to the gym where I would stay for a few hours and return home. I found that I had better success and used less time during the day when traveling straight to the gym after classes. There were also trips that I linked together as well when traveling to the beach as well. Before I would have gone home to get my surfboard since the decision to surf was spur of the moment. I planned my trips to the beach more where before I did not. I would take my surfboard directly to school now and surf after or before classes. This I found to be less exciting at the beach, since the waves are not always good at the time. I know just keep the surfboard in the back of my truck so I can go when or where I am ready to go.

My motivation to go to school changed as well because I knew the events or things I needed to do after I got out of class. Before I would go home after class and decide what I needed to do after classes. Now I was planning my days out before I left the house for the first time of the day and found that I had more motivation to complete class and the rest of my day. I found myself efficiently planning things that were closer to eachother and holding off on things that I needed to do that were closer to another days travels. This motivated me to get certain things done on certain days and helped me develop a certain pattern of traveling throughout the week. I was more motivated to get to the gym everyday as well since they were linked trips with me classes. I am in better shape, more active, and happier in general because of my ability to get the things done during the day that I needed to. My thinking has changed as well when discussing traveling to destinations with other people. I am usually the coordinator of trips and things to do with my friends, so in myself changing my patterns of travel and daily chores, I have effected not only myself, but some of my friends to a certain extent. My attitude has changed slightly when I have plan to go certain places, because now I have the assurance that I am traveling at the shortest distance that I can with less trips. I have also recognized that I do not fill up gas as much which directly affects my attitude since I drive a truck. My weekly gas bill has decreased dramatically and my parents have even said something to me about it and are happier. This also directly affects my attitude because if they are happy with me, then I am happy with me.

My future intents are to be as efficient as possible when mapping out my daily plan. I do not think I will be making maps, but in my head, I will be planning the things I need to do with relation to efficiency instead of doing things when they pop into my head. I have shared my trip logs and ways of steady planning to my family as well and I think that they are starting to take into account the trips that are unnecessary that we all do. With being efficient in travel, hopefully some of the methodical techniques will carry over into other aspects of my life. I will be applying knowledge I have gained from doing these trips logs to my everyday life even if it does not involve trips. I will be completing schoolwork with efficiency and working out at the gym harder in the time that I am allowed. By recognizing how much my time is worth, my attitude, future intents, and motivation to do certain tasks has changed and will continue to be on my mind. By knowing how much your time is worth, you can successfully apply the knowledge gained through this exercise of efficient trip planning.

Trip Log Analysis

Question 1:

Yes, nearly all of my twelve calculations were significantly different from TRIP LOG 1 to TRIP LOG 2. In my initial two weeks of doing the doing the trip logs I accumulated a total of 131 trips. Whereas, in my final two week I recorded only 80 trips traveled. This means that by planning my trips out ahead of time I was able to cut out 51 trips during my second week. By removing those extra 51 trips I was able to decrease my total number of vehicle miles traveled from 866.4 miles to just a little over half that amount at 481.4 miles. It goes without saying, that by decreasing my miles traveled by 385 miles, I too was able to lower the total trip time duration during a two week period from 1,508 minutes to only 899 minutes in my second two weeks of this project. This astonishing 609 minute differences allowed me to add ten hours and fifteen minutes of much deserved "me time" to my schedule this past two weeks. Now, because I work in a flower shop and occasionally I deliver flowers, I cannot control the distance and or the time it takes to reach a certain location. For this reason my next two calculations were not as significantly reduced. The average number of miles traveled per trip was only lessened by a mere .59 miles from my original 6.61 miles per trip. Likewise, the average number of minutes of duration per trip dropped a pitiful .27 minutes from 11.51 to 11.24 minutes per trip. However, by planning ahead and taking more deliveries at once, I was able to reduce my average number of miles traveled per day from 61.89 miles to 34.39 miles per day. Furthermore, because I stopped delivering flowers one by one I was able to lower the average number of trips I took in a day from 9.36 trips to 5.71, which is a difference of just shy of 4 trips. Overall by doing this I saved 43.5 minutes off of all of my trips taken per day.

