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By

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ABSTRACT

PROMOTING SUSTAINABILITY:
MENTAL MODELS RESEARCH TO INFORM THE DESIGN OF A CAMPUS RECYCLING PROGRAM

By

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The Michigan State University (MSU) initiative for comprehensive and campus-wide recycling program has a goal of increasing recycling participation. A coupled strategy to facilitate recycling will require more knowledgeable students, faculty, and staff, as well as a thoughtfully designed, well structured, and institutionalized program. This research speaks to the charge of educating the MSU community, and to a lesser extent the physical characteristics of the program. The mental models approach was used to inform the design of outreach efforts by quantifying the level of knowledge held by student and faculty subjects about recycling concepts. Responses were elicited by way of broad, open-end interviews associated with mental models research. The visual representation of subjects' recycling knowledge as mental models and statistical analysis of their scored responses, revealed distinct specific differences between students and faculty as well as common trends. Both students and faculty were aware of broad concepts of different materials and separation, but generally lacked knowledge of specific details. Knowledge was generally poor in terms of specific benefits of recycling; yet the disincentives of participation were relatively well understood. With a more targeted and systematic outreach program, the audience will (theoretically) have improved knowledge upon which they can base decisions to recycle more items, and—importantly—to recycle these items correctly.

In memory of Chickpea

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A product's life cycle begins with the extraction of raw materials, which are shaped into goods, sold, used, and then disposed of, usually in either an incinerator or a landfill (McDonough and Braungart 2002). Before disposal, a used product can potentially be collected for recycling, and subsequently made into a new products (Strong 1997). Formal recycling programs have gained popularity in the developed world because of wide-ranging concerns about landfilling and incinerating wastes, including the possible cumulative and long-term effects to the environment and human health. Despite their popularity, many communities have had considerable difficulty with designing and implementing robust recycling programs; in other words, programs that encourage people to divert the maximum amount possible from the waste-stream for recycling collection.

Recycling programs facilitate the collection of materials from consumers. The stage where the consumer is given the choice to recycle or not, is perhaps the most important stage of the recycling process, because the amount collected is strictly dependent on the consumer's involvement. For this reason, programs designed to engage consumers in recycling activities are given considerable study.

In terms of its history, recycling became an important cause for governments and institutions in the mid 1980's. Since then, recycling rates in the United States have doubled from 16.2% in 1990 to 32.5% in 2006 (Environmental Protection Agency 2007). In 1988, when the Journal of Composting and Organics Recycling (also known as *Biocycle*) started publishing yearly reports on "The State of Garbage in America," less than 1,000 curbside programs were known to exist (Simmons, Goldstein et al. 2006). In the latest report of 2004 data, 7,689 curbside programs were known to exist in 41 of 50

American states (Simmons, Goldstein et al. 2006). It is worth noting that these figures include neither community drop-off locations nor universities or colleges that provide recycling services.

Beyond residential communities, recycling at university campuses grew from the fringes to become a mainstream practice around the same time as governmental (municipal) programs, with the University of Colorado at Boulder creating the first position for a campus-wide recycling coordinator in 1984 (Keniry 1995). This university's move recognized the need for an institutionalized program comprised of dedicated facilities and full-time custodial staff because of the belief that successful, large-scale recycling demands more than volunteer student efforts (Keniry 1995). In 1993, the National Recycling Coalition, the main national recycling trade association, recognized the occupational association of College and University Recycling Coordinators, signaling that campus recycling needed to be treated with the same level of seriousness as municipal recycling programs (Lounsbury 2001).

At Michigan State University (MSU), the site of this research, recycling has been an institutionalized activity since 1990. Like the University of Colorado at Boulder, MSU also has on staff a full-time recycling coordinator in MSU's Office of Recycling and Waste Management. In the first year of its program in 1990, MSU recycled 200 tons of paper, which increased to more than 1,600 tons in 2006 (Link 2007).

However, MSU's recycling program is not perfect. Beyond paper products—which includes white paper, mixed paper, cardboard, and newsprint—other types of recycling are not currently available on a campus-wide scale. In another example, some academic and residential halls have a system in place for the collection of batteries. This system for collection is uncoordinated and non-existent in other buildings and does not give students, faculty, or staff the option to participate. In general, expanding the amount and variety of materials collected for recycling will give these stakeholders more opportunities to divert material from the waste-stream to recycling. Providing recycling collection points is only half of the solution; the other is increasing the rate of participation in the recycling program.

MSU community is comprised of students, faculty, and staff[1] whose activities, sometimes inadvertently, yield abundant amounts of waste. In 2007, undergraduate students made up the largest segment of the campus community with 36,072 people representing the student body; graduate students were the second largest segment of the MSU population (9,973). Due to the sheer number of students—46,045 individuals strong—they have the greatest potential to create a large amount of waste, and thus to divert materials to recycling.

In addition to students, faculty members are also important in increasing recycling rates because they represent a much more stable population who can contribute to a lasting culture of waste reduction, without frequent interventions. There are approximately 4,800 faculty members on the MSU campus. While the majority of waste produced by faculty members seems to consist of paper products, they also generate waste in the form of hazardous and laboratory wastes. Their role in waste reduction will have perhaps the greatest impact—and long-term effect—in terms of reducing MSU's environmental footprint.

[1] University staff were also recognized as important participants in any campus-wide recycling initiative. This group was involved in a parallel, focus group based study of programmatic needs (Hansen, McMellen et al. 2008).

For MSU to have a successful recycling program, institutional support of infrastructure (i.e. consistent bins and collection points) must be coupled with buy-in and increased participation from students, faculty, and staff to change or enhance their waste reduction and waste recovery (i.e. recycling) practices accordingly.

Because all recycling programs are reliant on individual participation, many previous studies of recycling have focused on strategies to motivate recycling behavior. None of these strategies should be viewed as universally effective, however some have been shown to work better than others in terms of encouraging participation in recycling collection.

There has been some study of how to specifically tailor recycling programs to an audience on the basis of demographic variables such as income, ethnicity, and gender (Goldenhar and Connell 1992; Howenstine 1993). Nevertheless, the tailoring of recycling programs has been largely understudied in recycling literature, particularly when it comes to understanding the current state of knowledge possessed by today's recycler.

This paper outlines a mental models approach for assisting with communication and education efforts based on what people know and do not know about the topic of recycling at an institute of a higher education. The objectives of this research project were to: (1) quantify the recycling knowledge of non-expert populations (students and faculty) and identify relevant gaps or lack, and (2) provide recommendations to fill gaps in recycling knowledge, correct misconceptions, and reinforce correct beliefs. Overall, this research seeks to provide a foundation for informing recycling outreach plans.

2. Facilitating Pro-Recycling Behavior Change

Encouraging recycling behavior generally involves programs that use either *situational* or *personal* incentives. Situational incentives provide an extrinsic motivation to encourage recycling (Bagozzi and Dabholkar 1994). Personal incentives, by contrast, are internal motivations that define recyclers from non-recyclers. The notion is to increase these attributes that motivate recyclers, these attributes include: attitudes, beliefs, perceived control, and level of ascribed responsibility (Schultz 2002).

2.1 Situational Incentives to Recycle

Situational programs may come before (i.e. antecedent to) the recycling behavior, or they may be enacted as a result (i.e. consequence of) of recycling behavior (Porter, Leeming et al. 1995). For the remainder of this thesis, these will be referred to as "antecedent strategies" and "consequence strategies", respectively.

2.1.1 Antecedent Strategies

As an incentive to promote recycling behavior, antecedent strategies for recycling are designed to increase recycling behavior by altering a variable prior to the performance of the target behavior (e.g. collecting recyclables, delivering recyclables to a collection center) (Schultz, Oskamp et al. 1995). The goal is to provoke new instances of recycling participation, rather than increasing community and individual recycling or compliance rates of those already participating (see Section 2.1.2, Consequence Strategies). Common antecedent strategies include persuasive and educational prompts, environmental alteration, the solicitation of personal or community commitments, and goal setting (Schultz, Oskamp et al. 1995).

Persuasive and educational prompts are designed to help individuals remember to recycle (Austin, Hatfield et al. 1993; De Young 1993; Lord 1994). Information included in prompts can be presented before and during[2] the recycling program and is made available by direct-to-recycler means, commonly taking the form of printed notices. In a study integrating environmental alteration (see below), Austin, Hatfield et al. (1993) used prompts as informative cues in copy rooms at Florida State University. Some prompts were placed within sight of recycling and trash receptacles, while others were not. Compared with the control condition (i.e., the absence of persuasive prompts), all prompts were shown to increase recycling rates, with prompts in closest proximity to recycling and trash receptacles increasing compliance rates most dramatically. The specific prompts tested included information about *what* (i.e. types of recyclable products) and *how* (i.e. preparation and sorting of materials for recycling) to recycle. Overall, Austin, Hatfield et al. (1993) argue that successful prompts must include a specific request or appeal to recycle and be within close proximity to the intended recycling area; the requests themselves should be convenient for the consumer to do.

Environmental alteration is a second technique to increase the rate of recycling by making the act of recycling logistically easier. These techniques include decreasing the physical distance between containers and consumers, providing dedicated containers for curbside programs, and coordinating curbside recycling pick-up with garbage pick-up (Porter, Leeming et al. 1995). Derksen and Gartell (1993), for example, demonstrated

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[2] These strategies are conducted during the beginning stages of the program because not everyone starts recycling at the same time, hence, until enough people have begun recycling to the satisfaction of program managers, the intervention may continue.

that the most important determinant for recycling was access to a structured, institutionalized program allowing for easy and convenient recycling. Concern for the environment was positively correlated with both recycling and non-recycling behavior; but only those groups who benefited from environmental alteration showed an increase in recycling rates. It was concluded in this study that environmental concern cannot overcome logistical barriers of recycling (Derksen and Gartrell 1993).

Another form of environmental alteration is coordinating curbside recycling pick-up so that it is more convenient for participants recycling programs. In a study of waste management programs across Canada, Ferrara and Missios (2005) found that weekly (vs. biweekly) recycling opportunities had a positive impact on recycling for glass, aluminum, and toxic chemicals; on the other hand, it had little effect on the recycling intensity of newspaper, plastic bottles, tin cans, and cardboard. Overall, recycling appears to be more appealing when materials do not need to be stored for an extended period of time, perhaps causing people involved in weekly recycling programs to recycle a wider variety of materials. It is noteworthy that the communities with high curbside recycling intensity increased the amount of toxic chemicals (i.e. some paints and solvents) correctly recycled. These materials must to be taken to a proper disposal facility within the community; they are not available for curbside collection. This suggests an unintended spill-over effect of recycling curbside.

In the end, environmental alteration is considered by many to be a very effective technique in terms of leading to durable behavior change and increasing recycling rates (DeYoung 1986; Derksen and Gartrell 1993; Howenstine 1993; Boldero 1995; Lee, DeYoung et al. 1995; Oskamp, Zelezny et al. 1996; Ludwig, Gray et al. 1998; Barr 2004).

A third kind of antecedent approach is known as *commitment strategies*, which aim to increase recycling rates through the collection of personal pledges to recycle. This strategy typically takes the form of verbal or written promise to recycle (Bryce, Day et al. 1997). The commitments can be publicly announced to the community as displayed signs or published names in a newspaper (Burn and Oskamp 1986; DeLeon and Fuqua 1995). The strategy of publicized written commitments typically leads to action, compared to no commitment or a verbalized commitment (Bryce, Day et al. 1997). In one study by Burn and Oskamp (1986), households who committed verbally to recycle and publicly displayed a window sticker, alerting others to their decision, increased their recycling rates by a factor of four. However, since the study only lasted two months, the durable behavior is unknown.

Goal setting is a fourth incentive to increase recycling rate, and is one that has not received much attention in recent years. This strategy typically involves an organization or community setting a goal of diverting a higher proportion of materials from the waste-stream to recycling. To provide a reasonable goal, program managers need information about the amount of recycling taking place, as well as how much more waste could be recycled—based on the current system. In a nationwide study of recycling programs that were both municipal in scale and voluntary by nature, Folz (1991) found goals were an effective tool to increase recycling rates in voluntary programs, but not institutionalized municipal programs. Most programs choose a goal of at least 25% higher than the current diversion rate of recyclables (Folz 1991).

2.1.2 Consequence Strategies

Consequence strategies are aimed at those who are already recycling, with incentives or penalties based on the extent to which recycling takes (or does not take) place. Techniques typically include providing people with feedback, tangible rewards, and penalty structures (P. Wesley Schultz 1995; Porter, Leeming et al. 1995).

The first of these techniques, *feedback*, provides people with information about how they as an individual, household, community, or institution are performing. This information is often accompanied with measures of how much other people are recycling. In one study of this technique, DeLeon and Fuqua (1995) combined feedback with an antecedent, commitment strategy (see above). Three treatments were compared: one group of subjects made a public commitment to recycle with their names published in the local paper. A second group of subjects received weekly feedback based on the amount they recycled. The third group of subjects made both a public commitment and received feedback. A fourth group served as the control group, and received no experimental treatment.

Compared to the amount recycled by the control group, the commitment-only group recycled similar amounts (DeLeon and Fuqua 1995). The combined commitment and feedback group recycled the most, followed by the feedback-only group. This study indicates that combining feedback with public commitment strategies results in significant increases of recycling rates. As this was a relatively short study, durability of the change beyond the eight-week study period is unknown.

Along similar lines, Goldenhar and Connell (1991) conducted a large-scale study to examine the combined effects of a public feedback strategy and an educational (i.e. antecedent) strategy on attitudes, beliefs, and behaviors regarding the recycling of newspaper at the University of Michigan. In this study, all first year students who lived in campus dormitories were asked to complete a pre-test questionnaire during their summer orientation program (Goldenhar and Connell 1991). Then, students were assigned to one of four different treatment groups for the five month duration of the study; the treatments were: (1) educational posters that included a series of messages debunking recycling myths (such as the garbage crisis, the environmental impact of recycling) placed in recycling areas; (2) feedback in the form of posters that displayed, using bar graphs, how much each dorm had recycled, including information about the pounds of newspaper recycled per student; (3) a combined educational and feedback treatment group; and (4) a control group with no treatment.

In this study, the feedback group, as well as the combined treatment of feedback and education, proved to be more effective than the education-only or the control group in increasing recycling amounts. It is worth noting that the treatments were measured solely on the amount of newspaper recycling. The results may have been biased in that some students may not regularly read newspapers, and therefore do not have the opportunity to recycle newspapers (Goldenhar and Connell 1991). Also, because the recycling behavior was self-reported on a Likert scale, students may have over-reported recycling rates because of the well-documented tendency to base attitudes on the pro-environmental context of the survey, known as context effect (Tourangeau, Rasinski et al.

1989). Additionally, the altruistic nature of recycling (see section 2.2) may cause subjects to act in self-interest rather than truthfully report behavior (Guagnano 2001).

Rewards are a second commonly applied technique to increase recycling rates. This strategy involves—as the name suggests—giving tangible incentives to people for their participation in recycling activities. Rewards can take the form of financial payments or opportunities to take part in contests, raffles, or lotteries (Schultz, Oskamp et al. 1995). Because those who do not recycle often want rewards, rewards can be successful in increasing recycling rates (Vining and Ebreo 1990). However, problems tend to arise when rewards are removed. In a meta-anyalsis of recycling literature detailing situational incentives, Porter et al. (1995) found that the recycling rates returned to the baseline levels once rewards were removed in all nine studies reviewed. Another problem with reward-based strategies is the cost of the rewards versus the revenue generated from recycling. Usually, it is simply not cost effective to offer rewards over the long term (Porter, Leeming et al. 1995).

In a study comparing of lotteries to direct financial rewards, Diamond and Loewy (1991) found that the most significant attitude change toward recycling occurred among subjects who were rewarded with lottery tickets for recycling glass and newspaper. It is worth noting that if the lottery winners did not expect to win, their attitude was positive toward recycling with or without rewards. In the same study, small sums of money (direct rewards) were given for recycling, either to an individual or a group. Individualistic rewards promoted a greater amount of recycling than collective reward programs. Diamond and Loewy (1991) note that when people attribute their actions to extrinsic rewards, attitudes toward the behavior are likely to become less positive, as future decisions about recycling will be made without a reward.

Penalties are defined as negative economic incentives to recycle (Porter, Leeming et al. 1995). As the third form of consequence technique, they are the direct opposite of reward-based strategies (see above). Specific strategies that are considered penalties include unit-pricing on garbage pick-up and deposits on recycled materials that can only be recovered when an item is returned (e.g. bottle deposits).

Ferrara and Missios (2005) examined the connection between waste management policies and recycling behavior. Because many communities set different policies, the authors collected and examined data from several communities. Across Canada, 12 municipalities were studied through interviews with community members about which materials they recycled, and data about waste management program details, recycling program details, and household characteristics were collected (Ferrara and Missios 2005). Curbside recycling was available for all the households studied, which was an important constant variable. In this study, Ferrara and Missios (2005) found that user fees (price-per-bag of garbage) significantly increased the recycling intensity. This program is close to the true marginal pricing of trash disposal because households have the option to recycle more or reduce waste. The study discovered poor recycling in communities whose waste management policies allowed residents a free number of garbage bags; these policies almost completely offset the effect of the user fee system. Households act strategically to ensure their garbage output is not over the limit, yet do not try to decrease it any further—through increased waste reduction or recycling—because there is little motivation to go beyond what is required. Similar studies examining unit pricing for waste disposal and it's relation to recycling include Van Houtven and Morris (1999), Jenkins, Martinez et al. (2003), and Isely and Lowen (2007).

In a different study, Hong and Adams (1999) examined household demographics, waste management policies, recycling rates and waste production in Portland, Oregon. Unlike Ferrara and Missios (2005) who studied price-per-bag systems, Hong and Adams (1999) concentrated on volume-based waste systems. In this study, households pay a weekly fee for a container that holds a specified volume of waste. Fees were based on the number of gallons each container held, with the price per unit of volume discounted for larger volumes. In all households in the study, curbside recycling was offered to the residents free of charge to reduce their volume of waste by diverting appropriate materials for curbside recycling.

The price of the trash container did not appear to affect the amount of materials recycled by subjects. In other words recycling amounts did not increase as the fee charged for larger trash containers increased. However, the volume-based waste pricing system was thought to create a quasi incentive for more sustainable practices (e.g., reduce, reuse) because the amount of garbage disposed of could not exceed the physical constraints of the container. Overall, the demand for trash pick-up was inelastic, so any price increase for garbage disposal would cause very little decrease in trash output. This emphasizes the need to connect education programs and economic incentives to encourage community members to decrease garbage production and increase recycling rates.

In the end, consequence strategies typically work best when they are applied in combination with an antecedent strategy. Depending on the community, marginal pricing systems may not be feasible due to the restraints of the garbage pick-up provider or conveniently accountable in an institutional setting, such as university campus or office buildings. Feedback presents another logistical challenge, as recycling must be recorded based on household or another unit of housing measure. Rewards, although gratifying, present challenges for creating lasting behavior change, as rewards cannot be given indefinitely for every recycling action.

2.2 Personal Incentives to Recycle

Personal incentives are assessed through observation to correlate recyclers' motives and reasons with their high participation in recycling activities; vice-versa, those that do not recycle are studied to understand their underlying motives and reasons for non-participation. These motivations are intrinsic (vs. extrinsic) and arise out of active participation in an ongoing activity, and in turn provide a strong internal attribution and justification for acting (DeYoung 1986). These factors involved in the personal choice to recycle are commonly investigated using applications of the Theory of Reasoned Action including The Theory of Planned Behavior, analysis of the satisfaction derived from recycling activities, and understanding of norms as described in Schwartz's model of altruistic behavior (Schwartz 1977).

One technique employed to understand the reasons for why people recycle is the *Theory of Reasoned Action* (Fishbein and Ajzen 1975). It examines social consequences and attitudes as necessary components for conceptualizations of human behavior. This theory relies on the use of behavioral intervention to produce some action. Behavioral interventions may include attitude (anticipated consequences of an action and evaluation of those consequences) and subjective norm (normative expectations of the actions and acceptance of those actions). The Theory of Reasoned Action, and a theory derived from this model, called the Theory of Planned Behavior (Ajzen 1991), is used to explain recycling behavior and provide a conceptual framework to change norms and attitudes to induce recycling (Taylor and Todd 1995; Chueng, Chan et al. 1999; Tonglet, Phillips et al. 2003; Valle, Rebelo et al. 2005).

An example of the application of Theory of Reasoned Action to recycling is a study by Barr and Gilg (2005) in the context of developing policies for better waste management. Using a mailed survey, Barr and Gilg (2005) compared recycling frequency with the variables from the Theory of Reasoned Action. These variables included for the purposes of this study included: behavioral intention and willingness to carry out certain activities. Barr and Gilg (2005) conducted a path analysis using multiple regressions. The path analysis traces influences of variables that affect the participant's willingness to recycle and their recycling behavior; those were found to be (in order of importance): environmental protection, active concern for waste and recycling, acceptance of the norm to recycle, convenience and efforts, and norm awareness (Barr and Gilg 2005). The authors suggested that their results should be included into policy advertisements or social campaigns to increase recycling rates.

A second possible personal incentive is the *satisfaction* people may find in recycling. De Young (1986) suggested that motivations to please the self are critical to encouraging recycling, unlike an altruistic model that suggests selfless concern for others causes recycling. According to the satisfaction model, people may start recycling and then continue because, fundamentally, it made them feel satisfied and happy. To examine this model, students at the University of Michigan were surveyed to understand what level of satisfaction (if any) the students derived from the monthly curbside pick-up of recyclables (DeYoung 1986).

The results of the survey revealed that the students receive the most satisfaction from frugality, defined as the careful use of resources and the avoidance of waste. Strong feelings of frugality were directly correlated with participation in recycling and reuse activities. Being a participant in society showed a high correlation with recycling rates, which reflects the demands of recycling as a difficult activity. Regarding this finding, De Young (1986; p.446) noted, "recycling is sometimes portrayed as a primitive, time-consuming, and inconvenient behavior—hardly an appropriate behavior for a technologically advancing society." Although people may have these feelings, people appeared to gain satisfaction from acting in ways that make a difference to society as a whole.

A third possible technique for understanding why people recycle is the use of *Schwartz's model of altruistic behavior,* which seeks to explain why injunctive (i.e. personal) norms of altruism often do not lead to corresponding behavior. Altruistic behaviors are defined as any activity that most people agree upon as being morally normative, yet not everyone acts in accordance with the norm (Hopper and Nielsen 1991).

Recycling is an altruistic behavior because it is guided by the norm that recycling is the morally correct activity that warrants participation, yet not everyone does participate. Recycling is costly to the individual due to the time and energy involved in separation, storage, and transportation. Often, recycling yields no immediate rewards, yet has benefits to society as a whole (Hopper and Nielsen 1991). Because recycling is generally believed to be a good idea, and there is a distinct population that does not recycle even though it is believed to be a good idea—recycling is by definition an altruistic behavior. This kind of behavior can be modified (in theory) by persuasion to behave accordingly.

Schwartz's (1977) model attempts to explain why social norms that would result in behavior change do not become personal norms resulting in behavior change. According to this theory, awareness of consequences and ascription of responsibility are the variables, , connecting personal norms to the ascribed behavior. Bratt (1999) applied Swartz's model to recycling; the model proposed that the relationship between personal norms and recycling behavior would be higher for those that assumed the consequences of recycling were high. However, those who assumed the consequences of recycling to be low still had a strong relationship between personal norms and recycling, which caused Bratt (1999) to question the applicability of Schwartz's theory to recycling.

Guagnano, Stern et al. (1995) conducted a study of behavioral change associated with recycling using a survey based on Schwartz's model, and attempted to pull together external and internal factors. External factors are physical structures, social institutions, and economic forces. Internal factors are general and specific attitudes, beliefs, information, and behavioral intention. The resulting model predicts a context for effective recycling programs using education or information intended to improve the knowledge as important predictors of behavior change.

2.3 Knowledge as a Precursor to Recycling Behavior

While knowledge about recycling may not be the sole motivator for recycling, lack of this knowledge is generally viewed as an important barrier to recycling (Schultz 2002). The more knowledgeable an individual is about what items are recyclable, how to prepare items for recycling, and where to go to recycle, the more likely the individual will recycle (De Young 1989; Vining and Ebreo 1990; Gamba and Oskamp 1994; Scott 1999).

The goal of techniques to increase knowledge, such as communication and educational interventions, is to help people understand how they can help with the environmental problem and why it is important to do so (De Young 1993). By providing specific knowledge about the issue and cause, these techniques provide an avenue for durable change by prompting the actors to modify their behavior. Another perspective is that once people have information about how to proceed, they are more able move forward and act according to the needs of the situation (De Young 1993). Finally, increased knowledge is believe to create a durable behavior change.

These objectives are particularly important considering that lack of knowledge about the recycling program is a common trait of non-recyclers. Howenstine (1993) studied students at Northeastern Illinois University, and found that the most widely cited reasons non-recyclers gave as an explanation for their behavior were a lack of convenient curbside recycling in their neighborhood and a lack of knowledge about where to take recyclables. Even though the city of Chicago had more than 100 scattered drop-off sites, 79% of the respondents did not know the location of even one (Howenstine 1993).

Vining and Ebreo (1990) found similar characteristics that define non-recyclers in Champaign and Urbana Illinois. Based on a questionnaire given to community members, recyclers tended to be better informed about overall recycling procedures and acceptable materials than non-recyclers. Non-recyclers were unsure of their own knowledge of what can be recycled and how to begin recycling materials compared to recyclers.

Scott (1999) studied four communities in the greater Toronto area, which all had access to curbside recycling for over a decade, to determine why some of the community members recycle, while others recycle less—or not at all. Knowledge of the curbside recycling program was positively correlated with the number of materials recycled. Scott (1999) suggested that recycling departments distribute up-to-date information about eligible materials for recycling, proper techniques for curbside pick-up, and schedules for special collections to help increase recycling rates.

Overall, the importance of knowing what can and cannot be recycled should not be underestimated in the design of a successful recycling program. Lack of knowledge not only results in lower recycling intensity (thus lower diversion rates) and collection efficiency, but the resulting trial-and-error approach increases contamination levels in collected recyclables (Scott 1999). In the end, the good intentions of an uncertain public can reduce the efficiency and efficacy of recycling programs.

De Young (1989) explored the differences between recyclers and non-recyclers and found that both groups viewed recycling in a very positive light. The interviews suggested that consequence-based strategies such as monetary rewards or punishment would not cause non-recyclers to recycle; yet social pressure to comply with behavioral norms will motivate people to recycle. Even if the norm to recycle gives people a reason to recycle it, does not mean they possess all the required skills. New recyclers are probably not familiar enough with recycling to know how to carry out the activity successfully, and if they become overwhelmed with the task, recycling may continue as a non-activity. In the end, recycling education programs, according to De Young (1989), should concentrate on basic information needed, such as how much time and space to allot to carry out the activity successfully, what can be recycled, how the materials must be prepared, and where to go for assistance.

The good news is that lack of knowledge about how to recycle appropriately can be overcome through educational and communication campaigns. The bad news is that many of these campaigns fail. Meneses (2006) suggests that most recycling education programs fail because the organization focuses on what they want to transmit—based on rather ill-conceived notions about the information that they assume people need—rather than on what content people actually need. Frequently, these programs tell audiences what environmentalists want to communicate rather than taking into account an individual's information processing model. By information processing model, Meneses (2006) refers to an individual's understanding of programs based on ecological consciousness and personal beliefs about recycling.

The main focus of Meneses (2006) study was to first determine the recycling beliefs of an audience, which are identified as knowledge about the "how, what, and why" of recycling. Similarly, Howenstine (1993) and Goldenhar and Connell (1992) also studied how to specifically tailor recycling education programs to an audience on the basis of demographic variables such as income, ethnicity, and gender. Nevertheless, the tailoring of educational and communication campaigns has been largely understudied in the recycling literature, particularly when it comes to understanding the current state of knowledge possessed by the current recycler. Addressing this gap is the objective of the remainder of this thesis.

3. Mental Models

The objectives of this research are to (1) characterize the knowledge of members of the MSU community (i.e., students and faculty) to identify knowledge gaps or lack thereof, and (2) to provide recommendations for outreach based on the latent knowledge of the audience.

The emphasis upon knowing the audience is due to the history of most recycling education programs failing to increase recycling rates. These programs fail because an organization (e.g., the group responsible for sustainability or waste management efforts in cities, communities, universities, corporations, etc.) focuses on the messages they want to transmit, which are often based on ill-conceived assumptions about the information that people will need to make better informed choices (Meneses 2006). Educational programs should focus instead on including specific content people *actually* need to undertake a desired activity. Often, an organization's outreach efforts tell their intended recipients only what they either want to communicate or think that people need to know, rather than taking into account the information and decision support needs of those that they are trying to reach (Meneses 2006).

An explanation for the current general practice of recycling outreach could be explained by the outreach plans as part of a public relations effort of an organization to establish the legitimacy of recycling and create an understanding with the target population that causes them to act (Stalhofer and Isaac 2002). In public relations, the linear model of communication within information theory is one of the most popular, yet widely criticized, theories (Austin and Pinkleton 2006). The linear model prescribes publicity-based communication programs where messages are scattered through multiple channels with the hope that they ultimately reach the receiver. One can think of this as a "shotgun approach" to communication where, hopefully, at least a few of these messages will (1) find their intended recipient, and (2) are helpful in terms of informing choices. Although a message itself may gain a lot of exposure this way, either because it is repeated several times or in several different ways, it does not necessarily mean that anyone will receive, understand, or learn from it, let alone act differently because of it (Austin and Pinkleton 2006).

Instead of using the time and resource-intensive approach of scattering multiple messages, the mental models approach provides a systematic methodology to understand what the intended recipient does or does not know about the given issue, in this case recycling. This way, communicators can design and implement more effective (in terms of their ability to address knowledge gaps) outreach plans to encourage and foster recycling behavior.

This issue of inadequate research of the target audience is not unique to recycling and environmental education campaigns. Fischhoff, Bostrom et al. (1993) describe the issue of ill-conceived outreach plans as they apply to the discipline of "risk communication[3]": Risk communicators often make strong statements about other people's competence to manage risks, based solely on anecdotal observation. In risk communication efforts, the communicator is presumed to know exactly what people actually know, what they need to learn, what they want to hear, and how they will interpret the message (Fischhoff, Bostrom et al. 1993). This view has been proven wrong

[3] The stated aim of risk communication is to supply people with the information they need to make informed decisions about risks to their health, safety, and environment (Morgan, Fischhoff et al. 1992).

in many contexts. The mental model approach summarized in a recent text by Morgan, Fischhoff et al. (2002) was, therefore, developed for the purposes of helping risk communicators better understand their audience and to create better outreach efforts for them. While sustainability issues are not generally viewed as a "risk problem", outreach plans aimed at fostering behaviors such as recycling must address many of the same challenges faced in risk communication.

The mental models approach begins with the creation of an "expert model" that depicts the current state of knowledge surrounding a particular issue (recycling in this case). Expert models can be thought of as a snapshot of up-to-date knowledge surrounding a particular issue or problem, and these concepts are captured in the nodes of the model (Morgan, Fischhoff et al. 2002).

Although the model is called the "expert" model, it is really the product of insights from many different experts. In its truest form, the expert mental model is developed collaboratively with a diverse group of subject-area experts who are interviewed to gather their collective knowledge. Researchers must also consult experts for input on further iterations throughout the model's development process. During development, researchers can enrich draft models with concepts from the literature for further consideration by the experts. A full range of expertise is vital to ensure results that predict with accuracy the state of knowledge about a topic.

An expert model based on the knowledge from multiple experts, and on the current literature about a problem, can be difficult to represent in a cohesive form (Morgan, Fischhoff et al. 2002). However, these authors offer alternative strategies to create a map of linked concepts that can become the expert model. One strategy is the assembly method, in which the expert model is "assembled" by listing all the relevant factors associated with the issue of interest and then figuring out how they are interrelated. Another strategy is the materials/energy balance method that incorporates the physical properties of the issue, such as the factors that affect the amount of material available for human contact. A third approach to creating an expert model is through the scenario method, in which the model is formed based on the chain(s) of events leading to a particular event. Lastly, there is the template method for creating an expert model, a strategy that works best for issues that involve similar, recurrent exposure and effects processes. For example, this method could be used to build a model that illustrates the exposure processes preceding effects processes, and includes environmental, physiological, and behavioral dimensions for each step. In either case, the concepts elicited from experts and through a literature review are represented in hierarchical order with arrows indicating the relationship between general concepts and more specific content.

The expert model is used to develop an open-ended interview protocol that will eventually be administered to other subjects, typically non-experts whose behavior or knowledge managers would like to modify. The expert model is used as a base for the protocol to ensure that all relevant topics will be covered. The scope of the research helps determine the type of subjects who will be recruited to participate in the open-ended interviews. Each interview is a purposefully open-ended process to allow subjects to express both correct and incorrect knowledge and beliefs. Typically, a sample of between 20 and 30 subjects reveals most of the latent knowledge and beliefs held by a particular population with substantial confidence (Morgan, Fischhoff et al. 2002). These responses are analyzed to develop an individual mental model for each subject. When mental models are compared with one another, the graphical representations of knowledge indicate where knowledge gaps, or areas of confluence in knowledge, exist between and within the non-expert and expert groups (Morgan, Fischhoff et al. 2002).

An analysis of the interviews and their resulting mental models also allows researchers to better understand which gaps in people's knowledge may need to be addressed through education (and which ones may not). All responses are compared to the expert model, which serves as the basis for measures of comparison of subjects to experts. The simplest method of analysis is quantifying how frequently people talk about the concepts (Morgan, Fischhoff et al. 2002). A more complex analysis looks at frequency patterns, and the content and accuracy of what is said about each concept (Morgan, Fischhoff et al. 2002). An even more elaborate analytical option places similar concepts into categories and develops a measure of the relative frequency for those categories of data.

Often, subjects will suggest concepts that are not represented on the expert model. In these cases, it may be necessary to sort the provided concepts. Morgan, Fischhoff et al. (2002) suggest the categories of: (1) misconceptions; (2) peripheral beliefs, which are correct but not particularly relevant to the topic (although people believe they are); (3) indiscriminate beliefs, correct as far as they go, but not specific enough to be very useful; and (4) background beliefs, so basic that they do not explicitly show up in the expert model, even if they represent facts important to determining its operation.

Analysis of the resulting individual mental models reveals which knowledge gaps may need to be filled, which correct beliefs need to be reinforced, and which misconceptions ought to be corrected. These results become the basis for designing an informed communication effort. Later, beliefs captured in the interviews can be made into a questionnaire to confirm their prevalence on a larger, population-wide scale. Using the results of the interviews and surveys, communicators working closely with decision makers or policy analysts must decide which incorrect beliefs are most in need of correcting, and which knowledge gaps are most in need of filling (Morgan, Fischhoff et al. 2002). In the final stage of a complete exploration of the mental models method, communications that are ultimately designed based on the analysis are tested and refined both before and after communications are disseminated to the audience.

3.1 Mental Models: Historical Roots

Before their application to the field of risk communication, or recycling in the case of this research, mental models first appeared in psychology. The work of Kenneth Craik is cited for first introducing the concept of mental models. He sketched a theory in which an individual's thoughts and knowledge could be characterized according to a "small scale model" of external reality (Craik 1943). Craik argued that people mentally "try-out" various alternatives in a small-scale model when making decisions. This allows an individual to conclude which alternative is best, react to future situations before they arise, utilize the knowledge of past events when dealing with the present and future, and in every way react in a much fuller, safer, and competent manner to situations (Craik 1943).

The theory outlined by Craik (1943) formed the basis of the iconic models of knowledge, which started appearing in the late 1970's. At the time, the term "mental model" was coined by Johnson-Laird (2004) as a framework to represent how individuals understand a variety of phenomena. Johnson-Laird (2004), for example, detailed the use of knowledge-based mental models by experts and naïve persons (non-experts) on topics including: mechanics, hand-held calculators, and electrical circuits. In all early mental model studies, research involved two-dimensional spatial models that made inferences about how people learn to make—and then use—mental simulations of phenomena, either as a series of images or as a mental model (Johnson-Laird 2004).

Mental models research, as described by Morgan, Fischhoff et al. (2002), encompasses drawing forth and interpreting knowledge-based mental models to design risk communications. This research method has been applied in a wide variety of risk management contexts, including radon in homes (Bostrom, Fischhoff et al. 1992), nuclear energy sources for space missions (Maharik and Fischhoff 1993), climate change (Bostrom, Morgan et al. 1994), and wildfires (Zaksek and Arvai 2004).

3.2 Mental Models: Recent and High Profile Applications

Bostrom, Fischhoff et al. (1992) first used "modern" mental models research to understand non-expert knowledge of residential radon hazards. In their study, a single interviewer elicited data from 24 subjects, who had been recruited from several civic clubs. Half of the subjects were female, half were male, and all were adults. Though diverse, no claims were made as to the degree the subjects actually represented the community. The interviews lasted 45 minutes on average, and contained two types of questions: nondirective and directive.

The nondirective stage of the interview began with broad questions meant to elicit any knowledge a subject possessed about radon. The interviewer next asked subjects for detailed information about each comment until their responses were exhausted. In the directive stage of the interview, subjects were asked to sort through 36 black and white photographs and describe the photograph's relation to radon, if any. Only half of the photographs dealt directly with a major issue of radon hazards.

The interviews were taped and transcribed for accuracy, and responses were compared to the expert state of knowledge, represented in the expert mental model. Only when subjects explicitly mentioned a part of the expert model was it explored further as part of their individual mental model interview. Any concepts generated that did not fit into the expert model were coded either as misconceptions, peripheral beliefs, indiscriminate beliefs, background beliefs, or valuations. The final interviews offered very few new concepts.

The results from the mental model interviews of non-expert subjects were analyzed for completeness (how much the respondents knew), accuracy (the proportion of their beliefs that were correct), and specificity (either how detailed or general those beliefs were). The directive portion of the interviews, which involved sorting photographs, was designed to elicit more detailed latent knowledge than the non-directive interview segment, and contributed significantly to higher accuracy for the non-expert mental models. Accuracy was primarily established as a measure of *concurrence*, i.e. the percentage of concepts in a subject's model that also appeared in the expert model. Accuracy was also measured as the product of *completeness and concurrenc*e, i.e. the proportion of a respondent's concepts appearing in the expert diagram. This study included a measure of *specificity*, which was calculated as the ratio of specific (more detailed) concepts given by the subject to the number of specific concepts in the expert model. A second measure of *specificity* was made by calculating the ratio of general concepts offered by the subject compared to the expert model.

The subjects' responses were then analyzed based on each category of questions and the different interview types (nondirective and directive) in order to understand the effects of different ways of conducting mental models interviews. Overall, subjects' responses were much more general than those of experts. Both parts of the interview process resulted in eliciting about half of the concepts in the expert model. Measures of concurrence and completeness were strongly correlated in subjects' interviews. In other words, those who simply said more were more likely to give a higher percentage of correct information. Measures of completeness show that the second directive portion of the interview (picture sorting) elicited more latent knowledge than the non-directive portion (open-end questions), but measures of specificity showed that the picture-sorting portion also resulted in more wrong concepts.

Subjects tended to mention general concepts more frequently than specific concepts. All of the general concepts were mentioned in at least one interview (except that radon can be found in the gas supply), yet some specific concepts were not mentioned at all. Subjects were more aware of exposure than effects. Generally, radon was understood to be bad for human health but for unknown reasons. Common misconceptions were that radon originates from garbage, mining practices, or industrial waste. More misconceptions were developed from the use of the nondirective segment, in which photos of animals, plants, blood and food may have caused subjects to erroneously derive the effects of radon. The results indicate that people's understanding of radon hazards is incomplete and incoherent, in the sense that knowledge was scattered in inconsistent terms.

The goal of the mental models study carried out by Maharik and Fischhoff (1992) was to investigate people's responses to the risks of using nuclear energy in space exploration. The expert model had a general layout of events leading to an accident and the subsequent short- and long-term human health affects. Exposure of radioactive materials was defined in the categories of a space system failure, the release process of radioactive materials, transport processes of radioactive materials through the atmosphere and physical environment, and human exposure. In all, the exposure diagram contained 113 concepts including both general and specific concepts.

The subjects recruited for interviews were members of organizations active in promoting environmental or peace-related topics in the Pittsburg, PA area. Members of activist organizations were chosen because they are (1) generally opinion leaders in the community, and (2) often the target of communication efforts. Of the 30 subjects interviewed, half of the subjects were male, half were female, and most were college educated.

Once again, these interviews contained two stages: directive and non-directive prompts. The directive stage involved open-ended interviews that asked respondents to elaborate upon each comment they had made during the broad, open-ended interview. Each interview took 60-80 minutes, and the same researcher interviewed all subjects. The interviewer attempted to direct respondents without influencing the answers to avoid "reactivity," or the tendency to lead the subject's responses.

The subjects' responses were compared to the expert model for the completeness of knowledge (i.e. awareness of the concepts in the expert model). The results were first reported by the frequency which different concepts were mentioned. In the category of *aerospace system failure*, all level 1 concepts of the expert model were mentioned by at least one subject, while the level 2 concepts were harder to imagine and, as a result, were mentioned less frequently. *Release processes* concepts showed a general confusion among subjects about the energy sources derived from different nuclear materials and technologies that may be used during space missions (namely, radioisotope thermoelectric generators (RTGs) and fission reactors).

Plutonium was mentioned most frequently as the energy source for both RTGs and fission reactors, yet plutonium is used only is RTGs while uranium is the source of energy in fission reactors. Also, of the 30 subjects interviewed, only one subject correctly predicted that a nuclear explosion could happen only with fission reactors, and not with RTGs. The fact that *transport processes* entail a chance of explosion of the nuclear energy power source was familiar to most subjects, and the authors believe that general knowledge of environmental issues enhanced the ability to accurately identify it. *Personal exposure* to radioactive material was divided into three main routes: inhalation, ingestion, and external exposure. Most subjects mentioned external exposure, which may be avoided by seeking shelter, but did not mention exposure close to the launch site, such as direct heat blasts. Ingestion and inhalation pathways were also poorly understood.

The effects category of concepts in the expert model focused on personal *health effects.* Cancer development, e.g., in the lungs or bone marrow, was a well-known concept to about two-thirds of the subjects. Other effects were mentioned, but a detailed understanding of the health effects following exposure to plutonium was largely absent.

Respondents also mentioned 65 concepts that were not on the expert model. These concepts were classified as background knowledge and beliefs (correct concepts that may help clarify the expert model), general concepts (correct, but too broadly defined to clarify the process), peripheral concepts (correct, but only conditionally or marginally relevant), wrong concepts (misconceptions), and concepts outside the model's boundaries. The most commonly reported misconception was that radioactive material is released as radiation only because of an accident, and not by the radioactive material itself at all times (which is the correct statement).

Performance of the subjects was measured using four different summary statistics. The first was completeness, which as noted above, is the proportion of the concepts in the expert model also mentioned by a subject. Respondents were able to reproduce 28% of the total expert mental model and 51% of the general concepts. For concurrence, which is the percentage of subjects' concepts that appeared on the expert model, the mean was 0.67 for all subjects. Accuracy, the third measure, is computed as a product of concurrence and completeness, giving higher scores to subjects who were able to say right things and to say many of them. This figure was highly correlated with the subjects who had high concurrence. The fourth measure was specificity, or how detailed people's knowledge was compared to the expert model. Specificity measures showed that subjects had a more general oriented knowledge than experts.

Overall, Maharik and Fischhoff (1992) argue that knowing about the audience is the essential element to a well crafted risk communication effort. The communication effort should help clarify the situation, by meeting one of two desired outcomes, namely reducing conflicts between non-experts and experts because all parties have a better understanding of the topic, or sharpening conflicts by clarifying the basis of any disagreements between non-experts and experts.

In a third study, Bostrom, Morgan et al. (1994) set out to understand the current state of lay knowledge about climate change. At a Pittsburg, PA auto show, a single interviewer (with the exception of one interview conducted by a research assistant) interviewed all subjects (n=37). The subjects were randomly recruited at the event, and were somewhat representative of the state of Pennsylvania's adult education level. The interview protocol was much like the other mental models studies outlined here (e.g. Morgan, Fischhoff et al. 2002) in that it was open-ended, and responses were compared to an expert model for accuracy. In addition to the interview, subjects were asked to perform two additional tasks. The first task was to list the contributions to climate change on separate cards, arrange the cards in order of importance, and explain why they ranked them in that order. The second task asked subjects to describe U.S. policy towards mitigating the effects of climate change.

All interview questions were placed into one of five categories: definitions, exposure processes, effects processes, judgments, and decisions. In terms of the definitions, the layperson perspective was that "climate" and "weather" is basically the same thing. The greenhouse effect was commonly equated with global warming, and related to the ozone layer. While the subjects' responses were inconsistent with each other and with incorrect definitions, it was evident that their knowledge about the key terms in climate change was incomplete. As to the exposure effects of climate change, subjects overwhelmingly mentioned ozone depletion as a cause, which is incorrect. But, in the card sorting task, subjects correctly indicated that auto emissions are a contributor to climate change.

Subjects also presented a wide range of concepts related to the effects of climate change, many of which were included in the expert model. For example, subjects were able to correctly identify a number of second- and third-order effects, long-term effects, and some feedback loops. As with the definitions, ozone and UV-related health effects were predominantly mentioned, although the questions asked were about climate change.

Tasks were given after the open-ended interview, subjects were asked to respond to a variety of closed ended questions. First, they were asked to make judgments, a little more than half of those interviewed agreed that the greenhouse effect does exist. Subjects also generally agreed (78%) that climate change is a real phenomenon. Then subjects were asked whether the greenhouse effect was good, neural or bad, perhaps taking advantage of the general inability of most subjects to differentiate between "greenhouse effect" and "climate change." Most subjects (75%) believed that the greenhouse effect is in fact "bad", when it is the natural phenomenon that allows life to exist.

In this beginning stage of research determining what people understand about climate change, the results indicate that subjects had many misconceptions. These misconceptions largely revolved around the physical mechanisms of climate change and how climate change differed from ozone depletion. Overall, subjects agreed that climate change was a threat that deserved action and national attention, but their knowledge limited their abilities to distinguish between effective and ineffective strategies.

Finally, Zaksek and Arvai (2004) used mental models to study non-expert (i.e. homeowner) and expert knowledge regarding wildfire risk in British Columbia (B.C.), Canada. The study area's forests had accumulated large amounts of highly flammable logging debris, causing the forest service to prescribed burnings close to residences as part of a combination of wildfire threat reduction practices. The expert model (called the technical model in this study) was created through an extensive literature review plus consultation with wildfire experts across North America.

As with other mental model approaches, an interview protocol—based on the technical model—was developed for the non-expert interviews. Unlike other examples of mental models studies, the investigators also conducted mental model elicitations from local wildfire experts[4]. This was done to also test local experts—people that residents in the local community would go to for advice—against the technical model. Also unlike any previous risk studies that have been the subject of mental models research, the technical model developed by Zaksek and Arvai (2004) included both risks and benefits.

The non-expert subjects interviewed in the study were residents of the forest district surrounding the community of Whistler, B.C. (n=26). Local experts interviewed included subjects that were employed by the provincial government as fire managers (n=6). A single researcher (the first author, Zaksek) conducted all interviews, which typically lasted between 1 and 2 hours. At the beginning of each open-ended interview, questions were broad with neutral prompting until a subject's knowledge was exhausted. Then, interview questions became more specific to elicit the individual's complete mental model of the wildfire risk scenario.

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[4] This group did not include any of the experts that were interviewed during the development of the technical model.

Each subject's interview resulted in an individual mental model, to represent where concepts were also present in the technical diagram. Concepts that were noted by the subjects, but were not reflected in the technical diagram were also included.

In terms of analysis, each of the subject's responses were coded according to a five-point scheme (from 0 through 4), with higher scores reflecting more accurate comprehension of the concept; these codes were:

4 = concept discussed without prompting and understood by subject;

3 = concept discussed when prompted and understood by subject;

2 = concept discussed without prompting but misunderstood by subject;

1 = concept discussed when prompted but misunderstood by subject;

0 = subject was unable to answer interview question.

Using these codes, subjects' responses were compared using an analysis of variance (ANOVA) that tested for statistically significant differences between experts and non-experts.

Statistical analysis revealed the differences in expert knowledge compared to the knowledge represented in the technical diagram. Non-experts had knowledge of the "mainstream" causes of wildfire, as well as a number of the potential risks to the environment and quality of life of resident. Generally, non-experts seemed to lack any knowledge about *how* fires help reduce the risk of future fires. Experts had more knowledge than non-experts about the majority of the concepts (5 of the 9 categories of concepts). The largest statistical differences were observed for the knowledge of conditions that facilitate wild land fire ignition and a detailed understanding of wildfire's environmental benefits. Experts had a more developed understanding of these categories compared to non-experts. Only half of the experts were able to identify prescribed fires and fire suppression as factors that influence wildfire ignition and spread. Local experts did not outperform non-experts (statistically speaking) in knowledge of a majority of the concepts, including specific concepts.

3.3 Applying the Mental Models Approach

All of the studies noted here (Bostrom, Fischhoff et al. 1992; Maharik and Fischhoff 1992; Bostrom, Morgan et al. 1994; Zaksek and Arvai 2004) similarly implemented the mental models approach to better understand public risk perceptions. Interview delivery was consistent with the mental models approach detailed by Morgan, Fischhoff, et al. (2002), all interviews used open-ended protocols based on the expert model. The interviewer's delivery of questions was also important to ensuring the objectivity of the open-ended process. Marharik and Fischhoff (1992) described it as reactivity: directing the subject without influencing the answers. Bostrom, Fischhoff et al. (1992) described the open-ended interview delivery as a valuable way to gain insight on layperson perspective, while minimizing the imposition of the scientific perspective on respondents' conceptualizations. The open-ended interviews format is a strong part of the mental models approach because it allows the expression of both incorrect and correct beliefs without directing the subjects.

It is noteworthy that the subjects of the interviews do not necessarily have to be laypersons, although this population is usually associated with mental models research. Marharik and Fischhoff (1992) focused their attention on activist populations, who were working on either environmental or peace topics to understand what they did and did not know about nuclear energy sources for space exploration. Zaksek and Arvai (2004) interviewed local experts and non-expert residents to understand their knowledge of wildfire. Interviewing specific populations can allow for comparison between different populations, as illustrated by Zaksek and Arvai (2004), with their comparison of local-expert to layperson (non-expert) knowledge.

These studies also show that mental model interviews allow for the incorporation of additional tasks before or after the interview to enrich the results. Marharik and Fischhoff (1992) asked subjects value judgments and opinion questions regarding the use of nuclear energy sources in space. The results showed that most subjects were skeptical of using the technology, they felt that it is unsafe, and believed that it cannot be used in a sufficiently safe manner. These value judgments are important insights into understanding the audience (particularly the activist audience the research is trying to understand), but are considered as separate from the mental model interviews. Bostrom, Morgan, et al. (1994) asked subjects to write the causes of the climate change on cards, one cause per card, then order them from most important to least, and to explain why. The interviewers also asked a series of close-ended questions about United States policy toward climate change and gathered judgments on greenhouse effect as good, bad, or neutral. These questions allowed for further insight into the subjects' ability to apply knowledge to form policy decisions and to make value judgments. Zaksek and Arvai (2004) used similar tasks as Bostrom, Morgan, et al. (1994) to understand the subjects' familiarity and judgments of wildfire management options by asking subjects to name all the options for wildfire management, and rate the effectiveness of each option.

In addition to general measures used in some studies, all studies in this literature review reported results for the proportion of subjects that understood concepts. Zaksek and Arvai (2004) used an additional method of analysis for understanding results, a 5-point coding scheme. This coding scheme improves the mental model's ability to define the accuracy and latency of knowledge of each concept. This coding scheme is a derivation of the measures used by Bostrom, Fischhoff et al. (1992) for generalizing all subjects' accuracy and specificity of all concepts. Maharik and Fischhoff (1993) used a similar coding method in the form of a structured knowledge test. This test was created to measure the prevalence of certain interview results for a larger population. The application of this coding scheme to the results of the mental models interviews, rather than for a knowledge test for results, allows—in my view—for greater clarity than the coding schemes developed by Bostrom, Fischhoff et al. (1992) and those included in Morgan, Fischhoff et al. (2002).

The strengths and weakness of the application of mental models to inform outreach merit discussion. Of particular concern, in terms of the weaknesses of the approach, is the small sample size. Communication efforts are likely to be widely dispersed over a much greater number of people than those interviewed to inform the decision of included and excluded concept areas. Although Morgan et al. (2002) has found that the frequency of new concepts added by subjects' decreases substantially by 15 to 20 subject interviews, the matter of a large sample size is still a preference of many researchers. Another weakness of the technique, in all, is the time needed to complete the full process. Particularly, recruiting and interviewing subjects can be labor some considering the time required (an hour or more) to participate.

Mental models approach to outreach has strengths as well, which set the method apart of other techniques. In particular, mental models research can gather information about how well as concept is known, without using the terminology. Since mental models interviews use broad questions and neutral prompting, the exact term does not need to be used in the question (or defined for the subject) as it would in a survey question. Additionally the results of these interviews, the frequency at which concepts were known and unknown by the subjects, have direct implications to outreach because communicators or public relations managers can refer to the results to decide the emphasis of outreach. Because the results can be shown visually, managers without statistical or highly technical expertise can understand the results.

The method allows for a full range of concepts within the topic area to be covered in each interview, emphasizing depth over breadth. In other words, unlike a survey that may ask more subjects about fewer concepts (compared to mental models research), the mental models approach asks fewer subjects about more concepts (compared to typical short survey research). Specifically, the emphasis of depth allows for the results to reveal which concepts are unknown, rather an approach of survey research that may involve researchers anecdotally choosing which exact concept areas should be covered in the survey. Using the mental models method, the researchers have less influence over the results, granted the expert model represents the current knowledge about the situation.

Mental models have been used in a variety of situations. However, as of the time of this review, no other studies—to my knowledge—have been conducted on the topic of recycling. Zaksek and Arvai's (2004) application of mental models research to wildfire was the first study of a situation that involved both clear risks and benefits. Although recycling is a non-risk situation, it has clear drawbacks and opportunities (akin to risks and benefits). Additionally, the issues examined in the environmental communication and risk communication fields are relatively similar. In both fields, communicators typically proceed by developing messages that communicate information that they *believe* the audience needs to know, rather than what they *actually* need to know.

All of the examples outlined above used similar methods to those outlined by Morgan, Fischhoff, et al. (2002) for the elicitation of latent knowledge through mental models interviews. In each case, the interview results were used as the basis of well-informed communication efforts aimed at adding, refining, replacing parts, generalizing people's existing mental models surrounding an issue. Recycling offers an opportunity to integrate a new method into the design of informational interventions so that communicators can create outreach materials based on what the audience knows and needs to know. I draw upon these previous studies in my work to determine the appropriate focus for out reach and communications aimed at increasing recycling rates at an institution of higher education.

4. Promoting Sustainability: Mental Models Research to Inform the Design of a Campus Recycling Program

4.1 Introduction

In 2006[5], Americans collectively generated roughly 228.0 million metric tons of garbage (Environmental Protection Agency 2007); this is up from 216.2 metric tons in 2000 and 186.2 million metric tons in 1990. One way to keep pace with increasing rates of waste production is for manufactures to redesign their products to include less packaging, to use easily recyclable components for their products, and to design products with a longer functional lifespan. Another way to keep pace with higher annual tonnages of waste is by promoting reuse of products to customers, as illustrated in the recent popularity of reusable shopping bags and refillable plastic water bottles.

A third, and perhaps the most prominent way of reducing the high output of garbage is through increased recycling of products and packaging. While recycling recovery rates have doubled from 16.3% in 1990 to 32.5% in 2006 (Environmental Protection Agency 2007), there is still room for improvement. For example, according to the Environmental Protection Agency, about 50% of all paper and paperboard products are not recycled. These products account for the largest component of garbage in America by weight (33.9% of all waste). A common approach used to increase recycling rates is to motivate consumers' recycling habits so they will be diverting more recyclable materials (like paper products) from garbage to recycling collection.

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[5] The most recent year for which data about the amount of waste produced in the United States is available.

University and college campuses are particularly noteworthy in discussions about increasing recycling rates. Each day, they are responsible for creating massive quantities of waste that, to a large extent, could be captured in a well functioning recycling program. Many everyday campus activities produce waste; these include the widespread use of white and colored paper, magazines, softbound books, cardboard, containers and utensils used by food services, plastic used in laboratories, used batteries, outdated electronic equipment, and the list goes on and on.

On the positive side, attractive reasons for universities to recycle include reducing the need to dispose of garbage and increased revenue from the sale of recyclables. Most importantly, however, many universities take their recycling programs seriously because of their important leadership role in society. In short, many university and college campuses take pride in being at the forefront of the sustainability movement (Pike, Shannon et al. 2003). Recycling programs provide good evidence of—and a good opportunities for public relations around—sustainability practices.

To this end, the National Recycling Coalition, the primary US recycling trade association, recognized—in 1993—the occupational association of College and University Recycling Coordinators (CURC), signaling to the industry that campus recycling needed to be treated with the same level of seriousness as municipal recycling programs (Lounsbury 2001). Following suit, many higher education institutions around the country have since developed recycling programs.

Detailed information regarding (1) how many campuses have full-scale recycling programs, (2) the amount that college and universities recycle each year, and (3) the amount of garbage generated—is not readily available. However, we know that at

Michigan State University (MSU), 27,594 cubic meters of garbage were sent to the landfill in 2007. Currently, recycling takes place at MSU in many ways. One example is the recycling of a range of paper products; at MSU, the recovery of paper has increased by eightfold (200 tons to 1,600 tons) since the inception of the program in 1990 (Link 2007). However, the MSU recycling program only recycles paper products on a regular and completely campus-wide scale. Recycling of other materials is largely ad-hoc and scattered. For this reason, the administration of MSU decided to expand the campus recycling program by way of increasing the amount and variety of recyclables collections points that are routinely collected in more areas on campus. This decision motivated the research reported here, which was aimed at identifying ways to create a more successful recycling program at MSU.

Despite the ubiquity of recycling programs in higher education institutions, program managers have considerable difficulty designing and implementing programs that divert the maximum possible amount from the waste-stream for recycling collection. The initial stage of collection—when the consumer has the choice to recycle or not—is perhaps most important stage of a recycling program because these materials are needed for the recycling to begin. The consumer causes the most variability in the recycling system in terms of both its efficiency and its efficacy (e.g., in terms of sorting correctly between materials, recycling whenever possible). Because a recycling program's success is highly dependent on the consumer's involvement, programs designed to increase consumer engagement in recycling activities warrant study to (1) inform potential subjects of the benefits of recycling and (2) engage them in recycling the correct materials at the correct locations.

These objectives are particularly important considering that lack of knowledge about a recycling program is a common trait of non-recyclers. While knowledge about how to recycle may not be the sole motivator of recycling, lack of this knowledge is generally viewed as an important barrier to recycling (Schultz 2002). The more knowledgeable an individual is about what items are recyclable, how to prepare items for recycling, and where to go to recycle—the more likely the individual is to correctly take part in the activity (De Young 1989; Vining and Ebreo 1990; Gamba and Oskamp 1994; Scott 1999)

The good news for attracting people to recycling programs is that a lack of knowledge about how to recycle appropriately can be overcome through educational and communication campaigns. The bad news is that, historically, many of these campaigns have failed. Most recycling education programs fail because organizations (e.g., groups responsible for sustainability or waste management efforts in cities, communities, universities, corporations, etc.) focuses on the message they want to transmit, based on rather ill-conceived notions about the information that they assume people need (Meneses 2006). Often, communication strategies don't take into account key characteristics—e.g., areas where people have a clear understanding of issues as well as key deficiencies—of the audience they are trying to reach (Meneses 2006). Educational programs should focus instead on specific content people actually need to complete the desired activity.