Question 2:

All of these reductions in my time, distance, and cost to travel were possible with the help of the 60 sustainability slides and the instructions given in class, as well as the e-mail which include the traveling salesman model, trip chaining, carbon footprint, value of time, and the principle of least effort. The traveling salesman model is designed to take a predetermined set of locations and calculate the most efficient way to reach every location once and then return to the origin. By doing this the pattern of travel will tend to resemble a circle. This pattern is much more efficient and wallet friendly than the traditional wheel and spoke pattern that I had naively grown accustom too. In addition the concept of trip chaining makes the ability to use the traveling salesman model with a greater sense ease. Trip chaining is combining multiple errands into one trip that will help save gas, money and time. Doing this and planning what I needed to have done during the course of the day and over the two week period, I was able to get more tasks done, in less time, and with less gas because I eliminated the need the backtrack to places I had already visited. Another benefit of driving less and not having to backtrack is that it helps to reduce my carbon footprint. Carbon footprints are the total amounts of greenhouse gases produced to directly and indirectly support human activities, such as driving my car. Less people driving and use of the other forms of transportation such a public transportation, biking and a good old fashion walk can greatly reduces the amount of CO_2 emissions in the air which will better help our environment and keep our ozone from completely disappearing. A second benefit of driving less is more free time. My time is incredibly valuable to me and so by better understanding what my time is worth I can make smarter decisions about the things I do and how I go about achieving them. For this reason I found the principal of least effort to be very helpful. The principal of least effort is the idea that one should try to solve a problem in a way that minimizes the total amount of work that one must put into solving both the immediate problem as well as probable future problems. In short I took it to mean that I need to think and plan things out before I do them so as not to waste my valuable time, money and energy. This way I can focus on efficiently getting my entire present tasks done but still consciously planning out future tasks without creating more work or spending any extra money or unnecessary time.

Question 3:

This sustainability exercise has definitely affected my awareness of the true costs of travel. Especially as someone who delivers flowers for a living, it really is an I opener for me because not only can I see how much my time I have gained during this past two weeks of this exercise, but now I am capable of actually calculating the exact cost of driving and operating my vehicle. I now can figure out if it is even worth my time and energy to make certain trips. Even more so, if the trips are necessary is it practical and or economical to make those trips in a car, as opposed to another form of transportation. I drive an SUV, a 2004 Saturn Vue to be exact. This means I get 16mpg. So with gas prices being about $4.00 and rising, divided by my 16gallon tank it is costing me $0.25 per mile. Then I times this by 2 in order to add in the depreciation, maintenance, and insurance cost this brings my cost for operating my car to $0.50 per mile. If I then take the 480 miles I drove during the past two weeks I "lost" $240. However compare to the miles travel during the initial two weeks, in which I drove 866 miles and "lost" $433, due to this project I was able to save $193 using my new found sustainability methods. In addition with the decrease in trips taken and miles traveled I was also able to save 609 minutes, which is time that is much needed elsewhere in my life.

Question 4:

This sustainability trip log has certainly affected my ability to make more efficient and sustainable travel in many ways. This project has undoubtedly made me more conscious of the value of my time and the cost that is required for my vehicular travel. I too am more aware now of the repercussions of extensive driving on my environment as far as contributing to the greenhouse gases and the use of non reusable sources of energy. Knowing now that with everything I do I leave a carbon footprint behind me has made me feel a sense of responsibility and obligation to continue on and try to make more efficient and sustainable travel decisions in my future.

Question 5:

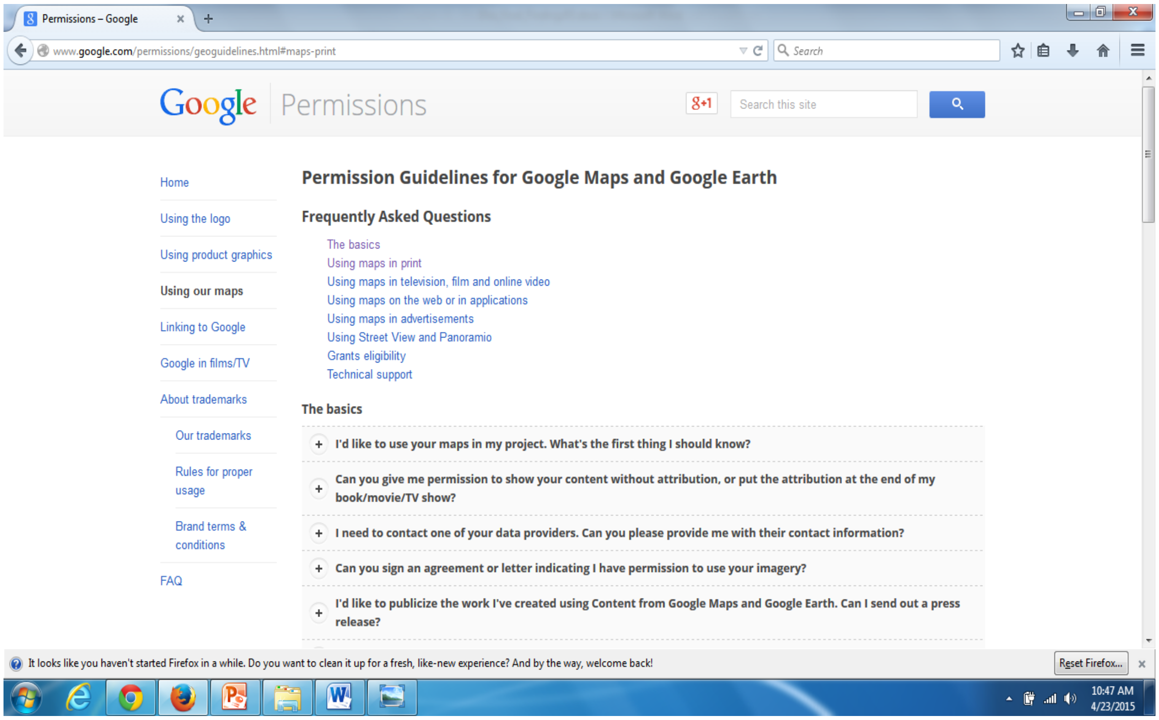
I do believe that I will be able to make sustainable changes in my travel in the future because of this exercise. My intensions are to continue with this program to the best of my abilities. I know it will not be easy for me at first, but like anything new, practice makes perfect. I know that this is something I do want to stick with, especially now that I realize how much more time and money I can save by doing this. I can now have time to spend doing more of the things I want to do like spending time with my family and friends instead of wasting my energy and time making redundant and repetitive trips. Despite the fact that I loathed having to make my daily plan ahead of time, mainly due to the fact that the concept of it felt strange and awkward to me, it did make my day run significantly smoother and more efficiently. So my goal is to continue planning out my days ahead of time. However in all honesty, I am a flawed human like everyone else. Therefore perhaps a better goal more attainable goal for me right now, especially with summer break coming, would be to plan the majority of my day out. As for my job, I believe that I have full heartedly embraced the model of the traveling salesman, as well as the principal of least effort and I will continue to apply both concepts to every delivery, they have made my job much less stressful and much simpler.

Question 6:

I think in order for me to become permanently more sustainable in my daily travel in the future it is going to take patience and persistence. I tend to be a very implosive and spontaneous person by nature. I think for that reason I found this exercise to be very difficult for me at time. I am not usually one who likes to plan every step of my day out. I would much rather "go where the wind takes me" so to say. However because I do see the benefits in a more sustainable manner of travel I believe with more practice and real determination I know in time I will be able to use and apply all of these new skills with a greater efficiency. I figure if I stick with it long enough it will become second nature to me. I look forward to being able to fully reap the all the benefits of this project. I feel I will be less stressed out worrying about my time management and running around trying to complete a thousand tasks, and hopefully I will have a little extra cash in my pocket to do the things I enjoy. For these reasons and more I believe I have already been convinced to become permanently more sustainable in my daily travel in the future.