These communication plans are most likely a public relations effort of an organization to establish the legitimacy of recycling and create an understanding with the target population that causes them to act (Stalhofer and Isaac 2002). In public relations, the linear model of communication is one of the most popular and criticized theories

(Austin and Pinkleton 2006). The linear model prescribes publicity-based communication programs where messages are scattered through multiple channels to ultimately reach the receiver. One can think of this as a "shotgun approach" to communication where the hope is that at least a few of these messages will be (1) helpful and (2) find their intended recipient. Yet, just because a message gains a lot of exposure—either because it is repeated several times or in several different ways—it does not mean that anyone will receive, understand, learn from, or act differently because of it (Austin and Pinkleton 2006).

Rather than deferring to the time and resource intensive process of scattering messages, one approach for empirically identifying the knowledge gaps that the audience needs addressed is known as mental models research. This approach, which is outlined by Morgan, Fischhoff et al. (2002), helps communicators to better understand their audience by undertaking a systematic analysis of the information they currently possess as well as their information needs. Based on the knowledge gained from mental models research, communicators can design and implement more effective outreach plans, in this case, for recycling programs. With a more targeted and systematic outreach program, the audience will (theoretically) have improved knowledge upon which they can base decisions to recycle more items, and—importantly—to recycle these items correctly. Recycling managers can use resources to educate individuals about the materials and practices that are unknown or misunderstood, while using less resources to enforce what the audience understands. Finally, the mental models approach offers an alternative to other ill-conceived messaging strategies (e.g., fear-based messaging, altruistic appeals) that recycling programs currently use to boost recycling rates.

Mental models research, as described by Morgan, Fischhoff et al. (2002), encompasses the elicitation and interpretation of knowledge for the design of communications. This method has been applied to a wide variety of management contexts, including radon in homes (Bostrom, Fischhoff et al. 1992), nuclear energy sources for space missions (Maharik and Fischhoff 1993), climate change (Bostrom, Morgan et al. 1994), and wildfires (Zaksek and Arvai 2004).

There has been some study of how to specifically tailor recycling programs to an audience on the basis of demographic variables such as income, ethnicity, and gender (Goldenhar and Connell 1992; Howenstine 1993). Nevertheless, the tailoring of recycling programs has been largely understudied in recycling literature, particularly when it comes to understanding the current state of knowledge possessed by today's recycler.

This paper reports the use of a mental models approach for assisting with communication and education efforts based on what people know and do not know about the topic of recycling at the setting of a higher education institution. The objectives of this research project were to: (1) quantify the knowledge of non-expert populations (students and faculty) and identify relevant gaps or lack, and (2) provide recommendations to fill gaps in recycling knowledge, correct misconceptions, and reinforce correct beliefs. Overall, this research seeks to provide a different approach to environmental communication plans by understanding and incorporating the audience's needs.

4.2 Methods

4.2.1 Study Area

This research was conducted on the main campus of Michigan State University (MSU), which is located in East Lansing, Michigan. At the time of this study (the spring and autumn of 2007), a total of 46,045 students were enrolled at MSU; 36,072 of these were in undergraduate degree programs and 9,973 in graduate programs. In addition to these students, approximately 4,800 faculty members work on campus.

4.2.2 Subjects

Because of their size and influence on the amount of waste generated (and potentially recycled), students and faculty[6] were identified by the university administration as the first target populations for the new campus recycling initiative.

Undergraduates living on campus were one focus of this study, due to their experience with a wide-range of campus recycling options. Student subjects were recruited via mail, 250 letters were sent by the administration's office to each residential hall. In collaboration with residential hall administration, four residential halls were that were considered representative of residential living options in terms of the diversity of the student residents. The letter sent to potential subjects briefly explaining the project and requesting they call in to schedule an interview. Additionally, there was a monetary incentive of $40 USD. While the initial mailed invitations went to randomly selected students, students were selected for the study using a purposeful sampling strategy (Patton 1990). Specifically, students were recruited so that the final sample contained an equal number of males and females that represented a wide diversity of degree programs.

[6] University staff were also recognized as important participants in any campus-wide recycling initiative. This group was involved in a parallel, focus group based study of programmatic needs (Hansen, McMellen et al. 2008).

The student sample was recruited to be diverse based on degree program because students living within the selected residential halls could reasonably represent the variety of degree programs available. Additionally, students were screened for any prior experience in the recycling industry or related organizational memberships either on- or off-campus. In all, the sample consisted of 20 males and 20 females who were selected from four different student residential halls (n=40)..

The faculty sample (n=18) was recruited from a randomized phone list, and consisted of 14 male and 4 female subjects[7]. With the assistance of the Department of Recycling and Solid Waste Management, which is responsible for the campus-wide recycling program, we identified buildings on campus that were thought to be "recycling-friendly" (e.g., buildings where there was adequate space and infrastructure available to carry out MSU's proposed recycling activities) as well as buildings where recycling is typically more difficult, called "recycling unfriendly" because these resources are not present. All of the faculty members with offices in each building type were in the initial list, and were recruited in order of a randomized priority to participate. Nine faculty members were recruited and interviewed from each type of building. The faculty members were not purposefully recruited on the basis of department or college, as some of these units' faculty worked in buildings that could not be identified as recycling friendly or unfriendly, and in turn were not included in the study.

4.2.3 Design

[7] For the faculty sample, the goal was to have the number of males and females be closely representative of the actual gender distribution on campus. In 2007, females accounted for 37% of all faculty members; in this study, 22% of the faculty subjects were female.

An expert model (Figure 4.1) was first developed based on an extensive review of the associated literature and with a series of open-ended interviews of recognized experts familiar with campus recycling efforts at MSU and elsewhere. The experts involved in the creation of this model were the administrator of MSU recycling program, the MSU's Sustainability Director, the two surrounding cities' Recycling Directors (from East Lansing and Lansing, MI), and the representatives for the contracted commercial recycling hauler for MSU. This model was structured around six general concept areas:

(1) *What*: a comprehensive listing of the items or materials available for recycling at MSU, but not necessarily collected from every area on campus.

(2) *Where*: an up to date account of places that have recycling infrastructure (e.g., pick-up or drop-off points, processing facilities, etc.) on the main campus of MSU.

(3) *How*: a depiction of the processes an individual carries out to recycle, including: separation, preparation, and general reasons to use a proper method.

(4) *Why*: the incentives or otherwise benefits of recycling in terms of environmental, economical, and social elements.

(5) *Why Not*: factors that impede people from recycling and are considered the disincentives to participating.

(6) *Alternatives*: recognizes that recycling is not the only way to dispose or eliminate a product that is no longer needed for its original purpose and includes garbage, reuse, and reduce.

An interview protocol was next derived from the expert model. The protocol was purposefully open-ended to allow subjects to express both correct and incorrect knowledge and beliefs. Each interview began with a broad question and was followed by subsequent questions that sought to exhaust a subject's knowledge. The first question was intentionally designed to elicit all latent knowledge, starting with: *What can you tell me about recycling at MSU?* Following this, more specific questions were asked branching from each main concept node depicted in the expert model. For example, a series of questions aimed at eliciting a subject's knowledge about paper recyclables might include the following prompts: *"Now that you've talked about recyclable containers, are there other materials that may be recycled on campus?"*; *"What about paper products?"*; and *"Are there any other kinds of paper or things made of paper that can be recycled on campus?"* Each interview was conducted by a single interviewer (the first author) and was digitally recorded for accuracy. When a subject indicated that their knowledge surrounding a given subject was exhausted, the interviewer moved on to the next question or concept. Each interview lasted between 30 to 80 minutes for both students and faculty ($\bar{x}$ = 45 minutes).

4.2.4 Analysis

Subjects' responses were transcribed to develop a mental model for each individual that took part in the research. These models were used to indicate both where their knowledge overlapped with the expert mental model and where there were gaps. Other concepts—both valid ones and misconceptions—were included in the analysis.

Using these models, it was possible to compute frequencies with which subjects understood concepts from the expert model.

In addition to developing a model for each subject, interview responses were also coded according to a five-point scheme, with higher scores reflecting more accurate comprehension of the concept; the codes used were:

4 = concept discussed without prompting and understood by subject;

3 = concept discussed when prompted and understood by subject;

2 = concept discussed without prompting but misunderstood by subject;

1 = concept discussed when prompted but misunderstood by subject;

0 = subject had no knowledge of the subject and was unable to answer interview question (Zaksek and Arvai 2004).

Scores of 3 and 4 indicated correct knowledge, the difference being the ability of the subject to be able to either discuss the concept on their own (a score of 4) or after gentle prompting (a score of 3). For this reason, a concept was part of an individual's mental model when the subject response was correct (a score of 3 or 4).

These codes were then used to estimate mean levels of knowledge for each concept present in the expert model. Chi-square tests were used to compare these means according to a series of independent variables (i.e. by gender, residential hall or building, between students and faculty). Because the sample sizes were relatively small, results had to be amplified using the Monte Carlo (Agresti and Finlay 1997) approach (see Tables 1 through 6).

4.3 Results

4.3.1 General Trends

A comprehensive model, depicting the relative frequency with which specific concepts were understood by subjects, was developed for both MSU students (Figure 4.2) and faculty (Figure 4.3) by combining all the individual mental models elicited from each subject group (e.g. see Figure 4.4 and Figure 4.5). These models revealed important gaps—on part of both MSU students and faculty—in understanding key recycling concepts that are relevant to established campus-based waste reduction practices.

For example, both MSU students and faculty displayed an incomplete understanding of *where* they could recycle on campus. While students knew that recycling opportunities were present in academic buildings and campus dining areas, few knew of specific details regarding where else recycling took place on the MSU campus (Figure 2). For example, only a small percentage of students knew of specific collection points for recyclables in on-campus sports venues (22.5%), MSU's popular International Center Food Court (10%), residential dining areas (40%), and cafés (12.5%).

The same was true of MSU faculty members interviewed (Figure 4.3); relatively few faculty members (33.3%) were aware of collection points for recyclables in dining and concession areas. Neither students (5%) nor faculty (11.1%) were well aware of recycling opportunities at the general campus recycling facility.

There were also distinct gaps in knowledge of students and faculty about a range of *what* specific items can be recycled on campus. For example, while all students and faculty generally knew that paper could be recycled on campus, relatively few subjects were aware of many common paper products that were recyclable; these included low levels of understanding regarding the fact that soft-bound books and telephone directories that were recyclable on-campus by students (25% and 2.5%, respectively) and faculty (27.8% and 38.9%, respectively). Faculty members lack knowledge of the recycling of mail compared to students (11.1% faculty, 40% students), and students need more information about paperboard[8] (12.5% faculty, 0% students). On the positive side, both students (97.5%) and faculty (94.4%) were aware of newspaper recycling opportunities on campus.

Beyond the general knowledge of categories of containers (plastics, glass, and metals), both students and faculty were not well aware of specific items. For example, only 55.6% of students and 42.5% of faculty mentioned recyclability of clear glass items. Similarly, another common container metal food cans was mentioned as a recyclable item by 55% of students and 44.4% of faculty. A few specific kinds of containers were known to be recyclable, including #1 PETE plastic found in most soda and water bottles (82.5% of students and 66.7% of faculty mentioned this material).

In addition to the categories of fibers/papers and containers, was the category of items called "other" with items that did not fit into either category. Of major significance to waste reduction in an academic setting, was the observation that students and faculty interviewed were not well aware of many common forms of electronic waste (e.g. computers, mp3 players, mobile phones), and how they needed to be recycled properly. Recyclability of items such as batteries, ink jet cartridges, fluorescent light bulbs, and toner cartridges—were not well known. Specifically, relatively few faculty members (22.2%) or students (30%) knew about battery recycling. All of these items mentioned

[8] Both groups had a low understanding of paperboard, but students are considered a larger producer of the material due to their personal food purchases. Should students be allowed to recycle this material more readily in the future, they need information regarding the material characteristics and collection points.

contain materials (e.g. mercury, lead, and cadmium) that bear potentially harmful consequences to the health of people and the environment if sent to the landfill.

Subjects also struggled with questions about *how* recycling must be carried out on the MSU campus. Students and faculty were aware of the importance of strict separation rules for a successful recycling program (82.5% of students and 94.4% of faculty mentioned proper sorting); they were, however, less knowledgeable regarding the specifics of this process. The knowledge of separation followed the pattern of knowledge of general items (i.e. paper, glass, metals, and plastic) with much less knowledge of the specific items (e.g. separation of different types of plastic). Further, few subjects knew to rinse recyclable containers (cleaning recyclables was identified by 65%[9] of students interviewed and 38.9% of faculty interviewed), as well as removing caps or lids (with this concept understood by 32.5% of students and 27.8% of faculty).

Faculty and students were knowledgeable about the benefits that help explain *why* to recycle in terms of the general association of recycling with economic, social, and environmental benefits. But relatively few students and faculty could name any specific benefits. For example, the specific concepts of energy conservation, air quality, water protection, and land-use issues were not mentioned by a majority of students (37.5%, 47.5%, 32.5%, respectively) or faculty (44.4%, 22.8%, 16.7%, respectively). An exception to this trend was that of land-use benefits, which were understood by a majority of students (50%) and faculty (77.8%).

As far as disincentives are concerned, these were relatively well understood by both students and faculty; the only significant exception here was a relatively low

[9] Although 65% of students identifying the need to clean recyclables may seem high, this number was low compared to the needs of recycling administrators at MSU.

understanding displayed by both students (22.5%) and faculty (22.2%) regarding space constraints for recycling services in many campus buildings. Lack of understanding for how to recycle, described as the concept of know-how, was reported as a reason why people do not recycle by 72.2% faculty and 95.0% students interviewed.

Besides recycling, faculty and students were aware that they have a few *alternatives*, the most well known of these being (1) the placement of recyclables in the garbage (known by 100% of students and faculty) and (2) reusing items for the same or related purpose (known by 92.5% of students and 83.3% of faculty). The exception here was waste reduction practices (i.e. conscious decisions to use products that yield less waste), which were not well known with 47.5% of students and 38.9% of faculty included this item in their mental models.

4.3.2 Gender Differences

In addition to looking at general trends, we compared (using chi-square tests) levels of student and faculty understanding according to a series of independent variables. One of these independent variables was gender. Among students overall, very few—only four—significant differences were observed (Table 1). These included a greater understanding on the part of male students regarding recycling of biological wastes ($\bar{x}_{males}$=1.90, se= 0.44 and $\bar{x}_{females}$ =0.95, se= 0.34; p=0.02), pick-up options for recyclables ($\bar{x}_{males}$=2.95, se= 0.27 and $\bar{x}_{females}$=1.95, se= 0.35; p=0.05), the availability of a central processing facility ($\bar{x}_{males}$=3.00, se=0.31 and $\bar{x}_{females}$=1.30, se= 0.37; p=0.007), and the recycling of left-over food waste ($\bar{x}_{males}$=1.55, se= 0.24 and $\bar{x}_{females}$=0.95, se= 0.34; p=0.041).

Gender differences among faculty (Table 2) included, for example, a greater understanding by men of white paper ($\bar{x}_{males}$ =4.00, se= 0.21 and $\bar{x}_{females}$ = 3.50, se= 0.00; p= 0.004), and mixed paper ($\bar{x}_{males}$ =3.95, se= 0.34 and $\bar{x}_{females}$ = 3.50, se= 0.00; 0.043) as recyclable items. Male faculty members, by contrast, had a better understanding of how to separate containers from papers for recycling ($\bar{x}_{males}$ =3.50, se= 0.14 and $\bar{x}_{Females}$ =2.00, S se= 1.15; p=0.008).

4.3.3 Faculty/Student Differences

Another independent variable was the role of the subject as a student or faculty member on campus (Table 3). This analysis included differences based on where to recycle, such as students had a greater understanding of recycling collection points in the residential halls ($\bar{x}_{students}$=3.53, se=0.50 and $\bar{x}_{faculty}$= 0.50, se=0.23; p=0.0001) whereas faculty had a greater grasp of recycling collection points in academic buildings ($\bar{x}_{students}$=3.48, se=0.13 and $\bar{x}_{faculty}$=4.00, se=0.00; p=0.006).

In terms of what can be recycled, students were more knowledgeable than faculty about recycling cardboard ($\bar{x}_{students}$=3.25, se =0.20 and $\bar{x}_{faculty}$=2.11, se=0.46; p=0.019). Faculty, by contrast, had a greater knowledge of recycling magazines ($\bar{x}_{students}$=0.98, se=0.26 and $\bar{x}_{faculty}$= 2.89, se =0.39; p=0.001) and mixed paper ($\bar{x}_{students}$=1.93, se=0.30 and $\bar{x}_{faculty}$=3.83, se=0.09; p=0.003).

Students had a greater understanding of certain disincentives to recycling ($\bar{x}_{students}$=2.99, se= 0.46 and $\bar{x}_{faculty}$=2.56, se= 0.46; p= 0.006), including lack of time ($\bar{x}_{students}$=3.03, se=0.23 and $\bar{x}_{faculty}$=1.94, se=0.47; p=0.018) and lack of knowledge about where to recycle items, what items are recyclable, and how to prepare items for recycling ($\bar{x}_{students}$=3.55, se=0.15 and $\bar{x}_{faculty}$=2.78, se= 0.42; p= 0.036).

4.3.4 Campus Facilities Differences

The student subjects' residential hall (Tables 4 and 5) resulted in very few differences. For the most part, these differences were based on the comprehensive knowledge of a general concept, such as how to recycle ($\bar{x}_{Akers}$=1.94, se= 0.25 and $\bar{x}_{Butterfield}$=1.64, se= 0.22 and $\bar{x}_{Holmes}$=1.97, se= 0.23 and $\bar{x}_{Hubbard}$=2.01, se=0.23; p=0.049), and alternatives to recycling ($\bar{x}_{Akers}$=2.15, se= 0.94 and $\bar{x}_{Butterfield}$=2.23, se= 0.80 and $\bar{x}_{Holmes}$=2.35, se=0.90 and $\bar{x}_{Hubbard}$=2.45, se=0.92; p=0.043).

The building type (recycling "friendly" or "unfriendly") of a faculty subjects' office associated was associated with a few differences (Table 6). For example, faculty members in recycling "unfriendly" buildings had a greater awareness of used (post-consumer) newspapers ($\bar{x}_{friendly}$=0.44, se= 0.44 and $\bar{x}_{unfriendly}$=2.22, se=0.70; p= 0.046), and removing impurities from items to prepare them for recycling ($\bar{x}_{friendly}$=1.33, se=0.55 and $\bar{x}_{unfriendly}$=3.113, se= 0.31; p= 0.032).

4.4 Discussion

The mental models approach provides communicators the opportunity to provide information that meets people's information needs, rather than relying on their own anecdotal perceptions. Without an informed understanding of the current level of knowledge held by the communities that communicators are trying to reach, they run the risk of wasting valuable resources and time scattering uncoordinated messages with the hope of influencing behavior. In the end, research which develops a view of the the audience's information needs are—rather than what the communicators want to communicate—is a step in the right direction for thoughtfully designed communication efforts. Mental models research, as used in this study, is the first step in a long-term process to educate the Michigan State University community about recycling, and to a lesser extent, inform the operation and design of recycling collection on-campus.

There are two complementary ways of drawing conclusions from these results. First, one can look to the results from the various statistical analyses to determine if there is a specialized need to address a particular issue (e.g., paper recycling) or to target a specific group of consumers (e.g., faculty members). Second, analysts can look for so-called "big picture" issues that highlight important gaps, misconceptions, or needs that are largely shared by the groups that were the focus of this research (students and faculty).

4.4.1 Statistical Results Implications

Relatively few specific comparisons (which were made using chi-square tests) revealed significant differences either between individuals (e.g., between faculty and students, or by gender) or across groups (e.g., by residential hall, academic building). Of 580 total comparisons, only 36 (or 6.55% of the comparisons) revealed significant differences. There are three implications from these statistical analysis, (1) practical and significant results, (2) significant but not practical results, and (3) non-results.

4.4.1.1 Practical and significant results

Of these significant comparisons, however, there were some notable results. For example, there were distinct differences between the knowledge levels of students and faculty regarding the different kinds of papers that may be recycled on campus (Table 3). Faculty members appear to need additional information regarding the recycling of cardboard ($\bar{x}_{students}$=3.25, se =0.20 and $\bar{x}_{faculty}$= 2.11, se =0.46; p=0.019) while students need information regarding the recycling of mixed paper ($\bar{x}_{students}$=1.93, se=0.30 and $\bar{x}_{faculty}$=3.83, se=0.09; p=.003), magazines ($\bar{x}_{students}$=0.98, se=0.26 and $\bar{x}_{faculty}$=2.89, se=0.39; p=0.001). On the other hand, students outperformed faculty in terms of their level of knowledge about the recyclability of post-consumer paper materials such as newspaper ($\bar{x}_{students}$=2.88, se=0.22 and $\bar{x}_{faculty}$=2.33, se=0.46; p=.039) and white paper ($\bar{x}_{students}$=2.85, se=0.25 and $\bar{x}_{faculty}$=1.33, se=0.46; p=0.001). These kinds of results point to the possibility of identifying different areas of emphasis—between students and faculty, for example—in subject-specific outreach plans.

Along similar lines, students were more likely than their faculty counterparts to provide detailed reasons behind why people do not recycle. Among the reasons why is their view that recycling activities are a time consuming ($\bar{x}_{students}$= 3.03, se= 0.23 and $\bar{x}_{faculty}$= 1.94, se =0.47; p= 0.018) and difficult activity ($\bar{x}_{students}$= 2.99, se= 0.46 and $\bar{x}_{faculty}$= 2.56, se = 0.46; p= 0.006). This important difference between students and faculty warrants perhaps the most attention in future outreach—and importantly, planning—efforts. Students are by a wide margin the largest population on campus and their participation in sustainability activities such as recycling is critical to improving the university's performance in this area.

Thus, it is our view that administrators of the MSU recycling program must approach the design of campus recycling from the standpoint of removing logistical barriers that may make students relate recycling to these negative connotations. Related, outreach efforts must work to counteract the idea that recycling is too difficult (or worse, a waste of time) and, therefore, an activity that is to be avoided. This latter objective could be accomplished through social marketing efforts that provide reasons for students to take the extra steps to recycle (such as the specific benefits of recycling to the environment or revenue of recycling positively affecting student programs).

4.4.1.2 Significant, but not practical results

It is worth pointing out, however, that alongside these differences that were both statistically and practically significant, several other statistically significant differences were of limited value vis-à-vis informing the development of a recycling-specific outreach plan. For example, mean scores of faculty male and female knowledge of white paper recycling were significantly different ($\bar{x}_{males}$ =4.00, se= 0.21 and $\bar{x}_{females}$ = 3.50, se= 0.00; p= 0.004). But the similarity in the mean scores (4.00 vs. 3.50) suggests that both groups clearly understand this issue and, therefore, addressing it further in outreach plans may not be necessary.

Along these lines, when considering both faculty and students, the differences across the genders were largely minor, which mirrors results from other studies (e.g. Berger 1997) that are typically unable to correlate recycling behavior with gender.

Although some differences exist (see above, and Tables 1 and 2), focusing on these in the design of a recycling-specific outreach plan for MSU is—in our view—unlikely to be productive. Both genders need accurate information specific to their student or faculty role in recycling on campus. In sum, the role of a particular subject on campus seems to be a greater determinant of what a subject would know and need to know, rather than their gender.

To further illustrate this point, many of the faculty and student differences that were evident from the chi-square tests (Table 3) can also be explained by considering their roles at the university. For example, one would expect undergraduates living in residential halls to know more about recycling opportunities in these areas. Likewise, one could expect students to be more cost-conscious and therefore, aware of a wider range of products that could be returned to a recycling depot in exchange for a fee (e.g., in the form of a returned deposit). In contrast, faculty are expected to be better aware of specialized office products—e.g., toner cartridges, certain kinds of paper—because they are more likely to use these on a regular basis.

4.4.1.3 Non-results

Equally important in these kinds of analyses are what are commonly referred to as "non-results"; these are areas where statistically significant difference are expected (and hence, inform the design of the mental models study) were absent. But the absence of statistical significance does not necessarily mean that these "non-results" lack outreach implications. For example, student understanding of how to separate cloudy plastic from other plastics was not a significantly different between genders ($\bar{x}_{males}$= 1.15, se= 0.36

and $\bar{x}_{females}$= 1.15, se =0.34; p>0.05), nor was knowledge of recycling florescent light bulbs ($\bar{x}_{males}$= 0.15, se= 0.15 and $\bar{x}_{females}$= 0.00, se =0.00; p>0.05). Both of these items were not well known as recycable and deserve attention in outreach plans. For future communication plans, it is less important that the results yielded few significant differences between genders, but more important that generally subjects were unknowledgeable about certain topics that could be necessary for MSU community members to successfully recycle.

The general lack of significant and systematic differences in this study between the four residential halls where students live and the buildings labeled "recycling friendly" and "recycling unfriendly" where faculty members work is another example of the important role of "non-results." In all, residential hall difference resulted in two significant comparisons among the 116 comparisons conducted (see Table 4.6); building differences resulted in only two differences as well. This is good news from the standpoint of designing a recycling-specific outreach effort because it means that sustainability planners at MSU need not develop building specific communication plans (which would be time consuming and costly).

One notable exception in this regard relates to differences observed across students from the four residential halls in terms of how to recycle; these levels of knowledge were different depending upon which residence hall a student calls home ($\bar{x}_{Akers}$= 1.94, se= 0.25 and $\bar{x}_{Butterfield}$ = 1.64, se= 0.22 and $\bar{x}_{Holmes}$ = 1.97, se= 0.23 and $\bar{x}_{Hubbard}$ = 2.01, se= 0.23; p= 0.049). These differences can be explained by the variation in the operations of the recycling program, some areas have consistent collection points and signage allowing the student to easily recycle, while others do not. This emphasizes the need to couple education with environmental alteration—the technique to increase the rate of recycling by making it logistically easier to do. Access to a structured, institutionalized program allowing for easy and convenient recycling is considered by many to be a very effective technique in terms of leading to durable behavior change and increasing recycling rates (DeYoung 1986; Derksen and Gartrell 1993; Howenstine 1993; Boldero 1995; Lee, DeYoung et al. 1995; Oskamp, Zelezny et al. 1996; Ludwig, Gray et al. 1998; Barr 2004).

4.4.2 Recommendations

The second and final level of analysis draws conclusions based on trends that were evident from the mental models (Figures 4.2 and 4.3). Based on the these results, four general observations stand out as universally important; each of these deals with issues that were either misunderstood or largely unknown by subjects based on the frequency with which concepts were mentioned.

First, recycling locations were not well known outside of the typically used areas of the academic building and residential hall, including dining and food venues, campus owned apartments, and at the recycling processing facility on campus. This lack of knowledge shows, perhaps, a slight indifference for recycling opportunities when they exist outside of one's usual working or socializing areas. Besides education about locations to recycle outside the dorm room and classroom, the idea that recycling *should* and *can* be done almost anywhere and anytime on campus, needs reinforcement.

A second salient finding of this research was the lack of knowledge about how specific types of paper, plastics, glass, and metals must be separated for proper recycling.

An example of this is that all student subjects knew the generally plastics were recycled on campus, but knowledge of the different types of plastic were less known; #1 PETE was mentioned by 82.5% of student subjects. #2 HDPE cloudy (55%), and #2 HDPE colored (15%). Students and faculty need to know what types of these materials can be recycled and how to identify the material (e.g. by looking for a specific plastic recycling number) to better understand how each material needs to be separated. The good news is that subjects were usually aware of these general concepts regarding material types and separation (i.e. paper, plastics, and metals categories).. We recommend outreach plans build upon student and faculty general knowledge for a more complete understanding.

Overall, the importance of knowing what items can and can't be recycled should be stressed to achieve a successful recycling program. Lack of knowledge not only results in lower recycling intensity, lower diversion rates, and lower collection efficiency, but the resulting trial-and-error approach increases contamination levels in collected recyclables (Scott, 1999). In the end, the good intentions of an uncertain public can reduce the efficiency and efficacy of recycling programs.

Third, questions related to why one should recycle also revealed some important knowledge gaps. How much students and faculty should know about the reasons why they ought to recycle relates to the philosophy of higher education. Based on the long-term vision and purpose of MSU, which is to educate citizens—including students, faculty, and staff—about community and environmental stewardship, it stands to reason that gaps regarding the lesser-known concepts of the environmental and the socio-economic benefits of recycling should be addressed.

These results reveal that MSU community members are not made aware of the concepts related to outreaching benefits of sustainable practices, in this case recycling. Students and faculty were well aware of deposit of soda cans and bottles as a monetary incentive (due to Michigan having the largest bottle deposit of any state, at ten cents), but not other socio-economic benefits (e.g., jobs in the recycling industry and the sale of materials collected for recycling). All students and faculty interviewed understood the general connection between recycling and environmental benefits. However, relatively few student and faculty subjects understood the specific nature of these benefits (e.g., benefits in terms of energy efficiency (37.5% and 44.4%, respectfully), cleaner air (47.5% and 22.8%, respectfully), and cleaner water (32.5% and16.7%, respectfully). In accordance with MSU's mission to empower people and communities, I recommend that all community members be helped to understand (via metrics, for example) how their resource use affects the both local and global environmental footprint of MSU.

Fourth, faculty and students were typically aware of reuse as an alternative to waste generation and recycling, but were generally unaware of reduction practices. Female faculty members and female students had a good understanding in general of reduction, but the majority of the students and faculty did not. Reduction is perhaps the hardest lesson to teach and practice, but it can be done. These measures can be accomplished in many ways: through contracts with manufacturers who design products with less packaging; through institution purchases of more durable products and internal reuse of products; and through institutional changes in practices (i.e. default printing paper on two sides); and through institutional purchases of less toxic products (Fishbein and Gelb 1992). Without the MSU community's full cooperation, reduction practices will be difficult to coordinate and implement. The temporary inconvenience of critically thinking about purchases may require more work for purchasing departments and administrators; however, in the long-term, the reduction of waste is perhaps the best way to divert he most waste from the landfill.

4.5 Conclusion

The mental models approach carried out in this study allows the level of stakeholder knowledge to be visible to those who are designing outreach plans. The results can be used to allocate resources to fill gaps in knowledge, and vice-versa, areas of high understanding would need less communication. But mental models do not show how important a concept is compared to all others on the model in terms of priority. The models do not reveal how knowledgeable subjects should be about each concept or item.; all subjects being knowledgeable about every item maybe unnecessary for the success of the program.

When considering residential hall recycling, for example, 87.5% of students knew the location of at least one recycling collection point. Students' seemingly well-developed knowledge of the location is perhaps an argument for not highlighting the topic in outreach effort. But an argument could also be made for further education on the basis of informing students in residential halls about different recycling options available. This may lead to informing students about recycling locations closer to their room and thus, increasing the convenience and recycling rates of students. On the other hand, tire recycling was known by none (0%) of the faculty subjects. But this lack of knowledge is not particularly a concern of outreach plans, because their duties do not require them to service University vehicles.

In the end, the mental models approach reveals how well specific concepts are known, but it does not make the decisions about how well the concepts should be known (or if they are worth knowing at all). The method is meant to help people make decisions about outreach plans, but it is not meant be the decision-maker. These decisions should be equitable and made by a larger group of people including the recycling department administrators, building/residential hall managers, people affected by the program, and building maintenance employees who deal with recycling.

One approach to understand what items are necessary to communicate, could be a future study comparing knowledge of recycling to actual recycling amounts. Although this study shows subjects lack knowledge of certain areas, it does not have a component that shows how this knowledge directly affects the amount of recycling and the levels of contamination. This study could further develop the mental models research to design recycling communications, and to a lesser extent, the physical characteristics of collection.

Another approach to solve these unresolved questions could take the form of a future comparative study using the same mental models interviews, to understand the effectiveness of outreach plans to change and enhance knowledge. In this way, the outreach messages could be measured by the change in the level of knowledge for each item.

Table 4.1: The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Where	24.67	23.67	1.84	1.75	0.37	0.39	n/s
Residence Hall	47.50	45.00	3.50	3.55	0.25	0.22	n/s
Location on Campus	45.00	45.00	3.35	3.40	0.25	0.24	n/s
Location in Residence Hall	45.00	45.00	3.35	3.45	0.25	0.25	n/s
Dining/Concessions	35.00	35.00	2.45	2.30	0.34	0.36	n/s
Sports Venues	15.00	10.00	1.20	0.65	0.34	0.30	n/s
Residential Dining	25.00	15.00	1.85	1.25	0.37	0.33	n/s
International Center Food Court	2.50	7.50	0.25	0.55	0.18	0.28	n/s
Sparty's Cafes	7.50	7.50	0.60	0.40	0.30	0.28	n/s
Campus and Academic Buildings	50.00	47.50	3.50	3.45	0.21	0.17	n/s
Location on Campus	47.50	47.50	3.30	3.35	0.27	0.17	n/s
Location in the Building	45.00	45.00	3.25	3.25	0.30	0.18	n/s
Campus-owned Apartments	2.50	2.50	0.25	0.25	0.16	0.6	n/s
Location in Complex	0.00	0.00	0.05	0.00	0.05	0.00	n/s
Location on Campus	0.00	0.00	0.05	0.05	0.05	0.05	n/s
Processing Facility	2.50	2.50	0.60	0.35	0.18	0.18	n/s
What	21.69	19.46	1.51	1.43	0.20	0.20	n/s
Fibers	0.00	5.00	0.00	0.35	0.00	0.24	n/s
Fabric	2.50	12.50	0.15	0.85	0.15	0.34	n/s
Paper	52.5	50.00	3.95	3.95	0.05	0.05	n/s
Magazines	15.00	17.50	0.9	1.05	0.36	0.37	n/s
White Paper	52.50	45.00	3.75	3.35	0.10	0.24	n/s
Pre-Consumer	2.50	5.00	0.20	0.20	0.20	0.20	n/s
Post-Consumer	47.50	35.00	3.10	2.65	0.26	0.36	n/s
Paperboard	7.50	7.50	0.50	0.40	0.28	0.22	n/s
Mixed Paper	30.00	20.00	2.25	1.60	0.43	0.41	n/s
Junk Mail	22.50	22.50	1.45	1.30	0.41	0.37	n/s
Newspaper	52.50	47.50	3.85	3.80	0.08	0.20	n/s
Pre-Consumer	2.50	0.00	0.15	0.00	0.15	0.00	n/s
Post-Consumer	40.00	40.00	2.95	2.75	0.35	0.38	n/s
Softbound Books	12.50	15.00	0.65	0.90	0.30	0.32	n/s
Cardboard	45.00	42.50	3.30	3.20	0.23	0.32	n/s
Non-Fibers "Containers"	50.00	45.00	3.50	3.25	0.17	0.24	n/s
Metals (Tin, Aluminum)	50.00	50.00	3.60	3.80	0.21	0.09	n/s
Scrap Metal	27.50	22.50	1.70	1.60	0.40	0.41	n/s
Food Cans	30.00	22.50	2.20	1.70	0.42	0.40	n/s
Pop Cans	47.50	47.50	3.45	3.65	0.28	0.21	n/s
Foil	12.50	7.50	0.90	0.30	0.36	0.21	n/s
Glass	52.50	42.50	3.60	3.20	0.11	0.27	n/s
Clear	22.50	20.00	1.50	1.25	0.36	0.35	n/s
Brown	10.00	5.00	0.60	0.40	0.28	0.22	n/s
Plastics	52.50	55.00	3.90	3.95	0.07	0.05	n/s
#1 PETE	40.00	42.50	2.60	3.40	0.36	0.28	n/s
#2 HDPE (Cloudy)	25.00	30.00	1.55	2.20	0.40	0.38	n/s
#2 HDPE (Colored)	7.50	7.50	0.50	0.50	0.28	0.28	n/s

Table 4.1 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Other	42.50	30.00	2.95	0.35	2.25	0.39	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	7.50	5.00	0.50	0.28	0.35	0.24	n/s
Tires	7.50	7.50	0.55	0.30	0.55	0.30	n/s
Toner	0.00	0.00	0.00	0.00	0.15	0.15	n/s
Tennis Shoes	2.50	2.50	0.15	0.15	0.20	0.20	n/s
Electronic Waste	7.50	12.50	0.55	0.30	1.05	0.37	n/s
Biological	25.00	15.00	1.90	0.44	0.95	0.34	0.022
Leaves	10.00	2.50	0.60	0.28	0.15	0.15	n/s
Grass	7.50	10.00	0.45	0.25	0.60	0.28	n/s
Branches	7.50	2.50	0.45	0.25	0.15	0.15	n/s
Food Waste	20.00	5.00	1.55	0.44	0.35	0.24	0.041
Manure	7.50	5.00	0.55	0.30	0.03	0.21	n/s
Hazardous Waste	12.50	10.00	0.80	0.32	0.70	0.33	n/s
Pallets	0.00	2.50	0.00	0.00	0.20	0.20	n/s
Batteries	20.00	10.00	1.30	0.41	0.80	0.32	n/s
Ink-Jet Cartridges	5.00	17.50	0.30	0.21	1.40	0.40	n/s
Florescent Light Bulbs	2.50	0.00	0.15	0.15	0.00	0.00	n/s
How	28.66	25.77	1.97	0.02	1.81	0.22	n/s
Quality Control	47.50	45.00	3.60	0.22	3.35	0.27	n/s
Proper Sorting	42.50	42.50	3.20	0.33	3.10	0.32	n/s
Signs	22.50	22.50	1.70	0.44	1.55	0.40	n/s
Removing Impurities	40.00	37.50	2.55	0.33	2.50	0.32	n/s
Clean	37.50	30.00	2.30	0.36	2.05	0.37	n/s
Remove Caps	12.50	20.00	0.75	0.32	1.45	0.37	n/s
Processing Facility	45.00	20.00	3.00	0.31	1.30	0.37	0.007
Pick-up	40.00	30.00	2.95	0.27	1.95	0.35	0.048
Self-Sorting	47.50	42.50	3.30	0.27	3.15	0.29	n/s
Non-Fibers "Containers"	42.50	40.00	2.85	0.32	2.65	0.36	n/s
Plastics	52.50	50.00	3.60	0.11	3.55	0.11	n/s
#1 PETE	20.00	17.50	1.35	0.39	1.35	0.36	n/s
#2 HDPE (Cloudy)	17.50	15.00	1.15	0.36	1.15	0.34	n/s
#2 HDPE (Colored)	7.50	5.00	0.50	0.28	0.45	0.25	n/s
Metals (Tin, Aluminum)	40.00	37.50	3.00	0.36	3.00	0.36	n/s
Glass	45.00	40.00	3.05	0.31	2.70	0.37	n/s
Brown	10.00	7.50	0.75	0.32	0.45	0.25	n/s
Clear	12.50	7.50	0.95	0.36	0.45	0.25	n/s
Paper	52.50	50.00	3.55	0.11	3.65	0.11	n/s
Magazines	2.50	5.00	0.20	0.20	0.35	0.24	n/s
Softbound Books	0.00	5.00	0.00	0.00	0.30	0.21	n/s
White Paper	22.50	27.50	1.55	0.40	1.80	0.38	n/s
Paperboard	0.00	2.50	0.00	0.00	0.15	0.15	n/s
Mixed Paper	27.50	17.50	1.85	0.39	1.15	0.36	n/s
Newspaper	30.00	32.50	1.90	0.40	2.25	0.35	n/s
Cardboard	27.50	20.00	1.6	0.35	1.25	0.34	n/s

Table 4.1 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Knowledge Concept	% Correct		Mean Score		Standard Error		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Why	32.31	29.23	2.22	0.34	2.07	0.22	n/s
Environmental Benefits	52.50	50.00	3.80	0.22	3.85	0.08	n/s
Water	17.50	12.50	1.15	0.08	0.95	.034	n/s
Land	32.50	17.50	2.20	.034	1.25	0.40	n/s
Air	20.00	27.50	1.40	0.40	1.90	0.40	n/s
Energy	17.50	20.00	1.15	0.40	1.45	0.41	n/s
Economic Benefits	52.50	50.00	3.60	0.41	3.55	0.11	n/s
Monetary Incentive	47.50	47.50	3.35	0.11	3.40	0.21	n/s
Deposit	47.50	45.00	3.35	0.21	3.30	0.27	n/s
Garbage Fees	10.00	5.00	0.70	0.27	0.40	0.24	n/s
Jobs	20.00	12.50	1.25	0.24	0.80	0.30	n/s
Tipping Fees	15.00	10.00	0.90	0.30	0.60	0.28	n/s
Social Benefits	45.00	42.50	3.05	0.28	2.85	0.26	n/s
Awareness	42.50	40.00	2.90	0.26	2.65	0.32	n/s
Why Not	40.83	40.00	2.94	0.32	3.04	0.45	n/s
Disincentives	50.00	50.00	3.95	0.45	4.00	0.00	n/s
Time	42.50	40.00	3.05	0.00	3.00	0.36	n/s
Ease	45.00	42.50	3.15	0.36	3.10	0.32	n/s
Convenience	47.50	47.50	3.30	0.32	3.70	0.21	n/s
Space	10.00	12.50	0.65	0.21	0.90	0.36	n/s
Know-how	50.00	47.50	3.55	0.36	3.55	0.21	n/s
Alternatives	31.88	29.38	2.33	0.21	2.26	0.92	n/s
Reduce	25.00	20.00	1.55	0.92	1.55	0.36	n/s
Reuse	47.50	47.50	3.55	0.36	3.55	0.17	n/s
Surplus Store	2.50	0.00	0.00	0.17	0.00	0.00	n/s
Garbage	52.50	50.00	3.95	0.00	3.95	0.05	n/s

Table 4.2: The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Where	22.59	25.00	1.13	0.50	1.03	0.41	n/s
Residence Hall	11.11	0.00	0.50	0.29	0.50	0.29	n/s
Location on Campus	5.56	0.00	0.21	0.21	0.00	0.00	n/s
Location in Residence Hall	5.56	0.00	0.21	0.21	0.00	0.00	n/s
Dining/Concessions	27.78	25.00	1.29	0.45	1.00	0.71	n/s
Sports Venues	11.11	0.00	0.50	0.34	0.25	0.25	n/s
Residential Dining	11.11	25.00	0.50	0.34	1.00	0.71	n/s
International Center Food Court	16.67	25.00	0.71	0.34	0.75	0.75	n/s
Sparty's Cafes	16.67	0.00	0.86	0.38	0.00	0.00	n/s
Campus and Academic Buildings	77.78	100.00	4.00	0.00	4.00	0.00	n/s
Location on Campus	72.22	100.00	3.79	0.21	4.00	0.00	n/s
Location in the Building	72.22	100.00	3.79	0.21	4.00	0.00	n/s
Campus-owned Apartments	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Processing Facility	11.11	0.00	0.57	0.34	0.00	0.00	n/s
What	30.07	36.41	1.42	0.26	1.36	0.22	n/s
Fibers	0.00	0.00	0.00	0.00	0.00	0.75	n/s
Fabric	0.00	25.0	0.00	0.00	0.75	0.00	n/s
Paper	77.78	100.00	4.00	0.49	4.00	0.29	n/s
Magazines	55.56	100.00	2.71	0.00	3.50	0.29	n/s
White Paper	77.78	100.00	4.00	0.21	3.50	0.00	0.004
Pre-Consumer	5.56	0.00	0.21	0.54	0.00	0.25	0.005
Post-Consumer	38.89	100.00	1.93	0.00	3.75	0.00	n/s
Paperboard	0.00	0.00	0.00	0.07	0.00	0.29	n/s
Mixed Paper	77.78	100.00	3.93	0.34	3.50	0.00	0.043
Junk Mail	11.11	0.00	0.50	0.29	0.00	0.00	n/s
Newspaper	72.22	100.00	3.64	0.00	4.00	0.00	n/s
Pre-Consumer	0.00	0.00	0.00	0.50	0.00	1.15	n/s
Post-Consumer	22.22	50.00	1.14	0.38	2.00	1.00	n/s
Softbound Books	22.22	25.00	0.86	0.51	1.00	1.00	n/s
Cardboard	50.00	25.00	2.43	0.35	1.00	0.00	n/s
Non-Fibers "Containers"	61.11	100.00	2.93	0.29	4.00	0.00	n/s
Metals (Tin, Aluminum)	72.22	100.00	3.36	0.42	4.00	0.00	n/s
Scrap Metal	50.00	0.00	2.00	0.44	0.00	0.75	n/s
Food Cans	38.89	25.00	1.57	0.29	0.75	0.00	n/s
Pop Cans	72.22	100.00	3.50	0.38	4.00	1.00	n/s
Foil	22.22	25.00	0.86	0.27	1.00	0.87	n/s
Glass	72.22	50.00	3.17	0.43	1.50	0.87	n/s
Clear	44.44	50.00	1.79	0.41	1.50	0.75	n/s
Brown	33.33	25.00	1.29	0.38	0.75	0.25	n/s
Plastics	66.67	100.00	3.21	0.48	3.75	1.00	n/s
#1 PETE	50.00	75.00	2.43	0.40	3.00	1.03	n/s
#2 HDPE (Cloudy)	38.89	50.00	1.57	0.29	1.75	0.00	n/s
#2 HDPE (Colored)	11.11	0.00	0.57	0.38	0.00	1.00	n/s

Table 4.2 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Other	66.67	75.00	3.29	0.00	3.00	0.00	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Tires	0.00	0.00	0.00	0.39	0.00	1.00	n/s
Toner	11.11	25.00	0.57	0.29	1.00	0.75	n/s
Tennis Shoes	5.56	25.00	0.29	0.49	0.75	1.03	n/s
Electronic Waste	38.89	50.00	1.71	0.47	1.75	1.00	n/s
Biological	22.22	25.00	1.07	0.29	1.00	0.00	n/s
Leaves	5.56	0.00	0.29	0.29	0.00	0.00	n/s
Grass	5.56	0.00	0.36	0.07	0.00	0.00	n/s
Branches	0.00	0.00	0.07	0.29	0.00	0.00	n/s
Food Waste	5.56	0.00	0.29	0.39	0.00	0.00	n/s
Manure	11.11	0.00	0.57	0.29	0.00	0.00	n/s
Hazardous Waste	5.56	0.00	0.29	0.00	0.00	0.00	n/s
Pallets	0.00	0.00	0.00	0.47	0.00	0.00	n/s
Batteries	22.22	0.00	1.07	0.49	0.00	1.15	n/s
Ink-Jet Cartridges	27.78	50.00	1.29	0.34	2.00	0.00	n/s
Florescent Light Bulbs	11.11	0.00	0.50	0.29	0.00	0.29	n/s
How	43.80	52.89	2.03	0.35	1.99	0.29	n/s
Quality Control	72.22	100.00	3.57	0.23	3.75	0.25	n/s
Proper Sorting	72.22	100.00	3.57	0.23	3.75	0.25	n/s
Signs	44.44	25.00	2.14	0.52	1.00	1.00	n/s
Removing Impurities	38.89	100.00	1.93	0.45	3.25	0.25	n/s
Clean	22.22	75.00	1.29	0.42	2.50	0.87	n/s
Remove Caps	27.78	0.00	1.36	0.44	0.00	0.00	n/s
Processing Facility	11.11	0.00	0.50	0.34	0.00	0.00	n/s
Pick-up	33.33	75.00	1.57	0.48	2.50	0.87	n/s
Self-Sorting	78.78	100.00	3.86	0.10	4.00	0.00	n/s
Non-Fibers "Containers"	78.78	50.00	3.50	0.14	2.00	1.15	0.008
Plastics	66.67	75.00	3.00	0.36	3.00	1.00	n/s
#1 PETE	38.89	75.00	1.71	0.49	2.75	0.95	n/s
#2 HDPE (Cloudy)	27.78	25.00	1.14	0.43	0.75	0.75	n/s
#2 HDPE (Colored)	11.11	0.00	0.43	0.29	0.00	0.00	n/s
Metals (Tin, Aluminum)	61.11	75.00	2.79	0.42	3.00	1.00	n/s
Glass	55.56	50.00	2.80	0.45	2.00	1.15	n/s
Brown	22.22	25.00	0.86	0.38	0.75	0.75	n/s
Clear	33.33	25.00	1.36	0.44	0.75	0.75	n/s
Paper	77.78	100.00	3.64	0.13	4.00	0.00	n/s
Magazines	33.33	50.00	1.50	0.49	2.00	1.15	n/s
Softbound Books	5.56	25.00	0.21	0.21	1.00	1.00	n/s
White Paper	72.22	100.00	3.36	0.29	4.00	0.00	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	72.22	100.00	3.21	0.28	4.00	0.00	n/s
Newspaper	55.56	0.00	2.50	0.45	0.00	0.00	n/s
Cardboard	27.78	25.00	1.29	0.49	1.00	1.00	n/s

Table 4.2 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Why	43.16	59.62	2.03	0.49	2.23	0.44	n/s
Environmental Benefits	77.78	100.00	3.86	0.56	4.00	0.00	n/s
Water	11.11	25.00	0.43	0.10	0.70	0.75	n/s
Land	55.56	100.00	2.64	0.29	3.50	0.29	n/s
Air	16.67	25.00	0.71	0.48	0.75	0.75	n/s
Energy	38.89	25.00	1.64	0.38	1.00	1.00	n/s
Economic Benefits	66.67	100.00	3.29	0.46	4.00	0.00	n/s
Monetary Incentive	66.67	100.00	3.21	0.34	4.00	0.00	n/s
Deposit	61.11	100.00	2.86	0.38	4.00	0.00	n/s
Garbage Fees	27.78	0.00	1.21	0.43	0.00	0.00	n/s
Jobs	27.78	25.00	1.36	0.46	0.75	0.75	n/s
Tipping Fees	11.11	25.00	0.43	0.51	0.75	0.75	n/s
Social Benefits	50.00	75.00	2.43	0.29	2.75	0.95	n/s
Awareness	50.00	75.00	2.36	0.44	2.75	0.95	n/s
Why Not	50.93	70.83	2.51	0.46	2.75	0.65	n/s
Disincentives	77.78	100.00	4.00	0.81	4.00	0.00	n/s
Time	33.33	75.00	1.64	0.00	3.00	1.00	n/s
Ease	55.56	50.00	2.64	0.53	1.75	1.03	n/s
Convenience	66.67	100.00	3.36	0.48	3.75	0.25	n/s
Space	22.22	0.00	1.00	0.39	0.00	0.00	n/s
Know-how	50.00	100.00	2.43	0.44	4.00	0.00	n/s
Alternatives	48.89	87.5	2.39	0.51	3.50	0.40	n/s
Reduce	16.67	100.00	0.86	0.20	4.00	0.00	0.004
Reuse	61.11	100.00	2.79	0.46	4.00	0.00	n/s
Surplus Store	38.89	50.00	1.93	0.42	2.00	1.15	n/s
Garbage	77.78	100.00	4.00	0.54	4.00	0.00	n/s

Table 4.3: The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
Where	46.83	28.15	1.79	0.38	1.11	0.38	0.001
Residence Hall	90.00	11.11	3.53	0.16	0.50	0.23	0.0001
Location on Campus	87.50	5.56	3.38	0.17	0.17	0.17	n/s
Location in Residence Hall	87.50	5.56	3.40	0.17	0.17	0.17	0.0001
Dining/Concessions	67.50	33.33	2.38	0.24	1.22	0.38	n/s
Sports Venues	22.50	11.11	0.93	0.23	0.44	0.27	n/s
Residential Dining	40.00	16.67	1.55	0.25	0.61	0.30	n/s
International Center Food Court	10.00	22.22	0.40	0.16	0.72	0.30	n/s
Sparty's Cafes	12.50	16.67	0.50	0.20	0.67	0.30	n/s
Campus and Academic Buildings	95.00	100.00	3.48	0.13	4.00	0.00	0.006
Location on Campus	92.50	94.44	3.33	0.16	3.83	0.17	0.003
Location in the Building	87.50	94.44	3.25	0.17	3.83	0.17	0.014
Campus-owned Apartments	5.00	0.00	0.25	0.11	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.03	0.03	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.05	0.03	0.00	0.00	n/s
Processing Facility	5.00	11.11	0.48	0.13	0.44	0.27	n/s
What	40.33	38.16	1.42	0.30	1.40	0.20	n/s
Fibers	5.00	0.00	0.18	0.12	0.00	0.00	n/s
Fabric	15.00	5.56	0.50	0.19	0.17	0.17	n/s
Paper	100.00	100.00	3.95	0.03	4.00	0.00	n/s
Magazines	27.50	77.78	0.98	0.26	2.89	0.39	0.001
White Paper	95.00	100.00	3.55	0.13	3.89	0.08	n/s
Pre-Consumer	5.00	5.56	0.20	0.14	0.17	0.17	n/s
Post-Consumer	82.50	61.11	2.88	0.22	2.33	0.46	0.039
Paperboard	12.50	0.00	0.45	0.18	0.00	0.00	n/s
Mixed Paper	50.00	100.00	1.93	0.30	3.83	0.09	0.003
Junk Mail	40.00	11.11	1.38	0.27	0.39	0.27	n/s
Newspaper	97.50	94.44	3.83	0.11	3.72	0.23	n/s
Pre-Consumer	2.50	0.00	0.08	0.08	0.00	0.00	n/s
Post-Consumer	77.50	33.33	2.85	0.25	1.33	0.46	0.001
Softbound Books	25.00	27.78	0.78	0.22	0.89	0.35	n/s
Cardboard	85.00	55.56	3.25	0.20	2.11	0.46	0.019
Non-Fibers "Containers"	92.50	83.33	3.38	0.15	3.17	0.29	n/s
Metals (Tin, Aluminum)	97.50	94.44	3.70	0.11	3.50	0.23	n/s
Scrap Metal	47.50	50.00	1.65	0.28	1.56	0.38	n/s
Food Cans	55.00	44.44	1.95	0.29	1.39	0.38	n/s
Pop Cans	92.50	94.44	3.55	0.17	3.61	0.23	n/s
Foil	17.50	27.78	0.60	0.21	0.89	0.35	n/s
Glass	92.50	83.33	3.40	0.15	2.78	0.32	0.039
Clear	42.50	55.56	1.38	0.25	1.72	0.38	n/s
Brown	15.00	38.89	0.50	0.18	1.17	0.35	n/s
Plastics	100.00	88.89	3.93	0.04	3.33	0.30	0.018
#1 PETE	82.50	66.67	3.00	0.23	2.56	0.42	n/s
#2 HDPE (Cloudy)	55.00	50.00	1.88	0.28	1.61	0.37	n/s

Table 4.3 (continued): The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
#2 HDPE (Colored)	15.00	11.11	0.50	0.19	0.44	0.23	n/s
Other	72.50	83.33	2.60	0.27	3.22	0.36	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	12.50	0.00	0.43	0.18	0.00	0.00	n/s
Tires	15.00	0.00	0.55	0.21	0.00	0.00	n/s
Toner	2.50	16.67	0.08	0.08	0.67	0.36	0.027
Tennis Shoes	5.00	11.11	0.18	0.12	0.39	0.27	n/s
Electronic Waste	22.50	50.00	0.80	0.24	1.72	0.43	n/s
Biological	40.00	27.78	1.43	0.28	1.06	0.42	n/s
Leaves	12.50	5.56	0.38	0.16	0.22	0.22	n/s
Grass	17.50	5.56	0.53	0.18	0.28	0.23	0.029
Branches	10.00	0.00	0.30	0.23	0.06	0.06	n/s
Food Waste	25.00	5.56	0.95	0.10	0.22	0.22	n/s
Manure	12.50	11.11	0.43	0.26	0.44	0.30	n/s
Hazardous Waste	22.50	5.56	0.75	0.23	0.22	0.22	n/s
Pallets	2.50	0.00	0.10	0.10	0.00	0.00	n/s
Batteries	30.00	22.22	1.05	0.26	0.83	0.38	n/s
Ink-Jet Cartridges	25.00	38.89	0.85	0.24	1.44	0.44	n/s
Florescent Light Bulbs	2.50	11.11	0.08	0.08	0.39	0.23	n/s
How	53.37	55.56	1.89	0.22	2.02	0.29	n/s
Quality Control	90.00	94.44	3.48	0.18	3.61	0.18	n/s
Proper Sorting	82.50	94.44	3.15	0.23	3.61	0.18	n/s
Signs	45.00	50.00	1.63	0.29	1.89	0.46	n/s
Removing Impurities	75.00	61.11	2.53	0.23	2.22	0.38	n/s
Clean	65.00	38.89	2.18	0.26	1.56	0.39	n/s
Remove Caps	32.50	27.78	1.10	0.25	1.06	0.37	n/s
Processing Facility	62.50	11.11	2.15	0.27	0.39	0.27	0.002
Pick-up	70.00	50.00	2.45	0.23	1.78	0.42	n/s
Self-Sorting	87.50	100.00	3.23	0.20	3.89	0.08	n/s
Non-Fibers "Containers"	77.50	88.89	2.75	0.24	3.17	0.29	n/s
Plastics	100.00	83.33	3.58	0.08	3.00	0.34	0.042
#1 PETE	40.00	55.56	1.35	0.26	1.94	0.43	n/s
#2 HDPE (Cloudy)	35.00	33.33	1.15	0.25	1.06	0.37	n/s
#2 HDPE (Colored)	15.00	11.11	0.48	0.18	0.33	0.23	n/s
Metals (Tin, Aluminum)	80.00	77.78	3.00	0.25	2.83	0.38	n/s
Glass	80.00	66.67	2.88	0.24	2.39	0.42	n/s
Brown	17.50	27.78	0.60	0.20	0.83	0.33	n/s
Clear	20.00	38.89	0.70	0.22	1.22	0.38	n/s
Paper	100.00	100.00	3.60	0.08	3.72	0.11	n/s
Magazines	7.50	44.44	0.28	0.16	1.61	0.44	0.004
Softbound Books	5.00	11.11	0.15	0.10	039	0.27	n/s
White Paper	50.00	94.44	1.68	0.27	3.50	0.23	0.000
Paperboard	2.50	0.00	0.08	0.08	0.00	0.00	n/s
Mixed Paper	45.00	94.44	1.50	0.27	3.39	0.23	0.001

Table 4.3 (continued): The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
Newspaper	62.50	55.56	2.08	1.94	0.26	0.43	n/s
Cardboard	42.50	33.33	1.43	1.22	0.27	0.42	n/s
Why	60.58	56.41	2.14	2.08	0.33	0.29	n/s
Environmental Benefits	100.00	100.00	3.83	3.89	0.06	0.08	n/s
Water	32.50	16.67	1.05	0.50	0.25	0.27	n/s
Land	50.00	77.78	1.73	2.83	0.28	0.38	n/s
Air	47.50	22.22	1.65	0.72	0.28	0.33	n/s
Energy	37.50	44.44	1.30	1.50	0.27	0.41	n/s
Economic Benefits	100.00	88.89	3.58	3.44	0.08	0.27	0.033
Monetary Incentive	92.50	88.89	3.38	3.39	0.17	0.30	n/s
Deposit	90.00	83.33	3.33	3.11	0.19	0.35	n/s
Garbage Fees	15.00	27.78	0.55	0.94	0.19	0.37	n/s
Jobs	32.50	33.33	1.03	1.20	0.23	0.42	0.029
Tipping Fees	25.00	16.67	0.75	0.50	0.21	0.27	n/s
Social Benefits	85.00	66.67	2.95	2.50	0.20	0.39	n/s
Awareness	80.00	66.67	2.78	2.44	0.23	0.41	n/s
Why Not	79.17	66.67	2.99	2.56	0.46	0.46	0.006
Disincentives	100.00	100.00	3.98	4.00	0.03	0.00	n/s
Time	82.50	50.00	3.03	1.94	0.23	0.47	0.018
Ease	85.00	66.67	3.13	2.44	0.22	0.43	n/s
Convenience	92.50	88.89	3.50	3.44	0.17	0.30	n/s
Space	22.50	22.22	0.78	0.78	0.23	0.36	n/s
Know-how	95.00	72.22	3.55	2.78	0.15	0.42	0.036
Alternatives	60.63	68.06	2.29	2.64	0.88	0.55	n/s
Reduce	47.50	38.89	1.73	1.56	0.26	0.47	0.010
Reuse	92.50	83.33	3.43	3.06	0.16	0.35	n/s
Surplus Store	2.50	50.00	0.08	1.94	0.08	0.47	0.0001
Garbage	100.00	100.00	0.50	4.00	0.03	0.00	n/s