APPENDIX I

PERMISSION FOR USE OF GOOGLE MAPS IN PRINT



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FAQ

Permission Guidelines for Google Maps and Google Earth

Frequently Asked Questions

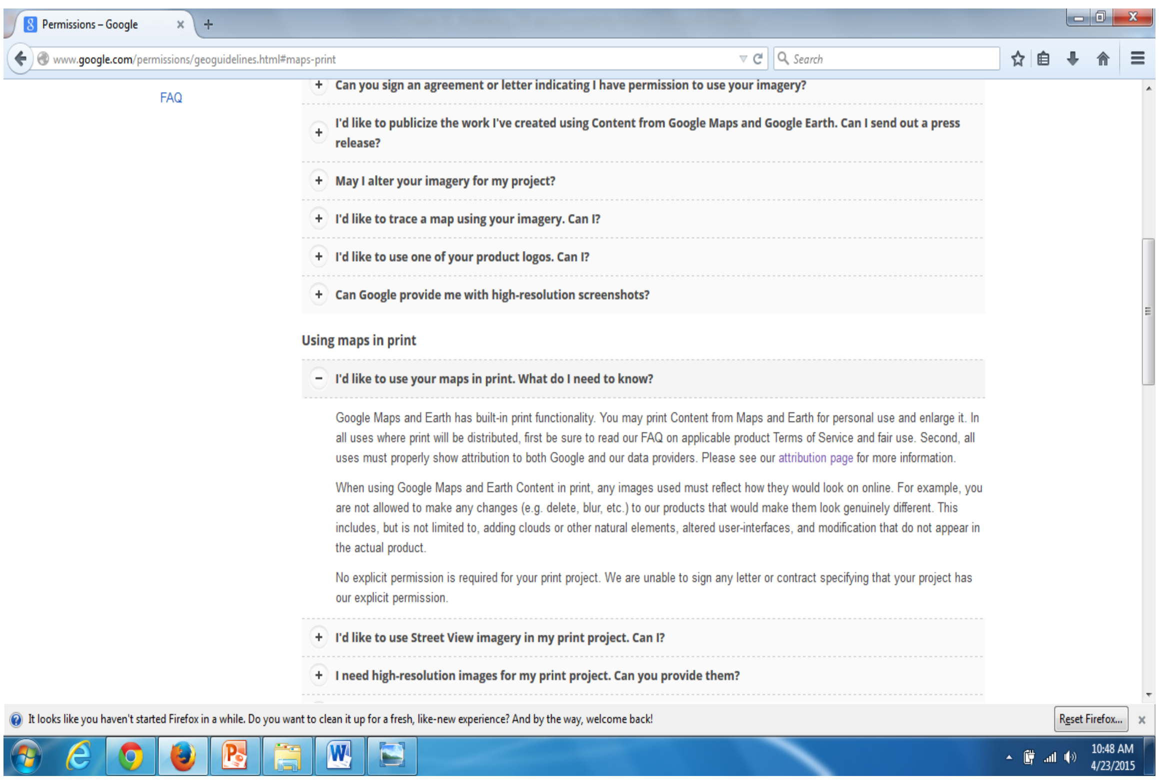
The basics
Using maps in print
Using maps in television, film and online video
Using maps on the web or in applications
Using maps in advertisements
Using Street View and Panoramio
Grants eligibility
Technical support

The basics

+ I'd like to use your maps in my project. What's the first thing I should know?
+ Can you give me permission to show your content without attribution, or put the attribution at the end of my book/movie/TV show?
+ I need to contact one of your data providers. Can you please provide me with their contact information?
+ Can you sign an agreement or letter indicating I have permission to use your imagery?
+ I'd like to publicize the work I've created using Content from Google Maps and Google Earth. Can I send out a press release?

It looks like you haven't started Firefox in a while. Do you want to clean it up for a fresh, like-new experience? And by the way, welcome back!

10:47 AM 4/23/2015



Permissions – Google

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FAQ

+ Can you sign an agreement or letter indicating I have permission to use your imagery?
+ I'd like to publicize the work I've created using Content from Google Maps and Google Earth. Can I send out a press release?
+ May I alter your imagery for my project?
+ I'd like to trace a map using your imagery. Can I?
+ I'd like to use one of your product logos. Can I?
+ Can Google provide me with high-resolution screenshots?

Using maps in print

− I'd like to use your maps in print. What do I need to know?