Table 4.4: The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Where	47.33	45.33	51.33	43.33
Residence Hall	100.00	80.00	90.00	90.00
Location on Campus	100.00	70.00	90.00	90.00
Location in Residence Hall	100.00	70.00	90.00	90.00
Dining/Concessions	70.00	70.00	70.00	60.00
Sports Venues	30.00	10.00	30.00	20.00
Residential Dining	40.00	50.00	60.00	10.00
International Center Food Court	10.00	10.00	10.00	10.00
Sparty's Cafes	0.00	20.00	10.00	20.00
Campus and Academic Buildings	90.00	100.00	100.00	90.00
Location on Campus	80.00	100.00	100.00	90.00
Location in the Building	80.00	100.00	100.00	70.00
Campus-owned Apartments	0.00	0.00	10.00	10.00
Location in Complex	0.00	0.00	0.00	0.00
Location on Campus	0.00	0.00	0.00	0.00
Processing Facility	10.00	0.00	10.00	0.00
What	43.70	36.09	42.83	38.70
Fibers	10.00	10.00	0.00	0.00
Fabric	20.00	20.00	10.00	10.00
Paper	100.00	100.00	100.00	100.00
Magazines	10.00	10.00	30.00	60.00
White Paper	90.00	90.00	100.00	100.00
Pre-Consumer	10.00	0.00	0.00	10.00
Post-Consumer	80.00	80.00	90.00	80.00
Paperboard	0.00	20.00	20.00	10.00
Mixed Paper	60.00	30.00	60.00	50.00
Junk Mail	50.00	40.00	30.00	40.00
Newspaper	100.00	100.00	100.00	90.00
Pre-Consumer	10.00	0.00	0.00	0.00
Post-Consumer	70.00	80.00	80.00	80.00
Softbound Books	20.00	10.00	40.00	30.00
Cardboard	80.00	100.00	80.00	80.00
Non-Fibers "Containers"	100.00	80.00	90.00	100.00
Metals (Tin, Aluminum)	90.00	100.00	100.00	100.00
Scrap Metal	60.00	40.00	40.00	50.00
Food Cans	60.00	60.00	60.00	40.00
Pop Cans	90.00	90.00	100.00	90.00
Foil	10.00	10.00	0.00	50.00
Glass	100.00	90.00	100.00	80.00
Clear	60.00	30.00	50.00	30.00
Brown	20.00	10.00	10.00	20.00
Plastics	100.00	100.00	100.00	100.00
#1 PETE	100.00	80.00	90.00	60.00
#2 HDPE (Cloudy)	70.00	30.00	60.00	60.00
#2 HDPE (Colored)	20.00	0.00	20.00	20.00

Table 4.4 (continued): The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Other	90.00	70.00	80.00	50.00
Fly Ash	0.00	0.00	0.00	0.00
Construction Waste	0.00	20.00	10.00	20.00
Tires	10.00	10.00	10.00	30.00
Toner	0.00	0.00	10.00	0.00
Tennis Shoes	20.00	0.00	0.00	0.00
Electronic Waste	30.00	20.00	30.00	10.00
Biological	60.00	20.00	50.00	30.00
Leaves	30.00	10.00	0.00	10.00
Grass	30.00	0.00	20.00	20.00
Branches	20.00	10.00	10.00	0.00
Food Waste	50.00	30.00	10.00	10.00
Manure	30.00	0.00	20.00	0.00
Hazardous Waste	10.00	10.00	50.00	20.00
Pallets	0.00	10.00	0.00	0.00
Batteries	20.00	30.00	40.00	30.00
Ink-Jet Cartridges	20.00	10.00	70.00	0.00
Florescent Light Bulbs	0.00	0.00	0.00	10.00
How	56.67	47.69	54.23	56.16
Quality Control	90.00	90.00	90.00	90.00
Proper Sorting	80.00	90.00	80.00	80.00
Signs	50.00	40.00	50.00	40.00
Removing Impurities	80.00	60.00	80.00	80.00
Clean	70.00	50.00	70.00	70.00
Remove Caps	50.00	30.00	30.00	20.00
Processing Facility	60.00	60.00	60.00	70.00
Pick-up	70.00	60.00	70.00	70.00
Self-Sorting	100.00	90.00	80.00	80.00
Non-Fibers "Containers"	100.00	60.00	70.00	80.00
Plastics	100.00	100.00	100.00	100.00
#1 PETE	60.00	10.00	40.00	50.00
#2 HDPE (Cloudy)	40.00	10.00	40.00	50.00
#2 HDPE (Colored)	10.00	10.00	20.00	20.00
Metals (Tin, Aluminum)	90.00	60.00	90.00	80.00
Glass	90.00	80.00	70.00	80.00
Brown	10.00	30.00	10.00	20.00
Clear	10.00	30.00	10.00	30.00
Paper	100.00	100.00	100.00	100.00
Magazines	0.00	0.00	10.00	20.00
Softbound Books	10.00	0.00	10.00	0.00
White Paper	40.00	50.00	50.00	60.00
Paperboard	0.00	0.00	10.00	0.00
Mixed Paper	40.00	30.00	50.00	60.00
Newspaper	60.00	60.00	70.00	60.00
Cardboard	30.00	40.00	50.00	50.00

Table 4.4 (continued): The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Why	56.16	54.17	67.69	57.50
Environmental Benefits	100.00	100.00	100.00	100.00
Water	20.00	30.00	50.00	30.00
Land	30.00	50.00	60.00	60.00
Air	30.00	50.00	70.00	40.00
Energy	40.00	20.00	50.00	40.00
Economic Benefits	100.00	100.00	100.00	100.00
Monetary Incentive	90.00	90.00	100.00	90.00
Deposit	80.00	90.00	100.00	90.00
Garbage Fees	0.00	10.00	30.00	20.00
Jobs	40.00	40.00	30.00	20.00
Tipping Fees	40.00	30.00	10.00	20.00
Social Benefits	80.00	30.00	90.00	90.00
Awareness	80.00	60.00	90.00	90.00
Why Not	81.67	78.33	85.00	71.67
Disincentives	100.00	100.00	100.00	90.00
Time	70.00	90.00	100.00	70.00
Ease	100.00	80.00	90.00	70.00
Convenience	100.00	100.00	90.00	80.00
Space	20.00	20.00	30.00	20.00
Know-how	100.00	80.00	100.00	100.00
Alternatives	55.00	60.00	65.00	62.50
Reduce	30.00	50.00	60.00	50.00
Reuse	90.00	80.00	100.00	100.00
Surplus Store	0.00	10.00	0.00	0.00
Garbage	100.00	100.00	100.00	100.00

Table 4.5: Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Where	1.73	0.40	1.75	0.39	1.89	0.38	1.80	0.38	n/s
Residence Hall	3.90	0.10	3.00	0.45	3.50	0.40	3.70	0.21	n/s
Location on Campus	3.90	0.10	2.80	0.44	3.30	0.40	3.50	0.31	n/s
Location in Residence Hall	3.90	0.10	2.80	0.44	3.40	0.40	3.50	0.31	n/s
Dining/Concessions	2.30	0.52	2.40	0.54	2.40	0.48	2.40	0.48	n/s
Sports Venues	0.90	0.46	0.60	0.40	1.30	0.54	0.90	0.46	n/s
Residential Dining	1.60	0.48	1.70	0.58	2.20	0.49	0.70	0.40	n/s
International Center Food Court	0.30	0.30	0.40	0.40	0.30	0.30	0.60	0.34	n/s
Sparty's Cafes	0.10	0.10	0.80	0.53	0.30	0.30	0.80	0.53	n/s
Campus and Academic Buildings	3.00	0.26	3.90	0.10	3.60	0.16	3.40	0.40	n/s
Location on Campus	2.70	0.40	3.80	0.13	3.40	0.16	3.40	0.40	n/s
Location in the Building	2.70	0.40	3.80	0.13	3.50	0.17	3.00	0.47	n/s
Campus-owned Apartments	0.00	0.00	0.10	0.10	0.40	0.31	0.50	0.31	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	n/s
Processing Facility	0.70	0.33	0.20	0.20	0.50	0.31	0.50	0.17	n/s
What	1.58	0.20	1.31	0.20	1.56	0.21	1.43	0.19	n/s
Fibers	0.30	0.30	0.40	0.40	0.00	0.00	0.00	0.00	n/s
Fabric	0.60	0.40	0.70	0.47	0.30	0.30	0.40	0.40	n/s
Paper	3.90	0.10	3.90	0.10	4.00	0.00	4.00	0.00	n/s
Magazines	0.30	0.30	0.40	0.40	1.00	0.52	2.20	0.61	n/s
White Paper	3.30	0.40	3.40	0.31	3.80	0.13	3.70	0.15	n/s
Pre-Consumer	0.40	0.40	0.00	0.00	0.00	0.00	0.40	0.40	n/s
Post-Consumer	2.70	0.47	2.50	0.43	3.40	0.40	2.90	0.50	n/s
Paperboard	0.00	0.00	0.80	0.42	0.70	0.47	0.30	0.30	n/s
Mixed Paper	2.20	0.61	1.00	0.52	2.40	0.60	2.10	0.64	n/s
Junk Mail	1.70	0.58	1.30	0.54	1.10	0.57	1.40	0.58	n/s
Newspaper	3.90	0.10	4.00	0.00	4.00	0.00	3.40	0.40	n/s
Pre-Consumer	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Post-Consumer	2.40	0.54	3.00	0.52	3.10	0.53	2.90	0.50	n/s
Softbound Books	0.60	0.40	0.30	0.30	1.20	0.49	1.00	0.52	n/s
Cardboard	3.40	0.27	3.60	0.16	3.10	0.53	3.60	0.50	n/s
Non-Fibers "Containers"	3.80	0.13	2.90	0.35	3.20	0.39	3.60	0.16	n/s
Metals (Tin, Aluminum)	3.50	0.40	3.60	0.16	3.80	0.13	3.90	0.10	n/s
Scrap Metal	2.00	0.56	1.20	0.49	1.60	0.65	1.80	0.61	n/s
Food Cans	2.10	0.59	2.00	0.56	2.10	0.59	1.60	0.65	n/s
Pop Cans	3.60	0.40	3.40	0.40	3.90	0.10	3.30	0.40	n/s
Foil	0.30	0.30	0.30	0.30	0.00	0.00	1.80	0.61	n/s
Glass	3.60	0.16	3.40	0.31	3.50	0.17	3.10	0.46	n/s
Clear	1.90	0.53	0.90	0.46	1.60	0.54	1.10	0.50	n/s
Brown	0.60	0.40	0.50	0.34	0.30	0.30	0.60	0.40	n/s
Plastics	3.90	0.10	3.90	0.10	4.00	0.00	3.90	0.10	n/s
#1 PETE	3.70	0.15	2.80	0.49	3.20	0.39	2.30	0/63	n/s
#2 HDPE (Cloudy)	2.30	0.52	1.00	0.52	2.10	0.59	2.10	0.59	n/s
#2 HDPE (Colored)	0.60	0.40	0.00	0.00	0.70	0.47	0.70	0.47	n/s

Table 4.5 (continued): Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Other	3.40	0.40	2.50	0.56	2.70	0.47	1.80	0.61	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.70	0.47	0.30	0.30	0.70	0.47	n/s
Tires	0.40	0.40	0.40	0.40	0.30	0.30	1.10	0.57	n/s
Toner	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.00	n/s
Tennis Shoes	0.70	0.47	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Electronic Waste	1.10	0.57	0.7	0.47	1.00	0.52	0.40	0.40	n/s
Biological	2.20	0.61	0.80	0.53	1.60	0.54	1.10	0.57	n/s
Leaves	0.90	0.46	0.30	0.30	0.00	0.00	0.30	0.30	n/s
Grass	0.90	0.46	0.00	0.00	0.60	0.40	0.60	0.40	n/s
Branches	0.60	0.40	0.30	0.30	0.30	0.30	0.00	0.00	n/s
Food Waste	1.80	0.61	1.20	0.61	0.40	0.40	0.40	0.40	n/s
Manure	1.10	0.57	0.00	0.00	0.60	0.40	0.00	0.00	n/s
Hazardous Waste	0.40	0.40	0.30	0.30	1.60	0.54	0.70	0.47	n/s
Pallets	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	n/s
Batteries	0.60	0.40	1.10	0.57	1.40	0.58	1.10	0.57	n/s
Ink-Jet Cartridges	0.70	0.47	0.30	0.30	2.40	0.54	0.00	0.00	n/s
Florescent Light Bulbs	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	n/s
How	1.94	0.25	1.64	0.22	1.97	0.23	2.01	0.21	0.05
Quality Control	3.60	0.22	3.40	0.40	3.60	0.40	3.30	0.40	n/s
Proper Sorting	3.20	0.42	3.40	0.40	3.20	0.53	2.80	0.49	n/s
Signs	1.60	0.54	1.50	0.62	1.90	0.64	1.50	0.62	n/s
Removing Impurities	2.70	0.47	2.10	0.53	2.80	0.42	2.50	0.43	n/s
Clean	2.40	0.54	1.60	0.54	2.40	0.48	2.30	0.52	n/s
Remove Caps	1.60	0.54	1.10	0.57	1.00	0.45	0.70	0.47	n/s
Processing Facility	2.10	0.59	1.90	0.53	2.00	0.56	2.60	0.58	n/s
Pick-up	2.40	0.43	2.30	0.45	2.50	0.45	2.60	0.58	n/s
Self-Sorting	3.40	0.6	3.20	0.29	3.20	0.53	3.10	0.53	n/s
Non-Fibers "Containers"	3.60	0.16	2.00	0.56	2.60	0.58	2.80	0.42	n/s
Plastics	3.70	0.15	3.30	0.15	3.70	0.15	3.60	0.16	n/s
#1 PETE	1.90	0.53	0.40	0.31	1.20	0.49	1.90	0.64	n/s
#2 HDPE (Cloudy)	1.20	0.49	0.40	0.31	1.20	0.49	1.80	0.61	n/s
#2 HDPE (Colored)	0.30	0.30	0.30	0.30	0.60	0.40	0.70	0.47	n/s
Metals (Tin, Aluminum)	3.40	0.40	2.10	0.59	3.60	0.40	2.90	0.50	n/s
Glass	3.30	0.40	2.70	0.47	2.60	0.58	2.90	0.50	n/s
Brown	0.50	0.40	1.00	0.52	0.30	0.30	0.60	0.40	n/s
Clear	0.50	0.40	1.00	0.52	0.30	0.30	1.00	0.52	n/s
Paper	3.60	0.16	3.40	0.16	3.90	0.10	3.50	0.17	n/s
Magazines	0.00	0.00	0.00	0.00	0.30	0.30	0.80	0.53	n/s
Softbound Books	0.30	0.30	0.00	0.00	03.0	0.30	0.00	0.00	n/s
White Paper	1.20	0.49	1.50	0.50	1.70	0.58	2.30	0.63	n/s
Paperboard	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.00	n/s
Mixed Paper	1.20	0.49	0.90	0.46	1.70	0.58	2.20	0.61	n/s
Newspaper	1.80	0.49	2.00	0.56	2.40	0.45	2.10	0.59	n/s
Cardboard	0.90	0.46	1.20	0.49	1.80	0.16	1.80	0.61	n/s

Table 4.5 (continued): Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Why	1.94	2.05	2.40	2.19	0.34	0.35	0.32	0.34	n/s
Environmental Benefits	3.80	3.90	3.80	3.80	0.13	0.10	0.13	0.57	n/s
Water	0.60	0.90	1.60	1.10	0.40	0.46	0.54	0.59	n/s
Land	1.00	1.60	2.20	2.10	0.52	0.54	0.61	0.59	n/s
Air	1.10	1.60	1.30	1.60	0.57	0.54	0.52	0.65	n/s
Energy	1.40	0.60	1.80	1.40	0.58	0.40	0.61	0.58	n/s
Economic Benefits	3.50	3.60	3.60	3.60	0.17	0.16	0.16	0.16	n/s
Monetary Incentive	3.20	3.30	3.70	3.30	0.39	0.40	0.15	0.40	n/s
Deposit	2.90	3.40	3.70	3.30	0.50	0.40	0.15	0.40	n/s
Garbage Fees	0.00	0.40	1.10	0.70	0.00	0.31	0.57	0.40	n/s
Jobs	1.20	1.20	1.10	0.60	0.49	0.49	0.50	0.40	n/s
Tipping Fees	1.20	0.0	0.30	0.60	0.40	0.46	0.30	0.40	n/s
Social Benefits	2.70	2.90	3.00	3.20	0.40	0.50	0.37	0.39	n/s
Awareness	2.60	2.30	3.00	3.20	0.45	0.63	0.37	0.39	n/s
Why Not	3.22	2.83	3.09	2.80	0.52	0.50	0.43	0.48	n/s
Disincentives	4.00	4.00	3.90	4.00	0.00	0.00	0.10	0.00	n/s
Time	2.80	3.00	3.60	2.70	0.61	0.37	0.16	0.60	n/s
Ease	3.90	2.60	3.40	2.60	0.10	0.45	0.40	0.58	n/s
Convenience	4.00	3.80	3.20	3.00	0.00	0.13	0.39	0.53	n/s
Space	0.80	0.60	1.00	0.70	0.53	0.40	0.52	0.47	n/s
Know-how	3.80	3.00	3.60	3.80	0.13	0.52	0.16	0.13	n/s
Alternatives	2.15	2.23	2.35	2.45	0.94	0.80	0.90	0.92	0.04
Reduce	1.20	1.70	1.90	2.10	0.44	0.45	0.53	0.64	n/s
Reuse	3.40	2.90	3.50	3.90	0.40	0.43	0.17	0.10	n/s
Surplus Store	0.00	0.30	0.00	0.00	0.00	0.30	0.00	0.00	n/s
Garbage	4.00	4.00	4.00	3.80	0.00	0.00	0.00	0.13	n/s

Table 4.6: Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Where	20.74	35.56	0.90	0.39	1.32	0.38	n/s
Residence Hall	0.00	22.22	0.22	0.15	0.78	0.43	n/s
Location on Campus	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Location in Residence Hall	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Dining/Concessions	11.10	55.56	0.56	0.34	1.89	0.61	n/s
Sports Venues	0.00	22.22	0.11	0.11	0.78	0.52	n/s
Residential Dining	0.00	33.33	0.11	0.11	1.11	0.56	n/s
International Center Food Court	11.11	33.33	0.44	0.34	1.00	0.50	n/s
Sparty's Cafes	11.11	22.22	0.56	0.44	0.78	0.43	n/s
Campus and Academic Buildings	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Location on Campus	88.89	100.00	3.67	0.33	4.00	0.00	n/s
Location in the Building	88.89	100.00	3.67	0.33	4.00	0.00	n/s
Campus-owned Apartments	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Processing Facility	0.00	22.22	0.11	0.11	0.78	0.52	n/s
What	36.23	40.10	1.32	0.21	1.49	0.19	n/s
Fibers	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Fabric	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Paper	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Magazines	66.67	88.89	2.67	0.67	3.11	0.42	n/s
White Paper	100.00	100.00	4.00	0.00	3.78	0.15	n/s
Pre-Consumer	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Post-Consumer	44.44	77.78	1.78	0.70	2.89	0.56	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	100.00	100.00	4.00	0.00	3.67	0.17	n/s
Junk Mail	22.22	0.00	0.78	0.52	0.00	0.00	n/s
Newspaper	100.00	88.89	3.89	0.11	3.56	0.44	n/s
Pre-Consumer	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Post-Consumer	11.11	55.56	0.44	0.44	2.22	0.70	0.046
Softbound Books	33.33	22.22	1.00	0.50	0.78	0.52	n/s
Cardboard	55.56	55.56	2.11	0.68	2.11	0.68	n/s
Non-Fibers "Containers"	88.89	77.78	3.11	0.42	3.22	0.43	n/s
Metals (Tin, Aluminum)	88.89	100.00	3.22	0.43	3.78	0.15	n/s
Scrap Metal	55.56	44.44	1.78	0.57	1.33	0.53	n/s
Food Cans	33.33	55.56	1.00	0.50	1.78	0.57	n/s
Pop Cans	100.00	88.89	3.78	0.15	3.44	0.44	n/s
Foil	11.11	44.44	0.33	0.33	1.44	0.58	n/s
Glass	88.89	77.78	2.89	0.39	2.67	0.53	n/s
Clear	66.67	44.44	2.11	0.54	1.33	0.53	n/s
Brown	44.44	33.33	1.33	0.53	1.00	0.50	n/s
Plastics	88.89	88.89	3.22	0.43	3.44	0.44	n/s
#1 PETE	66.67	66.67	2.56	0.65	2.56	0.58	n/s
#2 HDPE (Cloudy)	44.44	55.56	1.33	0.53	1.89	0.54	n/s
#2 HDPE (Colored)	0.00	22.22	0.11	0.11	0.78	0.43	n/s

Table 4.6 (continued): Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Other	88.89	77.78	3.44	0.44	3.00	0.58	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Tires	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Toner	11.11	22.22	0.44	0.44	0.89	0.59	n/s
Tennis Shoes	0.00	22.22	0.00	0.00	0.78	0.52	n/s
Electronic Waste	44.4	55.56	1.56	0.63	1.89	0.61	n/s
Biological	0.00	55.56	0.00	0.00	2.11	0.68	n/s
Leaves	0.00	11.11	0.00	0.00	0.44	0.44	n/s
Grass	0.00	11.11	0.00	0.00	0.56	0.44	n/s
Branches	0.00	0.00	0.00	0.00	0.11	0.11	n/s
Food Waste	0.00	11.11	0.00	0.00	0.44	0.44	n/s
Manure	0.00	22.22	0.00	0.00	0.89	0.59	n/s
Hazardous Waste	11.11	0.00	0.44	0.44	0.00	0.00	n/s
Pallets	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Batteries	33.33	11.11	1.22	0.62	0.44	0.44	n/s
Ink-Jet Cartridges	44.44	33.33	1.56	0.63	1.33	0.67	n/s
Florescent Light Bulbs	22.22	0.00	0.78	0.52	0.00	0.00	n/s
How	52.14	58.97	1.95	0.27	2.09	0.21	n/s
Quality Control	100.00	88.89	3.89	0.11	3.33	0.33	n/s
Proper Sorting	100.00	88.89	3.89	0.11	3.33	0.33	n/s
Signs	55.56	44.44	2.22	0.70	1.56	0.63	n/s
Removing Impurities	33.33	88.89	1.33	0.55	3.11	0.31	n/s
Clean	33.33	44.44	1.33	0.55	1.78	0.57	n/s
Remove Caps	22.22	33.33	0.78	0.52	1.33	0.53	n/s
Processing Facility	0.00	22.22	0.00	0.00	0.78	0.52	n/s
Pick-up	55.56	44.44	2.11	0.61	1.44	0.58	n/s
Self-Sorting	100.00	100.00	4.00	0.00	3.78	0.15	n/s
Non-Fibers "Containers"	88.89	88.89	3.11	0.42	3.22	0.43	n/s
Plastics	88.89	77.78	3.11	0.42	2.89	0.56	0.046
#1 PETE	44.44	66.67	1.67	0.67	2.22	0.57	n/s
#2 HDPE (Cloudy)	22.22	44.44	0.78	0.52	1.33	0.53	n/s
#2 HDPE (Colored)	0.00	22.22	0.00	0.00	0.67	0.44	n/s
Metals (Tin, Aluminum)	77.78	77.78	2.78	0.55	2.89	0.56	n/s
Glass	66.67	66.67	2.44	0.63	2.33	0.60	n/s
Brown	22.22	33.33	0.67	0.44	1.00	0.50	n/s
Clear	33.33	44.44	1.11	0.56	1.33	0.53	n/s
Paper	100.00	100.00	3.78	0.15	3.67	0.17	n/s
Magazines	44.44	44.44	1.67	0.67	1.56	0.63	n/s
Softbound Books	0.00	22.22	0.00	0.00	0.78	0.52	n/s
White Paper	100.00	88.89	3.78	0.15	3.22	0.43	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	88.89	100.00	3.33	0.44	3.44	0.18	n/s
Newspaper	55.56	55.56	2.11	0.68	1.78	0.57	n/s
Cardboard	22.22	44.44	0.89	0.59	1.56	0.63	n/s

Table 4.6 (continued): Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Why	51.28	61.54	1.89	0.33	2.26	0.37	n/s
Environmental Benefits	100.00	100.00	3.78	0.15	4.00	0.00	n/s
Water	0.00	33.33	0.00	0.00	1.00	0.50	n/s
Land	66.67	88.89	2.56	0.65	3.11	0.42	n/s
Air	11.11	33.33	0.44	0.44	1.00	0.50	n/s
Energy	44.44	44.44	1.56	0.63	1.44	0.58	n/s
Economic Benefits	77.78	100.00	3.00	0.50	3.89	0.11	n/s
Monetary Incentive	77.78	100.00	2.89	0.56	3.89	0.11	n/s
Deposit	77.78	88.89	2.78	0.55	3.44	0.44	n/s
Garbage Fees	44.44	11.11	1.56	0.63	0.33	0.33	n/s
Jobs	22.22	44.44	0.89	0.59	1.56	0.63	n/s
Tipping Fees	11.11	22.22	0.33	0.33	0.67	0.44	n/s
Social Benefits	66.67	66.67	2.44	0.56	2.56	0.58	n/s
Awareness	66.67	66.67	2.33	0.60	2.56	0.58	n/s
Why Not	61.11	72.22	2.39	0.52	2.74	0.43	n/s
Disincentives	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Time	44.44	55.56	1.67	0.67	2.22	0.70	n/s
Ease	66.67	66.67	2.56	0.65	2.33	0.60	n/s
Convenience	88.89	88.89	3.44	0.44	3.44	0.44	n/s
Space	11.11	33.33	0.44	0.44	1.11	0.56	n/s
Know-how	55.56	88.89	2.22	0.70	3.33	0.44	n/s
Alternatives	61.11	75.00	2.39	0.64	2.89	0.44	n/s
Reduce	22.22	55.56	0.89	0.59	2.22	0.70	n/s
Reuse	66.67	100.00	2.44	0.63	3.67	0.17	n/s
Surplus Store	55.56	44.44	2.22	0.70	4.00	0.67	n/s
Garbage	100.00	100.00	4.00	0.00	0.33	0.00	n/s

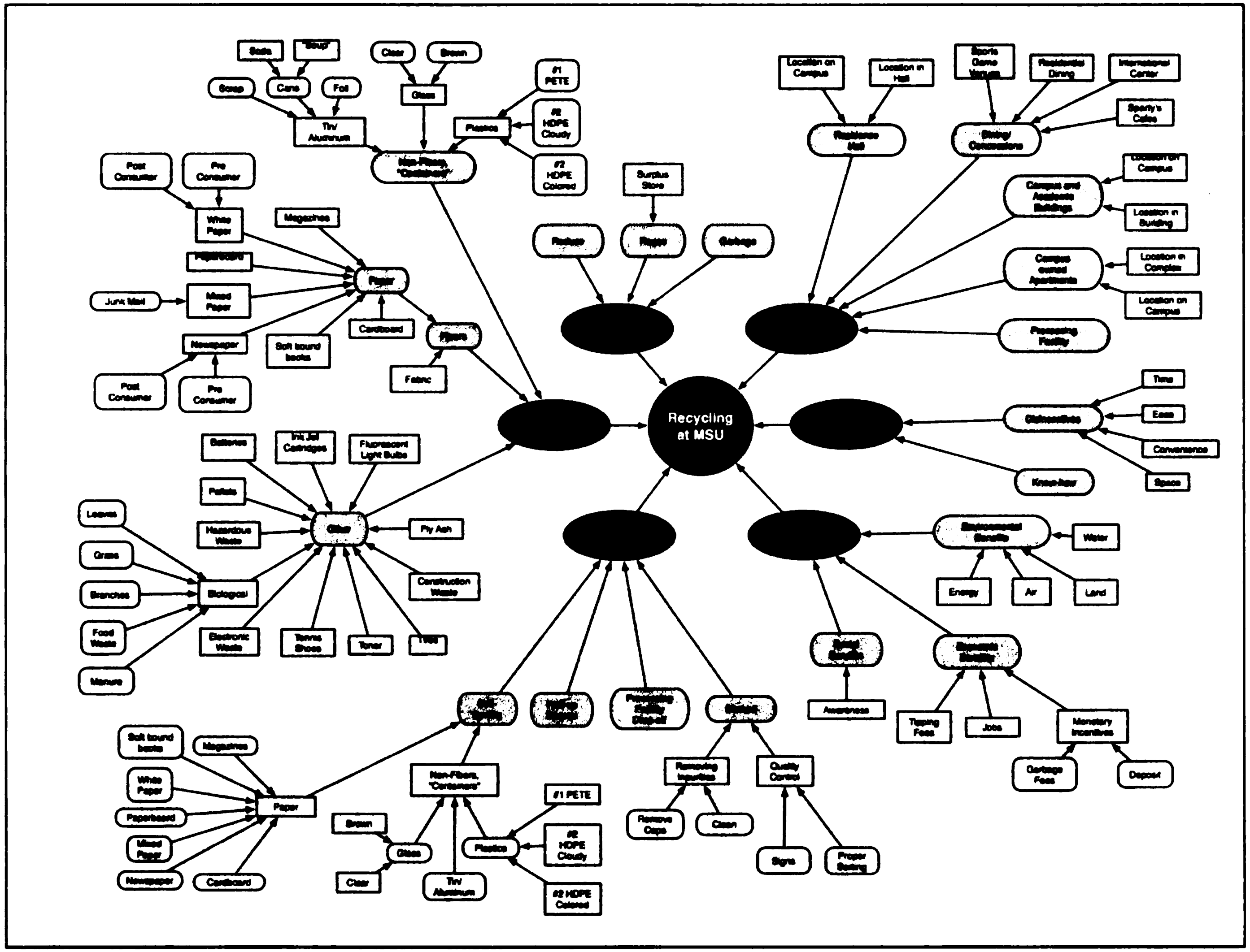

Figure 4.1: Expert mental model for recycling on the MSU campus.

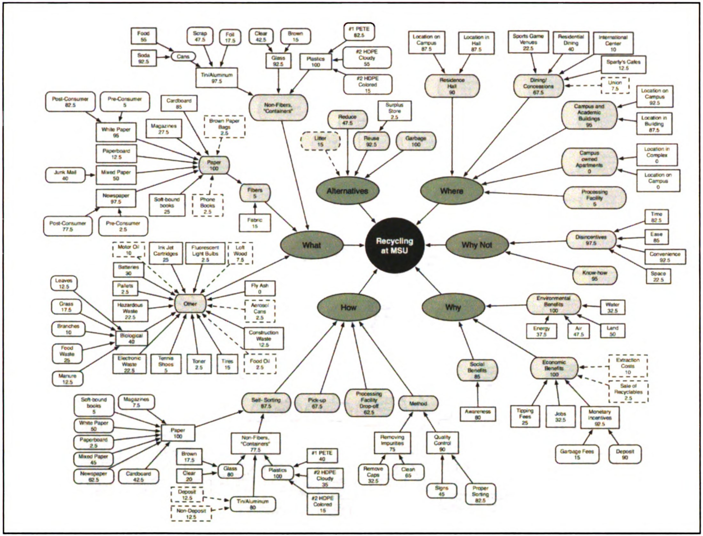

Figure 4.2. Comprehensive student mental model. Percent values indicate frequency of understanding across subjects. Hatched boxes indicate concepts mentioned by subjects that were not present in the expert model.

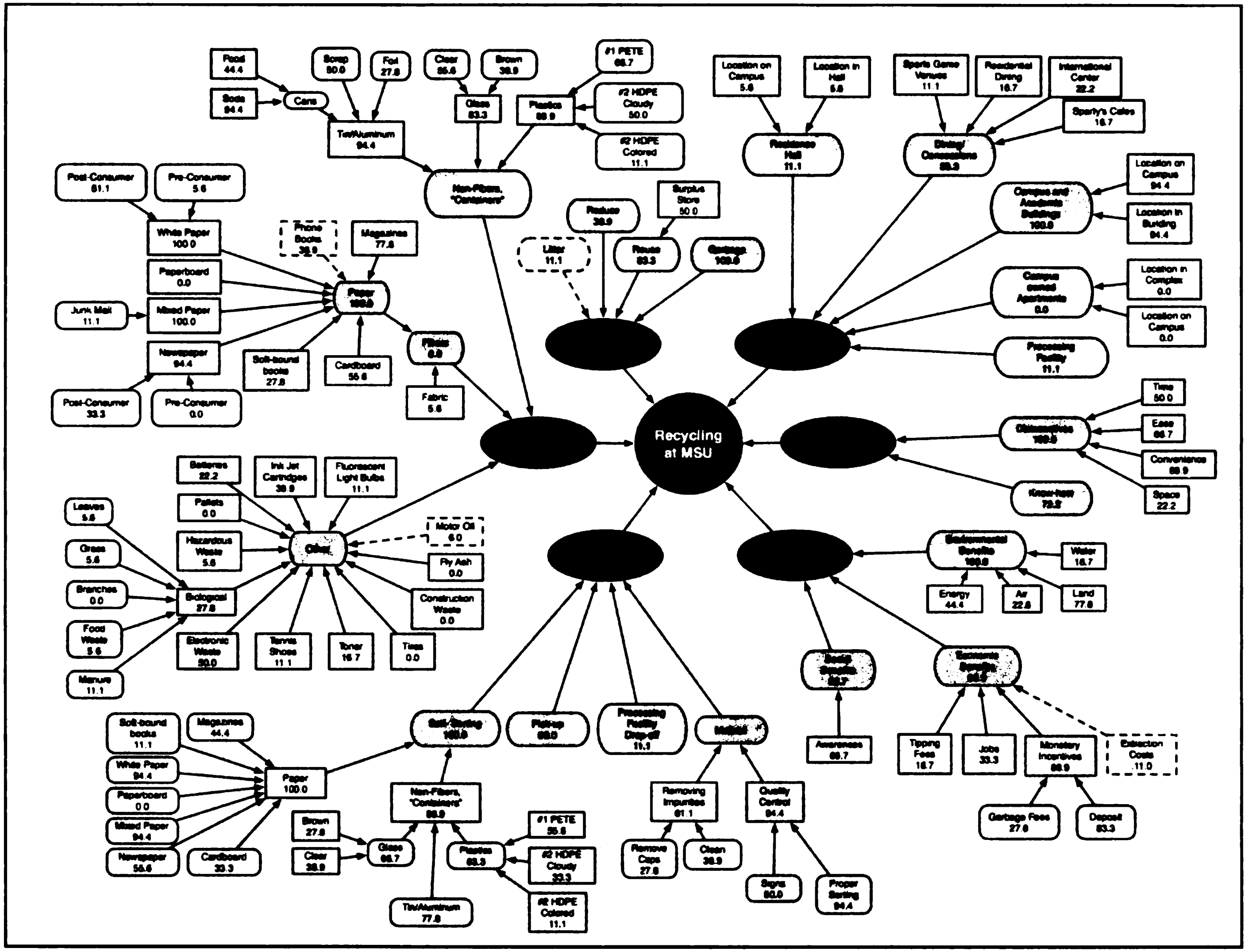

Figure 4.3. Comprehensive faculty mental model. Percent values indicate frequency of understanding across subjects. Hatched boxes indicate concepts mentioned by subjects that were not present in the expert model.

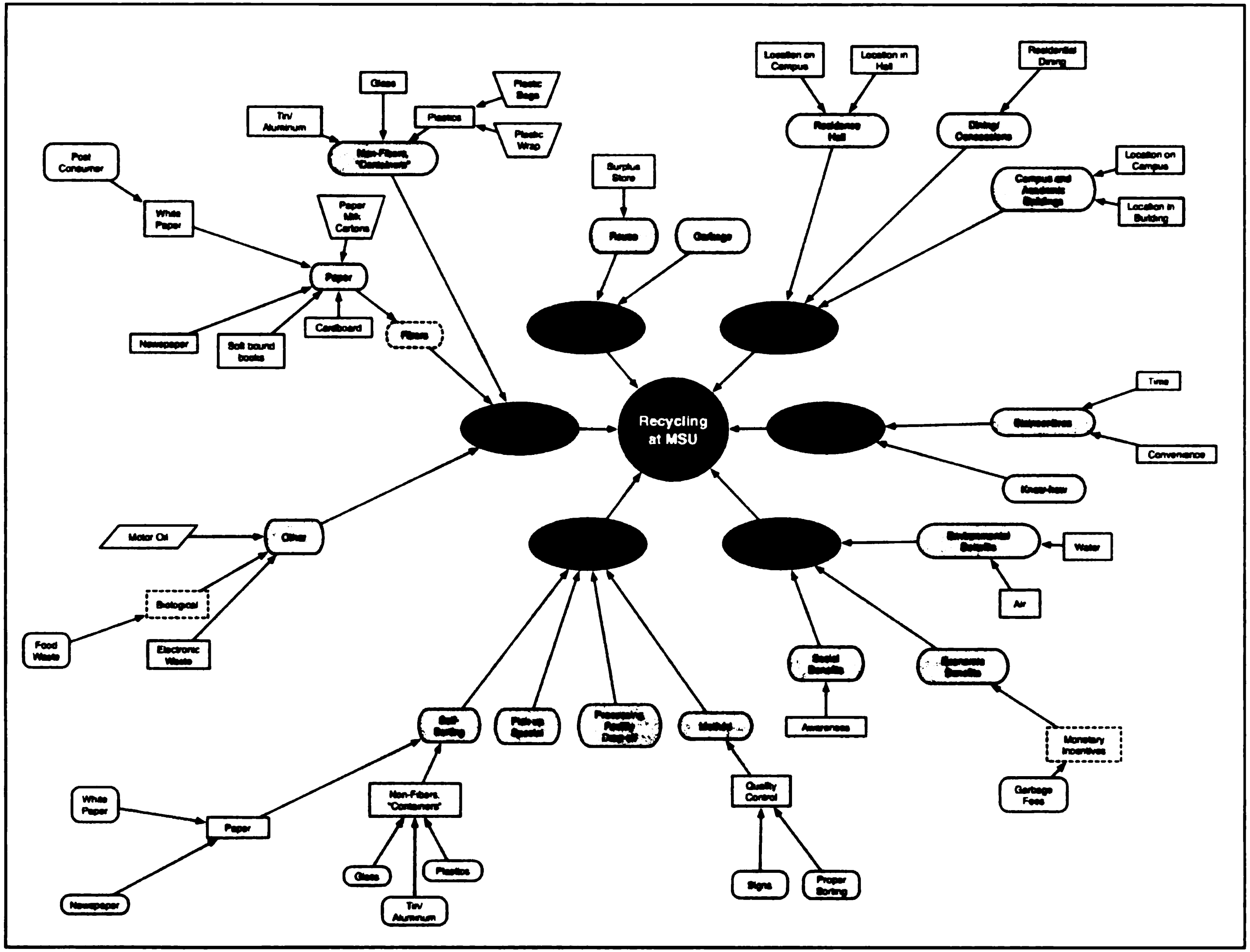

Figure 4.4. Example mental model elicited from a MSU undergraduate student.

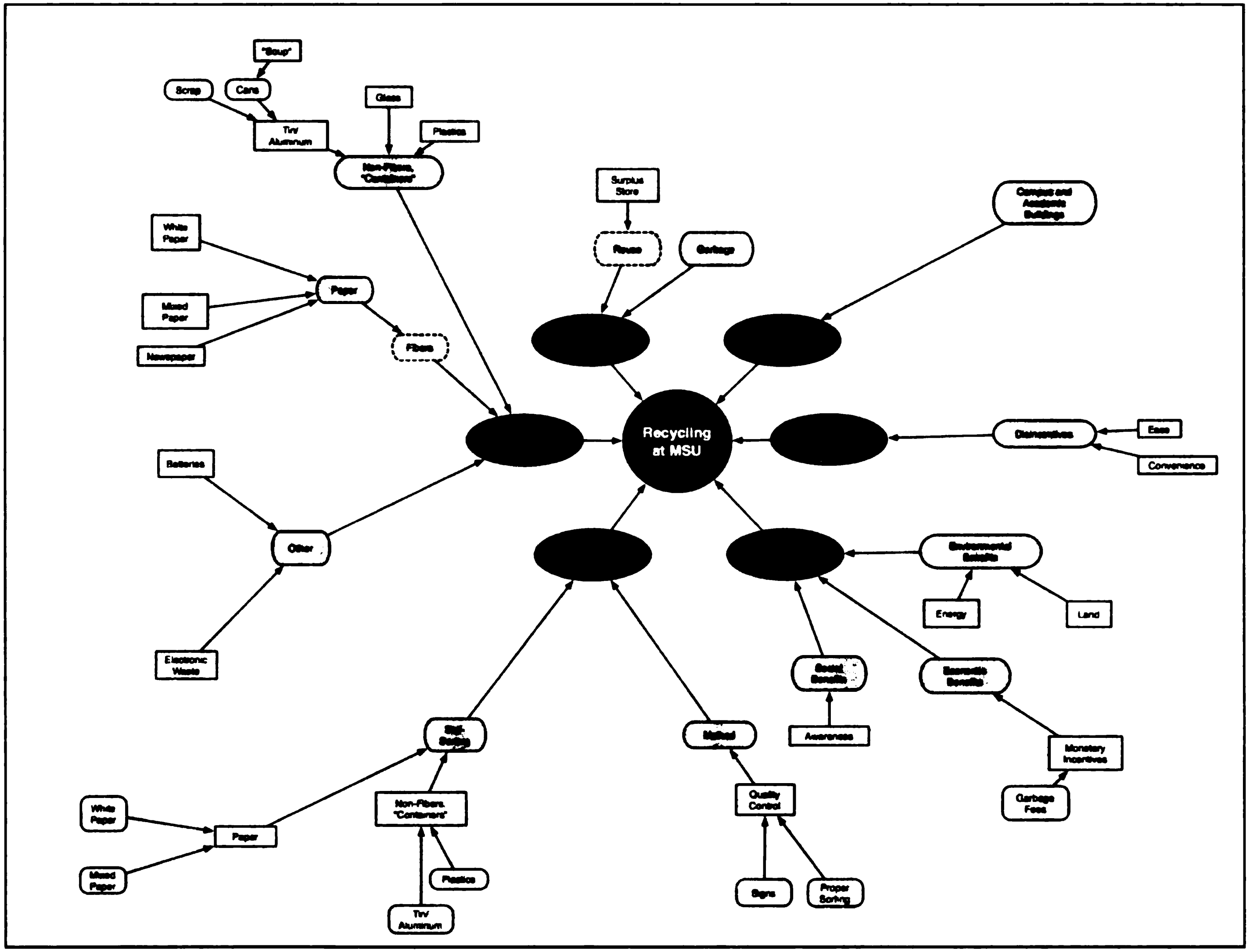

Figure 4.5. Example mental model elicited from a MSU faculty member.

5. Mental Models Research to Inform the Design of a Campus Recycling Program: Report to the Office of the Vice President of Finance and Operations

5.1 Executive Summary

The Michigan State University (MSU) initiative for comprehensive and campus-wide recycling program has the goal of increasing campus-wide participation in the university's recycling. The two-part strategy to achieve this goal will require (1) more knowledgeable students, faculty, and staff, as well as (2) a thoughtfully designed, well structured, and institutionalized program. The research reported here speaks mainly to Item 1 and the charge of educating the MSU community; specifically, the mental models approach was used to inform the design of outreach efforts to address specific knowledge gaps necessary for people to engage in the recycling program.

Based on the responses of student and faculty subjects, the conclusions reached from this research include the following:

- Students and faculty on campus have differing information needs about recycling; communication efforts should be designed to address their specific knowledge gaps.
- Students have a better understanding than faculty regarding various disincentives to recycling, such as the time involved, the difficulty of the activity, the inconvenience of recycling compared to throwing things away.
- Both students and faculty were generally knowledgeable about different recyclable materials (i.e. paper, plastics, glass, metals) but lacked specific knowledge about the different types (e.g. characteristics of the types of plastic) and how to separate the different types of materials (e.g. materials considered mixed paper).

- Opportunities for recycling hazardous items such as batteries, electronic waste, ink jet cartridges, and florescent light bulbs, was not well understood.
- Few subjects knew about the details of preparing items for recycling (e.g., removing caps and rinsing items before recycling them); recycling education efforts are needed to address this gap in knowledge
- Waste reduction practices (e.g., avoidance of disposable tableware, duplex printing) were not well known, however subjects generally understand the concept of reuse.
- Students and faculty had limited knowledge of other recycling opportunities outside the residential hall and classroom; recycling education efforts should inform the MSU community about recycling options at outside this area (i.e. sports venues, The Union, International Center).

These findings led to the following recommendations:

- Outreach efforts should build upon existing, general knowledge to enhance the understanding of specific materials recycled and how to separate them. Lack of knowledge can result in increased contamination through the trial-and-error approach.
- Outreach efforts should educate where recycling sites are located across campus, and clearly marked with visible signage.
- Both populations should learn about the specific environmental, social and economic benefits of recycling to create a lasting value change aligned with MSU's mission of environmental stewardship.
- In accordance with MSU's mission to empower people and communities, I recommend that all community members be helped to understand (via regular

reporting of metrics, for example) how their resource use affects the both local and global environmental footprint of MSU.

5.2 Introduction

Michigan State University (MSU) is comprised of students, faculty, and staff whose activities yield a large volume of waste. In 2006-2007, MSU sent 36,092 cubic yards of garbage to the landfill; this is enough to line a two-lane road, about 6.5 feet deep that is nearly 3.3 miles long (roughly the distance from the MSU Main Library to the Meridian Mall in Okemos, MI).

Often, institutions reduce their waste through initiatives like recycling. Of the Big Ten schools, MSU is the only institution without a campus-wide and multi-material recycling program. While MSU regularly recycles paper products on campus-wide scale, the recycling of other materials is somewhat ad-hoc and scattered.

The Boldness by Design Environmental Stewardship initiative set forth by the Office of the Vice President of Finance and Operations of MSU recognized the creation of a more comprehensive recycling program as an opportunity to improve environmental stewardship. The recycling program's expansion into more materials and more parts of campus motivated of this study: to inform the design of outreach plans aimed at increasing the MSU community's participation in recycling. Because the recycling program's success is highly dependent on the involvement if the campus community, programs designed to increase personal engagement in recycling activities warrant study to devise how to best to inform potential subjects of the benefits of recycling, and engage them in recycling the correct materials at the correct locations.

To help MSU achieve the goal of increasing recycling participation, I conducted a review of the current literature to understand the state of practices surrounding the development of recycling behavior. This work formed the bulk of my thesis research towards a Master's degree, with guidance from Dr. Joe Arvai. Based on my initial research, literature tends to point to two practices that allow for, and increase, recycling participation: (1) making the act of recycling logistically easier for people to carry out, and (2) educating people to know what, where, and how to recycle.

MSU is working to make recycling easier for people to do, as shown by the approval for a new recycling processing facility in January 2008 by President Lou Anna Simon and the MSU Board of Trustees. This demonstrated commitment to expanding recycling opportunities, coupled with making recycling on-campus easier and more convenient addresses the logistical needs of the program.

Knowledge of the recycling program's characteristics is considered to be necessary for participation. The more knowledgeable an individual is about what items are recyclable, how to prepare items for recycling, and where to go to recycle, the more likely the individual is to correctly take part in the activity. Outreach efforts can appropriately help overcome lack of knowledge and successfully attract people to recycling programs by fostering better recycling habits. This is particularly important for those who are new to the campus and to the activity so that they may gain the knowledge necessary to begin and continue recycling.

Outreach plans about recycling often make assumptions, rather than relying on research-based findings, of the audience's latent knowledge about topics of interest. Given time and resource constraints, outreach efforts should focus on information people *actually need* to complete the desired activity (because irrelevant information can waste valuable time and resources). An approach for empirically identifying knowledge gaps is mental models research. The mental models approach used in this study can be used to inform the design of outreach plans to better meet the needs of MSU community members, by way of effectively addressing deficiencies of knowledge without needlessly repeating clearly understood information.

5.3 Methodology

This study seeks to inform the design of outreach plans, using the mental models approach to quantify the level of knowledge about recycling concepts. The mental model methodology outlined by Morgan, Fischhoff et al. (2002), helps communicators to better understand their audience by way of (1) a systematic analysis of the information they currently possess and (2) an assessment of their information needs. Communicators can then design and implement more effective outreach plans to address knowledge gaps revealed through mental models research, while devoting relatively fewer resources to enforce what the audience already understands. With a more targeted and systematic outreach program, the audience will (theoretically) have improved knowledge upon which they can base decisions to recycle more items, and—importantly—to recycle these items correctly.

The process of mental model interviews begins with an expert mental model, which depicts the current state of knowledge surrounding a particular issue—recycling in this case. The expert model used in this study (Figure 5.1) was first developed based on an extensive review of the associated literature followed by a series of open-ended interviews with recognized experts familiar with campus recycling efforts at MSU and elsewhere. This model was structured around six general concept areas:

1. *What may be recycled on campus:* Includes a comprehensive listing of the items or materials available for recycling at MSU, but not necessarily collected from every area on campus.
2. *Where do recycling opportunities exist on campus:* Includes an up to date account of places that have recycling infrastructure (e.g., pick-up or drop-off points, processing facilities, etc.) on the main campus of MSU.
3. *How must recycling be carried out on campus*: Includes a depiction of the processes an individual carries out to recycle, including: separation, preparation, and general reasons to use a proper method.
4. *Why is recycling on the MSU campus important*: Includes a characterization of the incentives or benefits of recycling in terms of environmental, economical, and social elements.
5. *Why don't people recycle more frequently on campus*: Includes a list of factors that impede people from recycling and are considered the disincentives to participating.
6. *What are alternatives on the MSU campus*: Based on the recognition that recycling is not the only way to dispose or eliminate a product that is no longer needed for its original purpose and includes garbage, reuse, and reduce.

An interview protocol for use with faculty and student subjects (see below) was next derived from the expert model. The protocol is purposefully open-ended to allow subjects to express both correct and incorrect responses. Each interview starts with a broad question and is followed by subsequent questions that seek to exhaust a subject's knowledge. Subjects' responses are then analyzed to develop a mental model for each participant, indicating where their knowledge overlaps with expert knowledge.

5.3.1 Subjects

Because of their size and influence on the amount of waste generated (and potentially recycled), students and faculty[10] were identified by the university administration as the first target populations for the new campus recycling initiative. Undergraduates living on campus were one focus of this study, due to their experience with a wide-range of campus recycling options. In collaboration with residential hall administration, four residential halls that were considered representative of residential living options in terms of the diversity of the student residents were then selected. Student subjects were recruited via mail, 250 letters were sent to each residential hall. The letter sent to potential subjects briefly explaining the project and requesting they call in to schedule an interview. Additionally, there was a monetary incentive of $40 USD offered for the one hour interview. While the initial mailed invitations went to randomly selected students, students were selected for the study using a purposeful sampling strategy (Patton 1990). Specifically, students were recruited so that the final sample contained an equal number of males and females that represented a wide diversity of degree programs. Additionally, students were screened for any prior experience in the recycling industry or related organizational memberships either on- or off-campus. In all,

[10] University staff were also recognized as important participants in any campus-wide recycling initiative. This group was involved in a parallel, focus group based study of programmatic needs (Hansen, McMellen et al. 2008).

the sample consisted of 20 males and 20 females who were selected from four different student residential halls (n=40).

The faculty sample (n=18) was recruited from a randomized phone list, and consisted of 14 male and 4 female subjects[11]. With the assistance of the Department of Recycling and Solid Waste Management, which is responsible for the campus-wide recycling program, we identified buildings on campus that were thought to be "recycling-friendly" (e.g., buildings where there was adequate space and infrastructure available to carry out MSU's proposed recycling activities) as well as buildings where recycling is typically more difficult, called "recycling unfriendly" because these resources are not present. All of the faculty members with offices in each building type were in the initial list, and were recruited in order of a randomized priority to participate. Nine faculty members were recruited and interviewed from each type of building. The faculty members were not purposefully recruited on the basis of department or college, as some of these units' faculty worked in buildings that could not be identified as recycling friendly or unfriendly, and in turn were not included in the study. Faculty and student interviews lasted between 30 and 80 minutes, an average of 45 minutes.

5.3.2 Analysis

Student and faculty responses were analyzed to develop an individual mental model for each subject, indicating where their knowledge overlapped with the expert mental model. Both valid concepts and misconceptions suggested by the subjects, but not reflected in the expert model, were included in the individual diagrams.

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[11] For the faculty sample, the goal was to have the number of males and females be closely representative of the actual gender distribution on campus. In 2007, females accounted for 37% of all faculty members; in this study, 22% of the faculty subjects were female.

A comprehensive model, depicting the relative frequency with which specific concepts were understood by subjects, was developed for both MSU students (Figure 5.2) and faculty (Figure 5.3) by combining all the individual mental models elicited from each subject group (e.g. see Figure 5.4 and Figure 5.5). Additionally, the comprehensive models use a color-coding scheme to differentiate the levels of knowledge into three categories; the color red signifies 0-33% interviewed understood the subject, yellow signifies 34-66% understood the subject, and green signifies 67-100% understood the subject. This coloring is meant for quick observation of the models. These models revealed important gaps—on part of both MSU students and faculty—in understanding key recycling concepts that are relevant to established campus-based waste reduction practices.

In addition to these comprehensive mental models, each subject's response was coded according to a five-point scheme, with higher scores reflecting more accurate comprehension of the concept, the codes used were:

4 = concept discussed without prompting and understood by subject;

3 = concept discussed when prompted and understood by subject;

2 = concept discussed without prompting but misunderstood by subject;

1 = concept discussed when prompted but misunderstood by subject;

0 = subject was unable to answer interview question.

Mean scores were then computed for each concept on the comprehensive mental model and were compared using chi-square analysis according to a series of independent variables (i.e. by gender, residential hall or building, between students and faculty), allowing for the detection of differences in knowledge.

5.4 Findings

A comprehensive model, depicting the relative frequency with which specific concepts were understood by subjects, was developed for both MSU students (Figure 5.2) and faculty (Figure 3) by combining all the individual mental models elicited from each subject group (e.g. see Figure 5.4 and Figure 5.5). These models revealed important gaps—on part of both MSU students and faculty—in understanding key recycling concepts that are relevant to established campus-based waste reduction practices.

5.4.1 Where to Recycle at MSU?

Both MSU students and faculty displayed an incomplete understanding of where they could recycle on campus. While students knew that recycling opportunities were present in academic buildings and campus dining areas, few knew of specific details regarding where else recycling took place on the MSU campus (Figure 5.2). Only a small percentage of students knew of specific collection points for recyclables in on-campus sports venues (22.5%), MSU's International Center Food Court (10%), residential dining areas (40%), and Sparty's Café locations (12.5%).

The same was true of MSU faculty members surveyed (Figure 5.3); relatively few faculty members (33.3%) were aware of collection points for recyclables in dining and concession areas. Neither students (5%) nor faculty (11.1%) were well aware of recycling opportunities at the general campus recycling facility.

5.4.2 What is Recycled at MSU?

There were also distinct gaps in knowledge of students and faculty about a range of what specific items can be recycled on campus. While all students and faculty generally knew that paper could be recycled on campus, relatively few subjects were aware of many common paper products that were recyclable; these included low levels of understanding regarding the fact that soft-bound books and telephone directories that were recyclable on-campus by students (25% and 2.5%, respectively) and faculty (27.8% and 38.9%, respectively). Faculty members lack knowledge of the recycling of mail compared to students (11.1% faculty, 40% students), and both faculty and students need more information about paperboard (12.5% faculty, 0% students)[12]. On the positive side, both students (97.5%) and faculty (94.4%) were aware of newspaper recycling opportunities on campus.

Beyond the general knowledge of categories of containers (plastics, glass, and metals), both students and faculty were not well aware of specific items as it relates to container type. For example, only 55.6% of students and 42.5% of faculty mentioned recyclability of clear glass items. Similarly, metal food cans was mentioned as a recyclable item by 55% of students and 44.4% of faculty. A few specific kinds of containers were known to be recyclable, including #1 PETE plastic found in most soda and water bottles (82.5% of students and 66.7% of faculty mentioned this material).

In addition to the categories "fibers" and "containers", was the category of items called "other" with items that did not fit into either category. Of major significance to waste reduction in an academic setting, was the observation that students and faculty interviewed were not well aware of many common forms of electronic waste (e.g.

[12] Both groups had a low understanding of paperboard, but students are considered a larger producer of the material due to their personal food purchases. Should students be allowed to recycle this material more readily in the future, they need information regarding the material characteristics and collection points.

computers, personal digital assistants, mp3 players, mobile phones, etc.), and how they needed to be recycled properly. Recyclability of items such as batteries, ink jet cartridges, fluorescent light bulbs, and toner cartridges were also not well known. Specifically, relatively few faculty members (22.2%) or students (30%) knew about battery recycling. All of these items mentioned contain materials (e.g. mercury, lead, and cadmium) that bear potentially harmful consequences to the health of people and the environment if sent to the landfill.

The category of "other" items also contained items involving the recyclability wood, a potential future focus material. Subjects brought up two types of wood, wood pallets from shipping and loft wood from student housing. Recycling loft wood on-campus was not well understood by students, 7.5% of the subjects knew about its recyclability. Similarly, only one student and no faculty members mentioned wood pallet recycling. However, it is not likely that students or faculty would dispose of wood pallets themselves.

During discussions of "other" materials recycled on campus, Styrofoam was mentioned as a potential addition to MSU's recycling program. Of the faculty interviewed, seven subjects—all of whom worked in laboratory environments on campus—mentioned styrofoam recycling. Some lab materials manufacturers, as one faculty subject explained, send prepaid mailing labels to the lab to return the styrofoam packaging. According to communications with the Office of the Vice President of Finance and Operations as well as the Materials Committee, the future recycling program may collect this material, however the costs and benefits of styrofoam recycling will need to be assessed.

5.4.3 How to Recycle at MSU?

Subjects also struggled with questions about how recycling must be carried out on the MSU campus. Students and faculty were aware of the importance of strict separation rules for a successful recycling program (82.5% of students and 94.4% of faculty mentioned proper sorting); they were, however, less knowledgeable regarding the specifics of this process. The knowledge of separation followed the pattern of knowledge of general items (i.e. paper, glass, metals, and plastic) with much less knowledge of the specific items (e.g. separation of different types of plastic). Further, not all subjects knew to rinse recyclable containers (cleaning recyclables was identified by 65%[13] of students interviewed and 38.9% of faculty interviewed), as well as removing caps or lids (with this concept understood by 32.5% of students and 27.8% of faculty).

5.4.4 Why Recycle at MSU?

Faculty and students were knowledgeable about the economic, social, and environmental benefits associated with recycling. But relatively few students and faculty could name any specific benefits. For example, the specific concepts of energy conservation, air quality, water protection, and land-use issues were not mentioned by a majority of students (37.5%, 47.5%, 32.5%, respectively) or faculty (44.4%, 22.8%, 16.7%, respectively). An exception to this trend was that of land-use benefits, which were understood by a larger percentage of students (50%) and faculty (77.8%).

[13] Although 65% of students identifying the need to clean recyclables may seem high, this number was low compared to the needs of recycling administrators at MSU.

5.4.5 Why Don't People Recycle at MSU?

Disincentives to recycling were relatively well understood by both students and faculty; the only significant exception here was a limited understanding displayed by both students (22.5%) and faculty (22.2%) regarding space constraints for recycling services in many campus buildings. Lack of understanding for how to recycle, described as the concept of know-how, was reported as a reason why people do not recycle by 72.2% faculty and 95.0% students interviewed.