Google Maps and Earth has built-in print functionality. You may print Content from Maps and Earth for personal use and enlarge it. In all uses where print will be distributed, first be sure to read our FAQ on applicable product Terms of Service and fair use. Second, all uses must properly show attribution to both Google and our data providers. Please see our attribution page for more information.

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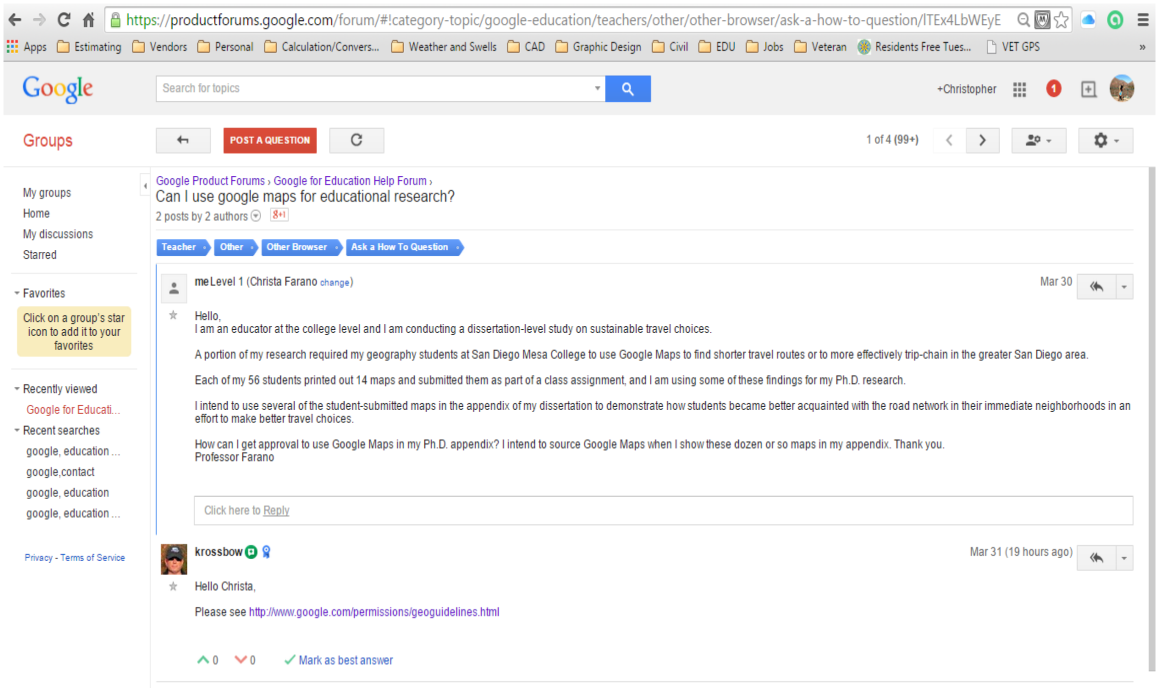
10:48 AM 4/23/2015



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Google Search for topics +Christopher

Groups POST A QUESTION 1 of 4 (99+)

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My discussions
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Google Product Forums › Google for Education Help Forum ›

Can I use google maps for educational research?

2 posts by 2 authors

Teacher Other Other Browser Ask a How To Question

me Level 1 (Christa Farano change) Mar 30

Hello,
I am an educator at the college level and I am conducting a dissertation-level study on sustainable travel choices.

A portion of my research required my geography students at San Diego Mesa College to use Google Maps to find shorter travel routes or to more effectively trip-chain in the greater San Diego area.

Each of my 56 students printed out 14 maps and submitted them as part of a class assignment, and I am using some of these findings for my Ph.D. research.

I intend to use several of the student-submitted maps in the appendix of my dissertation to demonstrate how students became better acquainted with the road network in their immediate neighborhoods in an effort to make better travel choices.

How can I get approval to use Google Maps in my Ph.D. appendix? I intend to source Google Maps when I show these dozen or so maps in my appendix. Thank you.
Professor Farano

Click here to Reply

krossbow Mar 31 (19 hours ago)

Hello Christa,

Please see http://www.google.com/permissions/geoguidelines.html

0 0 Mark as best answer

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