5.4.6 Alternatives to Recycling at MSU?

Besides recycling, faculty and students were aware that they have alternatives to handling waste, the most well known of these being (1) the placement of waste in the garbage (known by 100% of students and faculty) and (2) reusing items for the same or related purpose (known by 92.5% of students and 83.3% of faculty). The exception here was waste *reduction* practices (i.e. conscious decisions to use less or products that yield less waste), which were not well known with 47.5% of students and 38.9% of faculty included this item in their mental models.

5.4.7 Gender Differences

In addition to looking at general trends, the means of the scored responses were compared (using chi-square tests) levels of student and faculty understanding according to a series of independent variables. One of these independent variables was gender. Among students overall, only four significant differences were observed (Table 1). These included a greater understanding on the part of male students regarding recycling of biological wastes (p=0.02), pick-up options for recyclables (p=0.05), the availability of a central processing facility (p=0.007), and the recycling of leftover food as food waste (p=0.041).

Gender differences among faculty (Table 2) included, for example, a greater understanding by men of white paper (p= 0.004), and mixed paper (0.043) as recyclable items. Male faculty members, by contrast, had a better understanding of how to separate containers from papers for recycling (p=0.008).

5.4.8 Student/Faculty Differences

Another independent variable was the role of the subject as a student or faculty member on campus (Table 3). This analysis included differences based on where to recycle, such as students had a greater understanding of recycling collection points in the residential halls (p=0.0001) whereas faculty had a greater grasp of recycling collection points in academic buildings (p=0.006).

In terms of what can be recycled, students were more knowledgeable than faculty about recycling cardboard (p=0.019). Faculty, by contrast, had a greater knowledge of recycling magazines (p=.001) and mixed paper (p=.003).

Students had a greater understanding of disincentives to recycling (p= 0.006), including a lack of time (p= 0.018) and lack of knowledge about where to recycle items, what items are recyclable, and how to prepare items for recycling (p= 0.036).

5.4.9 Differences Across Campus Facilities

The student subjects' residential hall (Tables 4 and 5) resulted in very few differences. For the most part, these differences were based on the comprehensive knowledge of a general concept, such as how to recycle ($p= 0.049$), and alternatives to recycling ($p=0.043$).

The building type (recycling "friendly" or "unfriendly") of a faculty subjects' office was associated with a few differences (Table 6). For example, faculty members in recycling "unfriendly" buildings had a greater knowledge of used (post-consumer) newspapers ($p= 0.046$), and removing impurities from items to prepare them for recycling ($p= 0.032$).

5.5 Recommendations

The results of this mental models research are the first step in a long-term process to educate the Michigan State University community about recycling. The results should be used to inform the operation and design of recycling collection on-campus.

There are two complementary ways of drawing conclusions from these results. First, one can look to the results from the various statistical analyses to determine if there is a specialized need to address a particular issue (e.g., paper recycling) or to target a specific group of consumers (e.g., faculty members). Second, analysts can look for so-called "big picture" issues that highlight important gaps, misconceptions, or needs that are largely shared by the groups that were the focus of this research (students and faculty).

5.5.1 Statistical Analyses

Relatively few specific comparisons (made using chi-square tests) revealed significant differences either between individuals (i.e. between faculty and students), genders, and campus facilities (i.e. academic hall of faculty or residential hall of students). Of 580 total comparisons, only 36 revealed significant differences (6.55%). Of these, there were however, some notable findings.

5.5.1.1 Student and Faculty Specific Recommendations

Specifically, there were several areas where students and faculty differed in terms of their knowledge (Table 3). There were distinct differences, for example, between the knowledge levels of students and faculty regarding the different kinds of papers that may be recycled on campus. Faculty members appear to need additional information regarding the recycling of cardboard ($p=0.019$) while students need information regarding the recycling of mixed paper ($p=.003$), magazines ($p=.001$). On the other hand, students outperformed faculty in terms of their level of knowledge about the recyclability of post-consumer paper materials such as newspaper ($p=.039$) and white paper ($p=.001$). These kinds of results point to the possibility of identifying different areas of emphasis—between students and faculty, for example—in subject specific outreach plans.

Students were more likely than their faculty counterparts to provide detailed reasons behind why people do not recycle. Among their reasons were that recycling is a time consuming ($p= 0.018$) and difficult activity ($p= 0.006$). This important difference between students and faculty warrants perhaps the most attention in future outreach and planning efforts. Students are the largest population on campus and their participation in sustainability activities such as recycling is critical to improving the University's performance in this area.

Thus, it is my view that administrators of the MSU recycling program must approach the design of campus recycling from the standpoint of removing logistical barriers that may contribute to students negative perception of recycling. Related outreach efforts must work to counteract the idea that recycling is too difficult or a waste of time and, therefore, an activity that is to be avoided. This latter objective could be accomplished through social marketing efforts that provide reasons for students to take the extra steps to recycle (such as the specific benefits of recycling to the environment or revenue generated by recycling positively affecting student programs).

5.5.1.2 Gender Differences

Very few differences were found between male and female students or faculty. Most of these differences were of limited value vis-à-vis informing the development of a recycling-specific outreach plan. For example, mean scores of faculty male and female knowledge of white paper recycling were significantly different ($\bar{x}_{Males}$ =4.00, se= 0.21 and $\bar{x}_{Females}$ = 3.50, se= 0.00; p= 0.004). But the similarity in the mean scores (4.00 vs. 3.50) suggests that both groups clearly understand this issue and, therefore, addressing it further in outreach plans may not be necessary.

Along these lines, when considering both faculty and students, the differences across the genders were largely minor, which mirrors results from other studies (e.g. Berger 1997) that are typically unable to correlate recycling behavior with gender. Although some differences exist (see above, and Tables 1 and 2), focusing on these in the design of a recycling-specific outreach plan for MSU is—in our view—unlikely to be productive. Both genders need accurate information specific to their student or faculty role in recycling on campus. In sum, the role of a particular subject on campus seems to be a greater determinant of what a subject would know and need to know, rather than their gender.

Equally important in these kinds of analyses are what are commonly referred to as "non-results"; these are areas where statistically significant difference are expected (and hence, inform the design of the mental models study) were absent. But the absence of statistical significance does not necessarily mean that these "non-results" lack outreach implications. For example, student understanding of how to separate cloudy plastic from other plastics was not a significantly different between genders ($\bar{x}_{males}$= 1.15, se= 0.36 and $\bar{x}_{females}$= 1.15, se =0.34; p>0.05), nor was knowledge of recycling florescent light bulbs ($\bar{x}_{males}$= 0.15, se= 0.15 and $\bar{x}_{females}$= 0.00, se =0.00; p>0.05). Both of these items were not well known as recyclable and deserve attention in outreach plans. For future communication plans, it is less important that the results yielded few significant differences between genders, but more important that generally subjects were unknowledgeable about certain topics that could be necessary for MSU community members to successfully recycle.

5.5.1.3 Differences Across Campus Facilities

The general lack of significant and systematic differences in this study between the four residential halls where students live, and the buildings labeled "recycling friendly" and "recycling unfriendly" where faculty members work, is another example of the important role of "non-results." In all, residential hall difference resulted in two significant differences among the 116 comparisons conducted (see Table 5.6); building differences resulted in only two differences as well. This is good news from the standpoint of designing a recycling-specific outreach effort because it means that sustainability planners at MSU need not develop building specific communication plans (which would be time consuming and costly).

One notable exception in this regard relates to differences observed across students from the four residential halls in terms of how to recycle; these levels of knowledge were different depending upon which residence hall a student calls home ($\bar{x}_{Akers}$= 1.94, se= 0.25 and $\bar{x}_{Butterfield}$ = 1.64, se= 0.22 and $\bar{x}_{Holmes}$ = 1.97, se= 0.23 and $\bar{x}_{Hubbard}$ = 2.01, se= 0.23; p= 0.049). These differences can be explained by the building-specific variations in how MSU's recycling program is operated. For example, some areas have consistent collection points and signage allowing the student to easily recycle, while others do not. This emphasizes the need to couple education with environmental alteration—the technique to increase the rate of recycling by making it logistically easier to do. Access to a structured, institutionalized program allowing for easy and convenient recycling is considered by many to be a very effective technique in terms of leading to durable behavior change and increasing recycling rates (DeYoung 1986; Derksen and Gartrell 1993; Howenstine 1993; Boldero 1995; Lee, DeYoung et al. 1995; Oskamp, Zelezny et al. 1996; Ludwig, Gray et al. 1998; Barr 2004).

5.5.2 General Trends

The second and final level of analysis draws conclusions based on trends that were evident from the mental models (Figures 5.2 and 5.3). Based on the these results, four general observations stand out as universally important; each of these deals with issues that were either misunderstood or largely unknown by subjects based on the frequency with which concepts were mentioned.

First, recycling locations were not well known outside of the typically used areas of the academic building and residential hall, including dining and food venues, campus owned apartments, and at the recycling processing facility on campus. This lack of knowledge shows, perhaps, a slight indifference for recycling opportunities when they exist outside of one's usual working or socializing areas. Besides education about locations to recycle outside the dorm room and classroom, the idea that recycling *should* and *can* be done almost anywhere and anytime on campus, needs reinforcement.

A second salient finding of this research was the lack of knowledge about how specific types of paper, plastics, glass, and metals must be separated for proper recycling. An example of this is that all student subjects knew the generally plastics were recycled on campus, but knowledge of the different types of plastic were less known; #1 PETE was mentioned by 82.5% of student subjects. #2 HDPE cloudy (55%), and #2 HDPE colored (15%). Students and faculty need to know what types of these materials can be recycled and how to identify the material (e.g. by looking for a specific plastic recycling number) to better understand how each material needs to be separated. The good news is that subjects were usually aware of these general concepts regarding material types and separation (i.e. paper, plastics, and metals categories). We recommend outreach plans build upon the general knowledge possessed by students and faculty to help facilitate a more complete understanding about campus recycling opportunities.

Overall, the importance of knowing what items can and can't be recycled should be stressed to achieve a successful recycling program. Lack of knowledge not only results in lower recycling intensity, lower diversion rates, and lower collection efficiency, but the resulting trial-and-error approach increases contamination levels in collected recyclables (Scott, 1999). In the end, the good intentions of an uncertain public can reduce the efficiency and efficacy of recycling programs.

Third, questions related to why one should recycle also revealed some important knowledge gaps. How much students and faculty should know about the reasons why they ought to recycle relates to the philosophy of higher education. Based on the long-term vision and purpose of MSU, which is to educate citizens—including students, faculty, and staff—about community and environmental stewardship, it stands to reason that gaps regarding the lesser-known concepts of the environmental and the socio-economic benefits of recycling should be addressed.

These results reveal that MSU community members are not well aware of the concepts related to the broader overarching benefits of sustainable practices, in this case recycling. Students and faculty were well aware of deposit of soda cans and bottles as a monetary incentive (due to Michigan having the largest bottle deposit of any state, at ten cents), but not other socio-economic benefits (e.g., jobs in the recycling industry and the sale of materials collected for recycling). All students and faculty interviewed understood the general connection between recycling and environmental benefits. However, relatively few student and faculty subjects understood the specific nature of these benefits (e.g., benefits in terms of energy efficiency (37.5% and 44.4%, respectfully), cleaner air (47.5% and 22.8%, respectfully), and cleaner water (32.5% and16.7%, respectfully). In accordance with MSU's mission to empower people and communities, I recommend that all community members be helped to understand (via regular reporting of metrics, for example) how their resource use affects the both local and global environmental footprint of MSU.

Fourth, faculty and students were typically aware of reuse as an alternative to waste generation and recycling, but were generally unaware of reduction practices. Female faculty members and female students had a good understanding in general about reduction practices, but the majority of the students and faculty did not. Reduction is perhaps the hardest lesson to teach and concept to practice, but it can be done. These measures can be accomplished in many ways: through contracts with manufacturers who design products with less packaging, through institution purchases of more durable products and internal reuse of products; and through institutional changes in practices (i.e. default printing paper on two sides); and through institutional purchases of less toxic products (Fishbein and Gelb 1992). Without the MSU community's full cooperation, reduction practices will be difficult to coordinate and implement. The temporary inconvenience of critically thinking about purchases may require more work for purchasing departments and administrators; however, in the long-term, the reduction of waste is perhaps the best way to divert the most waste from the landfill.

5.6 Conclusion

The mental models approach carried out in this study allows the level of stakeholder knowledge to be visible to those who are designing outreach plans. The results can be used to allocate resources to fill gaps in knowledge, and vice-versa areas of high understanding would need less communication. But mental models do not show how important a concept is compared to all others on the model in terms of priority. The models do not reveal how knowledgeable subjects should be about each concept or item. All subjects being knowledgeable about every item may be unnecessary for the success of the recycling program.

When considering residential hall recycling, for example, 87.5% of students knew the location of at least one recycling collection point. Students' seemingly well-developed knowledge of the location is perhaps an argument for not highlighting the topic in outreach effort. But an argument could also be made for further education on the basis of informing students in residential halls about different recycling options available. This may lead to informing students about recycling locations closer to their room and thus, increasing the convenience and recycling rates of students. On the other hand, tire recycling was known by none (0%) of the faculty subjects. But this lack of knowledge is not particularly a concern of outreach plans, because their duties do not require them to service University vehicles.

In the end, it is important to note the mental models approach reveals how well specific concepts are known by a range of subjects, but it does not make the decisions about how well the concepts should be known (or if they are worth knowing at all). The method is meant to help managers make decisions about outreach plans, but it is not meant be the decision-maker. These decisions should be thoughtful vis-à-vis what program managers judge to be important concepts that should be the focus of outreach plans, and to a lesser extent, the design of recycling programs. To the extent possible, these decisions should also be equitable; they should be made by a diverse group of people including the recycling department administrators, building/residential hall managers, people affected by the program, and building maintenance employees who deal with recycling.

One approach to understand what items are necessary to communicate could be a future study comparing knowledge of recycling to actual recycling amounts. Although this study shows subjects lack knowledge of certain areas, it does not have a component that shows how this knowledge directly affects the amount of recycling and the levels of contamination. This study could further develop the mental models research to design recycling communications, and to a lesser extent, the physical characteristics of collection.

Another approach to solve these unresolved questions could take the form of a future comparative study using the same mental models interviews, to understand the effectiveness of outreach plans to change and enhance knowledge. In this way, the outreach messages could be measured by the change in the level of knowledge for each item.

Table 5.1: The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Where	24.67	23.67	1.84	1.75	0.37	0.39	n/s
Residence Hall	47.50	45.00	3.50	3.55	0.25	0.22	n/s
Location on Campus	45.00	45.00	3.35	3.40	0.25	0.24	n/s
Location in Residence Hall	45.00	45.00	3.35	3.45	0.25	0.25	n/s
Dining/Concessions	35.00	35.00	2.45	2.30	0.34	0.36	n/s
Sports Venues	15.00	10.00	1.20	0.65	0.34	0.30	n/s
Residential Dining	25.00	15.00	1.85	1.25	0.37	0.33	n/s
International Center Food Court	2.50	7.50	0.25	0.55	0.18	0.28	n/s
Sparty's Cafes	7.50	7.50	0.60	0.40	0.30	0.28	n/s
Campus and Academic Buildings	50.00	47.50	3.50	3.45	0.21	0.17	n/s
Location on Campus	47.50	47.50	3.30	3.35	0.27	0.17	n/s
Location in the Building	45.00	45.00	3.25	3.25	0.30	0.18	n/s
Campus-owned Apartments	2.50	2.50	0.25	0.25	0.16	0.6	n/s
Location in Complex	0.00	0.00	0.05	0.00	0.05	0.00	n/s
Location on Campus	0.00	0.00	0.05	0.05	0.05	0.05	n/s
Processing Facility	2.50	2.50	0.60	0.35	0.18	0.18	n/s
What	21.69	19.46	1.51	1.43	0.20	0.20	n/s
Fibers	0.00	5.00	0.00	0.35	0.00	0.24	n/s
Fabric	2.50	12.50	0.15	0.85	0.15	0.34	n/s
Paper	52.5	50.00	3.95	3.95	0.05	0.05	n/s
Magazines	15.00	17.50	0.9	1.05	0.36	0.37	n/s
White Paper	52.50	45.00	3.75	3.35	0.10	0.24	n/s
Pre-Consumer	2.50	5.00	0.20	0.20	0.20	0.20	n/s
Post-Consumer	47.50	35.00	3.10	2.65	0.26	0.36	n/s
Paperboard	7.50	7.50	0.50	0.40	0.28	0.22	n/s
Mixed Paper	30.00	20.00	2.25	1.60	0.43	0.41	n/s
Junk Mail	22.50	22.50	1.45	1.30	0.41	0.37	n/s
Newspaper	52.50	47.50	3.85	3.80	0.08	0.20	n/s
Pre-Consumer	2.50	0.00	0.15	0.00	0.15	0.00	n/s
Post-Consumer	40.00	40.00	2.95	2.75	0.35	0.38	n/s
Softbound Books	12.50	15.00	0.65	0.90	0.30	0.32	n/s
Cardboard	45.00	42.50	3.30	3.20	0.23	0.32	n/s
Non-Fibers "Containers"	50.00	45.00	3.50	3.25	0.17	0.24	n/s
Metals (Tin, Aluminum)	50.00	50.00	3.60	3.80	0.21	0.09	n/s
Scrap Metal	27.50	22.50	1.70	1.60	0.40	0.41	n/s
Food Cans	30.00	22.50	2.20	1.70	0.42	0.40	n/s
Pop Cans	47.50	47.50	3.45	3.65	0.28	0.21	n/s
Foil	12.50	7.50	0.90	0.30	0.36	0.21	n/s
Glass	52.50	42.50	3.60	3.20	0.11	0.27	n/s
Clear	22.50	20.00	1.50	1.25	0.36	0.35	n/s
Brown	10.00	5.00	0.60	0.40	0.28	0.22	n/s
Plastics	52.50	55.00	3.90	3.95	0.07	0.05	n/s
#1 PETE	40.00	42.50	2.60	3.40	0.36	0.28	n/s
#2 HDPE (Cloudy)	25.00	30.00	1.55	2.20	0.40	0.38	n/s
#2 HDPE (Colored)	7.50	7.50	0.50	0.50	0.28	0.28	n/s

Table 5.1 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Other	42.50	30.00	2.95	0.35	2.25	0.39	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	7.50	5.00	0.50	0.28	0.35	0.24	n/s
Tires	7.50	7.50	0.55	0.30	0.55	0.30	n/s
Toner	0.00	0.00	0.00	0.00	0.15	0.15	n/s
Tennis Shoes	2.50	2.50	0.15	0.15	0.20	0.20	n/s
Electronic Waste	7.50	12.50	0.55	0.30	1.05	0.37	n/s
Biological	25.00	15.00	1.90	0.44	0.95	0.34	0.022
Leaves	10.00	2.50	0.60	0.28	0.15	0.15	n/s
Grass	7.50	10.00	0.45	0.25	0.60	0.28	n/s
Branches	7.50	2.50	0.45	0.25	0.15	0.15	n/s
Food Waste	20.00	5.00	1.55	0.44	0.35	0.24	0.041
Manure	7.50	5.00	0.55	0.30	0.03	0.21	n/s
Hazardous Waste	12.50	10.00	0.80	0.32	0.70	0.33	n/s
Pallets	0.00	2.50	0.00	0.00	0.20	0.20	n/s
Batteries	20.00	10.00	1.30	0.41	0.80	0.32	n/s
Ink-Jet Cartridges	5.00	17.50	0.30	0.21	1.40	0.40	n/s
Florescent Light Bulbs	2.50	0.00	0.15	0.15	0.00	0.00	n/s
How	28.66	25.77	1.97	0.02	1.81	0.22	n/s
Quality Control	47.50	45.00	3.60	0.22	3.35	0.27	n/s
Proper Sorting	42.50	42.50	3.20	0.33	3.10	0.32	n/s
Signs	22.50	22.50	1.70	0.44	1.55	0.40	n/s
Removing Impurities	40.00	37.50	2.55	0.33	2.50	0.32	n/s
Clean	37.50	30.00	2.30	0.36	2.05	0.37	n/s
Remove Caps	12.50	20.00	0.75	0.32	1.45	0.37	n/s
Processing Facility	45.00	20.00	3.00	0.31	1.30	0.37	0.007
Pick-up	40.00	30.00	2.95	0.27	1.95	0.35	0.048
Self-Sorting	47.50	42.50	3.30	0.27	3.15	0.29	n/s
Non-Fibers "Containers"	42.50	40.00	2.85	0.32	2.65	0.36	n/s
Plastics	52.50	50.00	3.60	0.11	3.55	0.11	n/s
#1 PETE	20.00	17.50	1.35	0.39	1.35	0.36	n/s
#2 HDPE (Cloudy)	17.50	15.00	1.15	0.36	1.15	0.34	n/s
#2 HDPE (Colored)	7.50	5.00	0.50	0.28	0.45	0.25	n/s
Metals (Tin, Aluminum)	40.00	37.50	3.00	0.36	3.00	0.36	n/s
Glass	45.00	40.00	3.05	0.31	2.70	0.37	n/s
Brown	10.00	7.50	0.75	0.32	0.45	0.25	n/s
Clear	12.50	7.50	0.95	0.36	0.45	0.25	n/s
Paper	52.50	50.00	3.55	0.11	3.65	0.11	n/s
Magazines	2.50	5.00	0.20	0.20	0.35	0.24	n/s
Softbound Books	0.00	5.00	0.00	0.00	0.30	0.21	n/s
White Paper	22.50	27.50	1.55	0.40	1.80	0.38	n/s
Paperboard	0.00	2.50	0.00	0.00	0.15	0.15	n/s
Mixed Paper	27.50	17.50	1.85	0.39	1.15	0.36	n/s
Newspaper	30.00	32.50	1.90	0.40	2.25	0.35	n/s
Cardboard	27.50	20.00	1.6	0.35	1.25	0.34	n/s

Table 5.1 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Knowledge Concept	% Correct		Mean Score		Standard Error		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Why	32.31	29.23	2.22	0.34	2.07	0.22	n/s
Environmental Benefits	52.50	50.00	3.80	0.22	3.85	0.08	n/s
Water	17.50	12.50	1.15	0.08	0.95	.034	n/s
Land	32.50	17.50	2.20	.034	1.25	0.40	n/s
Air	20.00	27.50	1.40	0.40	1.90	0.40	n/s
Energy	17.50	20.00	1.15	0.40	1.45	0.41	n/s
Economic Benefits	52.50	50.00	3.60	0.41	3.55	0.11	n/s
Monetary Incentive	47.50	47.50	3.35	0.11	3.40	0.21	n/s
Deposit	47.50	45.00	3.35	0.21	3.30	0.27	n/s
Garbage Fees	10.00	5.00	0.70	0.27	0.40	0.24	n/s
Jobs	20.00	12.50	1.25	0.24	0.80	0.30	n/s
Tipping Fees	15.00	10.00	0.90	0.30	0.60	0.28	n/s
Social Benefits	45.00	42.50	3.05	0.28	2.85	0.26	n/s
Awareness	42.50	40.00	2.90	0.26	2.65	0.32	n/s
Why Not	40.83	40.00	2.94	0.32	3.04	0.45	n/s
Disincentives	50.00	50.00	3.95	0.45	4.00	0.00	n/s
Time	42.50	40.00	3.05	0.00	3.00	0.36	n/s
Ease	45.00	42.50	3.15	0.36	3.10	0.32	n/s
Convenience	47.50	47.50	3.30	0.32	3.70	0.21	n/s
Space	10.00	12.50	0.65	0.21	0.90	0.36	n/s
Know-how	50.00	47.50	3.55	0.36	3.55	0.21	n/s
Alternatives	31.88	29.38	2.33	0.21	2.26	0.92	n/s
Reduce	25.00	20.00	1.55	0.92	1.55	0.36	n/s
Reuse	47.50	47.50	3.55	0.36	3.55	0.17	n/s
Surplus Store	2.50	0.00	0.00	0.17	0.00	0.00	n/s
Garbage	52.50	50.00	3.95	0.00	3.95	0.05	n/s

Table 5.2: The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Where	22.59	25.00	1.13	0.50	1.03	0.41	n/s
Residence Hall	11.11	0.00	0.50	0.29	0.50	0.29	n/s
Location on Campus	5.56	0.00	0.21	0.21	0.00	0.00	n/s
Location in Residence Hall	5.56	0.00	0.21	0.21	0.00	0.00	n/s
Dining/Concessions	27.78	25.00	1.29	0.45	1.00	0.71	n/s
Sports Venues	11.11	0.00	0.50	0.34	0.25	0.25	n/s
Residential Dining	11.11	25.00	0.50	0.34	1.00	0.71	n/s
International Center Food Court	16.67	25.00	0.71	0.34	0.75	0.75	n/s
Sparty's Cafes	16.67	0.00	0.86	0.38	0.00	0.00	n/s
Campus and Academic Buildings	77.78	100.00	4.00	0.00	4.00	0.00	n/s
Location on Campus	72.22	100.00	3.79	0.21	4.00	0.00	n/s
Location in the Building	72.22	100.00	3.79	0.21	4.00	0.00	n/s
Campus-owned Apartments	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Processing Facility	11.11	0.00	0.57	0.34	0.00	0.00	n/s
What	30.07	36.41	1.42	0.26	1.36	0.22	n/s
Fibers	0.00	0.00	0.00	0.00	0.00	0.75	n/s
Fabric	0.00	25.0	0.00	0.00	0.75	0.00	n/s
Paper	77.78	100.00	4.00	0.49	4.00	0.29	n/s
Magazines	55.56	100.00	2.71	0.00	3.50	0.29	n/s
White Paper	77.78	100.00	4.00	0.21	3.50	0.00	0.004
Pre-Consumer	5.56	0.00	0.21	0.54	0.00	0.25	0.005
Post-Consumer	38.89	100.00	1.93	0.00	3.75	0.00	n/s
Paperboard	0.00	0.00	0.00	0.07	0.00	0.29	n/s
Mixed Paper	77.78	100.00	3.93	0.34	3.50	0.00	0.043
Junk Mail	11.11	0.00	0.50	0.29	0.00	0.00	n/s
Newspaper	72.22	100.00	3.64	0.00	4.00	0.00	n/s
Pre-Consumer	0.00	0.00	0.00	0.50	0.00	1.15	n/s
Post-Consumer	22.22	50.00	1.14	0.38	2.00	1.00	n/s
Softbound Books	22.22	25.00	0.86	0.51	1.00	1.00	n/s
Cardboard	50.00	25.00	2.43	0.35	1.00	0.00	n/s
Non-Fibers "Containers"	61.11	100.00	2.93	0.29	4.00	0.00	n/s
Metals (Tin, Aluminum)	72.22	100.00	3.36	0.42	4.00	0.00	n/s
Scrap Metal	50.00	0.00	2.00	0.44	0.00	0.75	n/s
Food Cans	38.89	25.00	1.57	0.29	0.75	0.00	n/s
Pop Cans	72.22	100.00	3.50	0.38	4.00	1.00	n/s
Foil	22.22	25.00	0.86	0.27	1.00	0.87	n/s
Glass	72.22	50.00	3.17	0.43	1.50	0.87	n/s
Clear	44.44	50.00	1.79	0.41	1.50	0.75	n/s
Brown	33.33	25.00	1.29	0.38	0.75	0.25	n/s
Plastics	66.67	100.00	3.21	0.48	3.75	1.00	n/s
#1 PETE	50.00	75.00	2.43	0.40	3.00	1.03	n/s
#2 HDPE (Cloudy)	38.89	50.00	1.57	0.29	1.75	0.00	n/s
#2 HDPE (Colored)	11.11	0.00	0.57	0.38	0.00	1.00	n/s

Table 5.2 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Other	66.67	75.00	3.29	0.00	3.00	0.00	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Tires	0.00	0.00	0.00	0.39	0.00	1.00	n/s
Toner	11.11	25.00	0.57	0.29	1.00	0.75	n/s
Tennis Shoes	5.56	25.00	0.29	0.49	0.75	1.03	n/s
Electronic Waste	38.89	50.00	1.71	0.47	1.75	1.00	n/s
Biological	22.22	25.00	1.07	0.29	1.00	0.00	n/s
Leaves	5.56	0.00	0.29	0.29	0.00	0.00	n/s
Grass	5.56	0.00	0.36	0.07	0.00	0.00	n/s
Branches	0.00	0.00	0.07	0.29	0.00	0.00	n/s
Food Waste	5.56	0.00	0.29	0.39	0.00	0.00	n/s
Manure	11.11	0.00	0.57	0.29	0.00	0.00	n/s
Hazardous Waste	5.56	0.00	0.29	0.00	0.00	0.00	n/s
Pallets	0.00	0.00	0.00	0.47	0.00	0.00	n/s
Batteries	22.22	0.00	1.07	0.49	0.00	1.15	n/s
Ink-Jet Cartridges	27.78	50.00	1.29	0.34	2.00	0.00	n/s
Florescent Light Bulbs	11.11	0.00	0.50	0.29	0.00	0.29	n/s
How	43.80	52.89	2.03	0.35	1.99	0.29	n/s
Quality Control	72.22	100.00	3.57	0.23	3.75	0.25	n/s
Proper Sorting	72.22	100.00	3.57	0.23	3.75	0.25	n/s
Signs	44.44	25.00	2.14	0.52	1.00	1.00	n/s
Removing Impurities	38.89	100.00	1.93	0.45	3.25	0.25	n/s
Clean	22.22	75.00	1.29	0.42	2.50	0.87	n/s
Remove Caps	27.78	0.00	1.36	0.44	0.00	0.00	n/s
Processing Facility	11.11	0.00	0.50	0.34	0.00	0.00	n/s
Pick-up	33.33	75.00	1.57	0.48	2.50	0.87	n/s
Self-Sorting	78.78	100.00	3.86	0.10	4.00	0.00	n/s
Non-Fibers "Containers"	78.78	50.00	3.50	0.14	2.00	1.15	0.008
Plastics	66.67	75.00	3.00	0.36	3.00	1.00	n/s
#1 PETE	38.89	75.00	1.71	0.49	2.75	0.95	n/s
#2 HDPE (Cloudy)	27.78	25.00	1.14	0.43	0.75	0.75	n/s
#2 HDPE (Colored)	11.11	0.00	0.43	0.29	0.00	0.00	n/s
Metals (Tin, Aluminum)	61.11	75.00	2.79	0.42	3.00	1.00	n/s
Glass	55.56	50.00	2.80	0.45	2.00	1.15	n/s
Brown	22.22	25.00	0.86	0.38	0.75	0.75	n/s
Clear	33.33	25.00	1.36	0.44	0.75	0.75	n/s
Paper	77.78	100.00	3.64	0.13	4.00	0.00	n/s
Magazines	33.33	50.00	1.50	0.49	2.00	1.15	n/s
Softbound Books	5.56	25.00	0.21	0.21	1.00	1.00	n/s
White Paper	72.22	100.00	3.36	0.29	4.00	0.00	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	72.22	100.00	3.21	0.28	4.00	0.00	n/s
Newspaper	55.56	0.00	2.50	0.45	0.00	0.00	n/s
Cardboard	27.78	25.00	1.29	0.49	1.00	1.00	n/s

Table 5.2 (continued): The frequency of, and mean level of understanding for, 116 concept areas across male (M) and female (F) faculty members on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Males		Females		P
	M	F	$\bar{x}$	SE	$\bar{x}$	SE	
Why	43.16	59.62	2.03	0.49	2.23	0.44	n/s
Environmental Benefits	77.78	100.00	3.86	0.56	4.00	0.00	n/s
Water	11.11	25.00	0.43	0.10	0.70	0.75	n/s
Land	55.56	100.00	2.64	0.29	3.50	0.29	n/s
Air	16.67	25.00	0.71	0.48	0.75	0.75	n/s
Energy	38.89	25.00	1.64	0.38	1.00	1.00	n/s
Economic Benefits	66.67	100.00	3.29	0.46	4.00	0.00	n/s
Monetary Incentive	66.67	100.00	3.21	0.34	4.00	0.00	n/s
Deposit	61.11	100.00	2.86	0.38	4.00	0.00	n/s
Garbage Fees	27.78	0.00	1.21	0.43	0.00	0.00	n/s
Jobs	27.78	25.00	1.36	0.46	0.75	0.75	n/s
Tipping Fees	11.11	25.00	0.43	0.51	0.75	0.75	n/s
Social Benefits	50.00	75.00	2.43	0.29	2.75	0.95	n/s
Awareness	50.00	75.00	2.36	0.44	2.75	0.95	n/s
Why Not	50.93	70.83	2.51	0.46	2.75	0.65	n/s
Disincentives	77.78	100.00	4.00	0.81	4.00	0.00	n/s
Time	33.33	75.00	1.64	0.00	3.00	1.00	n/s
Ease	55.56	50.00	2.64	0.53	1.75	1.03	n/s
Convenience	66.67	100.00	3.36	0.48	3.75	0.25	n/s
Space	22.22	0.00	1.00	0.39	0.00	0.00	n/s
Know-how	50.00	100.00	2.43	0.44	4.00	0.00	n/s
Alternatives	48.89	87.5	2.39	0.51	3.50	0.40	n/s
Reduce	16.67	100.00	0.86	0.20	4.00	0.00	0.004
Reuse	61.11	100.00	2.79	0.46	4.00	0.00	n/s
Surplus Store	38.89	50.00	1.93	0.42	2.00	1.15	n/s
Garbage	77.78	100.00	4.00	0.54	4.00	0.00	n/s

Table 5.3: The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
Where	46.83	28.15	1.79	0.38	1.11	0.38	0.001
Residence Hall	90.00	11.11	3.53	0.16	0.50	0.23	0.0001
Location on Campus	87.50	5.56	3.38	0.17	0.17	0.17	n/s
Location in Residence Hall	87.50	5.56	3.40	0.17	0.17	0.17	0.0001
Dining/Concessions	67.50	33.33	2.38	0.24	1.22	0.38	n/s
Sports Venues	22.50	11.11	0.93	0.23	0.44	0.27	n/s
Residential Dining	40.00	16.67	1.55	0.25	0.61	0.30	n/s
International Center Food Court	10.00	22.22	0.40	0.16	0.72	0.30	n/s
Sparty's Cafes	12.50	16.67	0.50	0.20	0.67	0.30	n/s
Campus and Academic Buildings	95.00	100.00	3.48	0.13	4.00	0.00	0.006
Location on Campus	92.50	94.44	3.33	0.16	3.83	0.17	0.003
Location in the Building	87.50	94.44	3.25	0.17	3.83	0.17	0.014
Campus-owned Apartments	5.00	0.00	0.25	0.11	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.03	0.03	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.05	0.03	0.00	0.00	n/s
Processing Facility	5.00	11.11	0.48	0.13	0.44	0.27	n/s
What	40.33	38.16	1.42	0.30	1.40	0.20	n/s
Fibers	5.00	0.00	0.18	0.12	0.00	0.00	n/s
Fabric	15.00	5.56	0.50	0.19	0.17	0.17	n/s
Paper	100.00	100.00	3.95	0.03	4.00	0.00	n/s
Magazines	27.50	77.78	0.98	0.26	2.89	0.39	0.001
White Paper	95.00	100.00	3.55	0.13	3.89	0.08	n/s
Pre-Consumer	5.00	5.56	0.20	0.14	0.17	0.17	n/s
Post-Consumer	82.50	61.11	2.88	0.22	2.33	0.46	0.039
Paperboard	12.50	0.00	0.45	0.18	0.00	0.00	n/s
Mixed Paper	50.00	100.00	1.93	0.30	3.83	0.09	0.003
Junk Mail	40.00	11.11	1.38	0.27	0.39	0.27	n/s
Newspaper	97.50	94.44	3.83	0.11	3.72	0.23	n/s
Pre-Consumer	2.50	0.00	0.08	0.08	0.00	0.00	n/s
Post-Consumer	77.50	33.33	2.85	0.25	1.33	0.46	0.001
Softbound Books	25.00	27.78	0.78	0.22	0.89	0.35	n/s
Cardboard	85.00	55.56	3.25	0.20	2.11	0.46	0.019
Non-Fibers "Containers"	92.50	83.33	3.38	0.15	3.17	0.29	n/s
Metals (Tin, Aluminum)	97.50	94.44	3.70	0.11	3.50	0.23	n/s
Scrap Metal	47.50	50.00	1.65	0.28	1.56	0.38	n/s
Food Cans	55.00	44.44	1.95	0.29	1.39	0.38	n/s
Pop Cans	92.50	94.44	3.55	0.17	3.61	0.23	n/s
Foil	17.50	27.78	0.60	0.21	0.89	0.35	n/s
Glass	92.50	83.33	3.40	0.15	2.78	0.32	0.039
Clear	42.50	55.56	1.38	0.25	1.72	0.38	n/s
Brown	15.00	38.89	0.50	0.18	1.17	0.35	n/s
Plastics	100.00	88.89	3.93	0.04	3.33	0.30	0.018
#1 PETE	82.50	66.67	3.00	0.23	2.56	0.42	n/s
#2 HDPE (Cloudy)	55.00	50.00	1.88	0.28	1.61	0.37	n/s

Table 5.3 (continued): The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
#2 HDPE (Colored)	15.00	11.11	0.50	0.19	0.44	0.23	n/s
Other	72.50	83.33	2.60	0.27	3.22	0.36	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	12.50	0.00	0.43	0.18	0.00	0.00	n/s
Tires	15.00	0.00	0.55	0.21	0.00	0.00	n/s
Toner	2.50	16.67	0.08	0.08	0.67	0.36	0.027
Tennis Shoes	5.00	11.11	0.18	0.12	0.39	0.27	n/s
Electronic Waste	22.50	50.00	0.80	0.24	1.72	0.43	n/s
Biological	40.00	27.78	1.43	0.28	1.06	0.42	n/s
Leaves	12.50	5.56	0.38	0.16	0.22	0.22	n/s
Grass	17.50	5.56	0.53	0.18	0.28	0.23	0.029
Branches	10.00	0.00	0.30	0.23	0.06	0.06	n/s
Food Waste	25.00	5.56	0.95	0.10	0.22	0.22	n/s
Manure	12.50	11.11	0.43	0.26	0.44	0.30	n/s
Hazardous Waste	22.50	5.56	0.75	0.23	0.22	0.22	n/s
Pallets	2.50	0.00	0.10	0.10	0.00	0.00	n/s
Batteries	30.00	22.22	1.05	0.26	0.83	0.38	n/s
Ink-Jet Cartridges	25.00	38.89	0.85	0.24	1.44	0.44	n/s
Florescent Light Bulbs	2.50	11.11	0.08	0.08	0.39	0.23	n/s
How	53.37	55.56	1.89	0.22	2.02	0.29	n/s
Quality Control	90.00	94.44	3.48	0.18	3.61	0.18	n/s
Proper Sorting	82.50	94.44	3.15	0.23	3.61	0.18	n/s
Signs	45.00	50.00	1.63	0.29	1.89	0.46	n/s
Removing Impurities	75.00	61.11	2.53	0.23	2.22	0.38	n/s
Clean	65.00	38.89	2.18	0.26	1.56	0.39	n/s
Remove Caps	32.50	27.78	1.10	0.25	1.06	0.37	n/s
Processing Facility	62.50	11.11	2.15	0.27	0.39	0.27	0.002
Pick-up	70.00	50.00	2.45	0.23	1.78	0.42	n/s
Self-Sorting	87.50	100.00	3.23	0.20	3.89	0.08	n/s
Non-Fibers "Containers"	77.50	88.89	2.75	0.24	3.17	0.29	n/s
Plastics	100.00	83.33	3.58	0.08	3.00	0.34	0.042
#1 PETE	40.00	55.56	1.35	0.26	1.94	0.43	n/s
#2 HDPE (Cloudy)	35.00	33.33	1.15	0.25	1.06	0.37	n/s
#2 HDPE (Colored)	15.00	11.11	0.48	0.18	0.33	0.23	n/s
Metals (Tin, Aluminum)	80.00	77.78	3.00	0.25	2.83	0.38	n/s
Glass	80.00	66.67	2.88	0.24	2.39	0.42	n/s
Brown	17.50	27.78	0.60	0.20	0.83	0.33	n/s
Clear	20.00	38.89	0.70	0.22	1.22	0.38	n/s
Paper	100.00	100.00	3.60	0.08	3.72	0.11	n/s
Magazines	7.50	44.44	0.28	0.16	1.61	0.44	0.004
Softbound Books	5.00	11.11	0.15	0.10	039	0.27	n/s
White Paper	50.00	94.44	1.68	0.27	3.50	0.23	0.000
Paperboard	2.50	0.00	0.08	0.08	0.00	0.00	n/s
Mixed Paper	45.00	94.44	1.50	0.27	3.39	0.23	0.001

Table 5.3 (continued): The frequency of, and mean level of understanding for, 116 concept areas comparing faculty members and undergraduate students on the MSU campus. Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Students		Faculty		P
	Stu	Fac	$\bar{x}$	SE	$\bar{x}$	SE	
Newspaper	62.50	55.56	2.08	1.94	0.26	0.43	n/s
Cardboard	42.50	33.33	1.43	1.22	0.27	0.42	n/s
Why	60.58	56.41	2.14	2.08	0.33	0.29	n/s
Environmental Benefits	100.00	100.00	3.83	3.89	0.06	0.08	n/s
Water	32.50	16.67	1.05	0.50	0.25	0.27	n/s
Land	50.00	77.78	1.73	2.83	0.28	0.38	n/s
Air	47.50	22.22	1.65	0.72	0.28	0.33	n/s
Energy	37.50	44.44	1.30	1.50	0.27	0.41	n/s
Economic Benefits	100.00	88.89	3.58	3.44	0.08	0.27	0.033
Monetary Incentive	92.50	88.89	3.38	3.39	0.17	0.30	n/s
Deposit	90.00	83.33	3.33	3.11	0.19	0.35	n/s
Garbage Fees	15.00	27.78	0.55	0.94	0.19	0.37	n/s
Jobs	32.50	33.33	1.03	1.20	0.23	0.42	0.029
Tipping Fees	25.00	16.67	0.75	0.50	0.21	0.27	n/s
Social Benefits	85.00	66.67	2.95	2.50	0.20	0.39	n/s
Awareness	80.00	66.67	2.78	2.44	0.23	0.41	n/s
Why Not	79.17	66.67	2.99	2.56	0.46	0.46	0.006
Disincentives	100.00	100.00	3.98	4.00	0.03	0.00	n/s
Time	82.50	50.00	3.03	1.94	0.23	0.47	0.018
Ease	85.00	66.67	3.13	2.44	0.22	0.43	n/s
Convenience	92.50	88.89	3.50	3.44	0.17	0.30	n/s
Space	22.50	22.22	0.78	0.78	0.23	0.36	n/s
Know-how	95.00	72.22	3.55	2.78	0.15	0.42	0.036
Alternatives	60.63	68.06	2.29	2.64	0.88	0.55	n/s
Reduce	47.50	38.89	1.73	1.56	0.26	0.47	0.010
Reuse	92.50	83.33	3.43	3.06	0.16	0.35	n/s
Surplus Store	2.50	50.00	0.08	1.94	0.08	0.47	0.0001
Garbage	100.00	100.00	0.50	4.00	0.03	0.00	n/s

Table 5.4: The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Where	47.33	45.33	51.33	43.33
Residence Hall	100.00	80.00	90.00	90.00
Location on Campus	100.00	70.00	90.00	90.00
Location in Residence Hall	100.00	70.00	90.00	90.00
Dining/Concessions	70.00	70.00	70.00	60.00
Sports Venues	30.00	10.00	30.00	20.00
Residential Dining	40.00	50.00	60.00	10.00
International Center Food Court	10.00	10.00	10.00	10.00
Sparty's Cafes	0.00	20.00	10.00	20.00
Campus and Academic Buildings	90.00	100.00	100.00	90.00
Location on Campus	80.00	100.00	100.00	90.00
Location in the Building	80.00	100.00	100.00	70.00
Campus-owned Apartments	0.00	0.00	10.00	10.00
Location in Complex	0.00	0.00	0.00	0.00
Location on Campus	0.00	0.00	0.00	0.00
Processing Facility	10.00	0.00	10.00	0.00
What	43.70	36.09	42.83	38.70
Fibers	10.00	10.00	0.00	0.00
Fabric	20.00	20.00	10.00	10.00
Paper	100.00	100.00	100.00	100.00
Magazines	10.00	10.00	30.00	60.00
White Paper	90.00	90.00	100.00	100.00
Pre-Consumer	10.00	0.00	0.00	10.00
Post-Consumer	80.00	80.00	90.00	80.00
Paperboard	0.00	20.00	20.00	10.00
Mixed Paper	60.00	30.00	60.00	50.00
Junk Mail	50.00	40.00	30.00	40.00
Newspaper	100.00	100.00	100.00	90.00
Pre-Consumer	10.00	0.00	0.00	0.00
Post-Consumer	70.00	80.00	80.00	80.00
Softbound Books	20.00	10.00	40.00	30.00
Cardboard	80.00	100.00	80.00	80.00
Non-Fibers "Containers"	100.00	80.00	90.00	100.00
Metals (Tin, Aluminum)	90.00	100.00	100.00	100.00
Scrap Metal	60.00	40.00	40.00	50.00
Food Cans	60.00	60.00	60.00	40.00
Pop Cans	90.00	90.00	100.00	90.00
Foil	10.00	10.00	0.00	50.00
Glass	100.00	90.00	100.00	80.00
Clear	60.00	30.00	50.00	30.00
Brown	20.00	10.00	10.00	20.00
Plastics	100.00	100.00	100.00	100.00
#1 PETE	100.00	80.00	90.00	60.00
#2 HDPE (Cloudy)	70.00	30.00	60.00	60.00
#2 HDPE (Colored)	20.00	0.00	20.00	20.00

Table 5.4 (continued): The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Other	90.00	70.00	80.00	50.00
Fly Ash	0.00	0.00	0.00	0.00
Construction Waste	0.00	20.00	10.00	20.00
Tires	10.00	10.00	10.00	30.00
Toner	0.00	0.00	10.00	0.00
Tennis Shoes	20.00	0.00	0.00	0.00
Electronic Waste	30.00	20.00	30.00	10.00
Biological	60.00	20.00	50.00	30.00
Leaves	30.00	10.00	0.00	10.00
Grass	30.00	0.00	20.00	20.00
Branches	20.00	10.00	10.00	0.00
Food Waste	50.00	30.00	10.00	10.00
Manure	30.00	0.00	20.00	0.00
Hazardous Waste	10.00	10.00	50.00	20.00
Pallets	0.00	10.00	0.00	0.00
Batteries	20.00	30.00	40.00	30.00
Ink-Jet Cartridges	20.00	10.00	70.00	0.00
Florescent Light Bulbs	0.00	0.00	0.00	10.00
How	56.67	47.69	54.23	56.16
Quality Control	90.00	90.00	90.00	90.00
Proper Sorting	80.00	90.00	80.00	80.00
Signs	50.00	40.00	50.00	40.00
Removing Impurities	80.00	60.00	80.00	80.00
Clean	70.00	50.00	70.00	70.00
Remove Caps	50.00	30.00	30.00	20.00
Processing Facility	60.00	60.00	60.00	70.00
Pick-up	70.00	60.00	70.00	70.00
Self-Sorting	100.00	90.00	80.00	80.00
Non-Fibers "Containers"	100.00	60.00	70.00	80.00
Plastics	100.00	100.00	100.00	100.00
#1 PETE	60.00	10.00	40.00	50.00
#2 HDPE (Cloudy)	40.00	10.00	40.00	50.00
#2 HDPE (Colored)	10.00	10.00	20.00	20.00
Metals (Tin, Aluminum)	90.00	60.00	90.00	80.00
Glass	90.00	80.00	70.00	80.00
Brown	10.00	30.00	10.00	20.00
Clear	10.00	30.00	10.00	30.00
Paper	100.00	100.00	100.00	100.00
Magazines	0.00	0.00	10.00	20.00
Softbound Books	10.00	0.00	10.00	0.00
White Paper	40.00	50.00	50.00	60.00
Paperboard	0.00	0.00	10.00	0.00
Mixed Paper	40.00	30.00	50.00	60.00
Newspaper	60.00	60.00	70.00	60.00
Cardboard	30.00	40.00	50.00	50.00

Table 5.4 (continued): The frequency of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas, namely Akers (Ak), Butterfield (Bu), Holmes (Ho), and Hubbard (Hu) Halls.

Concept	% Correct			
	Ak	Bu	Ho	Hu
Why	56.16	54.17	67.69	57.50
Environmental Benefits	100.00	100.00	100.00	100.00
Water	20.00	30.00	50.00	30.00
Land	30.00	50.00	60.00	60.00
Air	30.00	50.00	70.00	40.00
Energy	40.00	20.00	50.00	40.00
Economic Benefits	100.00	100.00	100.00	100.00
Monetary Incentive	90.00	90.00	100.00	90.00
Deposit	80.00	90.00	100.00	90.00
Garbage Fees	0.00	10.00	30.00	20.00
Jobs	40.00	40.00	30.00	20.00
Tipping Fees	40.00	30.00	10.00	20.00
Social Benefits	80.00	30.00	90.00	90.00
Awareness	80.00	60.00	90.00	90.00
Why Not	81.67	78.33	85.00	71.67
Disincentives	100.00	100.00	100.00	90.00
Time	70.00	90.00	100.00	70.00
Ease	100.00	80.00	90.00	70.00
Convenience	100.00	100.00	90.00	80.00
Space	20.00	20.00	30.00	20.00
Know-how	100.00	80.00	100.00	100.00
Alternatives	55.00	60.00	65.00	62.50
Reduce	30.00	50.00	60.00	50.00
Reuse	90.00	80.00	100.00	100.00
Surplus Store	0.00	10.00	0.00	0.00
Garbage	100.00	100.00	100.00	100.00

Table 5.5: Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Where	1.73	0.40	1.75	0.39	1.89	0.38	1.80	0.38	n/s
Residence Hall	3.90	0.10	3.00	0.45	3.50	0.40	3.70	0.21	n/s
Location on Campus	3.90	0.10	2.80	0.44	3.30	0.40	3.50	0.31	n/s
Location in Residence Hall	3.90	0.10	2.80	0.44	3.40	0.40	3.50	0.31	n/s
Dining/Concessions	2.30	0.52	2.40	0.54	2.40	0.48	2.40	0.48	n/s
Sports Venues	0.90	0.46	0.60	0.40	1.30	0.54	0.90	0.46	n/s
Residential Dining	1.60	0.48	1.70	0.58	2.20	0.49	0.70	0.40	n/s
International Center Food Court	0.30	0.30	0.40	0.40	0.30	0.30	0.60	0.34	n/s
Sparty's Cafes	0.10	0.10	0.80	0.53	0.30	0.30	0.80	0.53	n/s
Campus and Academic Buildings	3.00	0.26	3.90	0.10	3.60	0.16	3.40	0.40	n/s
Location on Campus	2.70	0.40	3.80	0.13	3.40	0.16	3.40	0.40	n/s
Location in the Building	2.70	0.40	3.80	0.13	3.50	0.17	3.00	0.47	n/s
Campus-owned Apartments	0.00	0.00	0.10	0.10	0.40	0.31	0.50	0.31	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	n/s
Processing Facility	0.70	0.33	0.20	0.20	0.50	0.31	0.50	0.17	n/s
What	1.58	0.20	1.31	0.20	1.56	0.21	1.43	0.19	n/s
Fibers	0.30	0.30	0.40	0.40	0.00	0.00	0.00	0.00	n/s
Fabric	0.60	0.40	0.70	0.47	0.30	0.30	0.40	0.40	n/s
Paper	3.90	0.10	3.90	0.10	4.00	0.00	4.00	0.00	n/s
Magazines	0.30	0.30	0.40	0.40	1.00	0.52	2.20	0.61	n/s
White Paper	3.30	0.40	3.40	0.31	3.80	0.13	3.70	0.15	n/s
Pre-Consumer	0.40	0.40	0.00	0.00	0.00	0.00	0.40	0.40	n/s
Post-Consumer	2.70	0.47	2.50	0.43	3.40	0.40	2.90	0.50	n/s
Paperboard	0.00	0.00	0.80	0.42	0.70	0.47	0.30	0.30	n/s
Mixed Paper	2.20	0.61	1.00	0.52	2.40	0.60	2.10	0.64	n/s
Junk Mail	1.70	0.58	1.30	0.54	1.10	0.57	1.40	0.58	n/s
Newspaper	3.90	0.10	4.00	0.00	4.00	0.00	3.40	0.40	n/s
Pre-Consumer	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Post-Consumer	2.40	0.54	3.00	0.52	3.10	0.53	2.90	0.50	n/s
Softbound Books	0.60	0.40	0.30	0.30	1.20	0.49	1.00	0.52	n/s
Cardboard	3.40	0.27	3.60	0.16	3.10	0.53	3.60	0.50	n/s
Non-Fibers "Containers"	3.80	0.13	2.90	0.35	3.20	0.39	3.60	0.16	n/s
Metals (Tin, Aluminum)	3.50	0.40	3.60	0.16	3.80	0.13	3.90	0.10	n/s
Scrap Metal	2.00	0.56	1.20	0.49	1.60	0.65	1.80	0.61	n/s
Food Cans	2.10	0.59	2.00	0.56	2.10	0.59	1.60	0.65	n/s
Pop Cans	3.60	0.40	3.40	0.40	3.90	0.10	3.30	0.40	n/s
Foil	0.30	0.30	0.30	0.30	0.00	0.00	1.80	0.61	n/s
Glass	3.60	0.16	3.40	0.31	3.50	0.17	3.10	0.46	n/s
Clear	1.90	0.53	0.90	0.46	1.60	0.54	1.10	0.50	n/s
Brown	0.60	0.40	0.50	0.34	0.30	0.30	0.60	0.40	n/s
Plastics	3.90	0.10	3.90	0.10	4.00	0.00	3.90	0.10	n/s
#1 PETE	3.70	0.15	2.80	0.49	3.20	0.39	2.30	0/63	n/s
#2 HDPE (Cloudy)	2.30	0.52	1.00	0.52	2.10	0.59	2.10	0.59	n/s
#2 HDPE (Colored)	0.60	0.40	0.00	0.00	0.70	0.47	0.70	0.47	n/s

Table 5.5 (continued): Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Other	3.40	0.40	2.50	0.56	2.70	0.47	1.80	0.61	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.70	0.47	0.30	0.30	0.70	0.47	n/s
Tires	0.40	0.40	0.40	0.40	0.30	0.30	1.10	0.57	n/s
Toner	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.00	n/s
Tennis Shoes	0.70	0.47	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Electronic Waste	1.10	0.57	0.7	0.47	1.00	0.52	0.40	0.40	n/s
Biological	2.20	0.61	0.80	0.53	1.60	0.54	1.10	0.57	n/s
Leaves	0.90	0.46	0.30	0.30	0.00	0.00	0.30	0.30	n/s
Grass	0.90	0.46	0.00	0.00	0.60	0.40	0.60	0.40	n/s
Branches	0.60	0.40	0.30	0.30	0.30	0.30	0.00	0.00	n/s
Food Waste	1.80	0.61	1.20	0.61	0.40	0.40	0.40	0.40	n/s
Manure	1.10	0.57	0.00	0.00	0.60	0.40	0.00	0.00	n/s
Hazardous Waste	0.40	0.40	0.30	0.30	1.60	0.54	0.70	0.47	n/s
Pallets	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	n/s
Batteries	0.60	0.40	1.10	0.57	1.40	0.58	1.10	0.57	n/s
Ink-Jet Cartridges	0.70	0.47	0.30	0.30	2.40	0.54	0.00	0.00	n/s
Florescent Light Bulbs	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	n/s
How	1.94	0.25	1.64	0.22	1.97	0.23	2.01	0.21	0.05
Quality Control	3.60	0.22	3.40	0.40	3.60	0.40	3.30	0.40	n/s
Proper Sorting	3.20	0.42	3.40	0.40	3.20	0.53	2.80	0.49	n/s
Signs	1.60	0.54	1.50	0.62	1.90	0.64	1.50	0.62	n/s
Removing Impurities	2.70	0.47	2.10	0.53	2.80	0.42	2.50	0.43	n/s
Clean	2.40	0.54	1.60	0.54	2.40	0.48	2.30	0.52	n/s
Remove Caps	1.60	0.54	1.10	0.57	1.00	0.45	0.70	0.47	n/s
Processing Facility	2.10	0.59	1.90	0.53	2.00	0.56	2.60	0.58	n/s
Pick-up	2.40	0.43	2.30	0.45	2.50	0.45	2.60	0.58	n/s
Self-Sorting	3.40	0.6	3.20	0.29	3.20	0.53	3.10	0.53	n/s
Non-Fibers "Containers"	3.60	0.16	2.00	0.56	2.60	0.58	2.80	0.42	n/s
Plastics	3.70	0.15	3.30	0.15	3.70	0.15	3.60	0.16	n/s
#1 PETE	1.90	0.53	0.40	0.31	1.20	0.49	1.90	0.64	n/s
#2 HDPE (Cloudy)	1.20	0.49	0.40	0.31	1.20	0.49	1.80	0.61	n/s
#2 HDPE (Colored)	0.30	0.30	0.30	0.30	0.60	0.40	0.70	0.47	n/s
Metals (Tin, Aluminum)	3.40	0.40	2.10	0.59	3.60	0.40	2.90	0.50	n/s
Glass	3.30	0.40	2.70	0.47	2.60	0.58	2.90	0.50	n/s
Brown	0.50	0.40	1.00	0.52	0.30	0.30	0.60	0.40	n/s
Clear	0.50	0.40	1.00	0.52	0.30	0.30	1.00	0.52	n/s
Paper	3.60	0.16	3.40	0.16	3.90	0.10	3.50	0.17	n/s
Magazines	0.00	0.00	0.00	0.00	0.30	0.30	0.80	0.53	n/s
Softbound Books	0.30	0.30	0.00	0.00	03.0	0.30	0.00	0.00	n/s
White Paper	1.20	0.49	1.50	0.50	1.70	0.58	2.30	0.63	n/s
Paperboard	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.00	n/s
Mixed Paper	1.20	0.49	0.90	0.46	1.70	0.58	2.20	0.61	n/s
Newspaper	1.80	0.49	2.00	0.56	2.40	0.45	2.10	0.59	n/s
Cardboard	0.90	0.46	1.20	0.49	1.80	0.16	1.80	0.61	n/s

Table 5.5 (continued): Mean levels of understanding for 116 concept areas comparing undergraduate students living in four MSU residential areas (Akers, Butterfield, Holmes, and Hubbard Halls). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	Akers		Butterfield		Holmes		Hubbard		P
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Why	1.94	2.05	2.40	2.19	0.34	0.35	0.32	0.34	n/s
Environmental Benefits	3.80	3.90	3.80	3.80	0.13	0.10	0.13	0.57	n/s
Water	0.60	0.90	1.60	1.10	0.40	0.46	0.54	0.59	n/s
Land	1.00	1.60	2.20	2.10	0.52	0.54	0.61	0.59	n/s
Air	1.10	1.60	1.30	1.60	0.57	0.54	0.52	0.65	n/s
Energy	1.40	0.60	1.80	1.40	0.58	0.40	0.61	0.58	n/s
Economic Benefits	3.50	3.60	3.60	3.60	0.17	0.16	0.16	0.16	n/s
Monetary Incentive	3.20	3.30	3.70	3.30	0.39	0.40	0.15	0.40	n/s
Deposit	2.90	3.40	3.70	3.30	0.50	0.40	0.15	0.40	n/s
Garbage Fees	0.00	0.40	1.10	0.70	0.00	0.31	0.57	0.40	n/s
Jobs	1.20	1.20	1.10	0.60	0.49	0.49	0.50	0.40	n/s
Tipping Fees	1.20	0.0	0.30	0.60	0.40	0.46	0.30	0.40	n/s
Social Benefits	2.70	2.90	3.00	3.20	0.40	0.50	0.37	0.39	n/s
Awareness	2.60	2.30	3.00	3.20	0.45	0.63	0.37	0.39	n/s
Why Not	3.22	2.83	3.09	2.80	0.52	0.50	0.43	0.48	n/s
Disincentives	4.00	4.00	3.90	4.00	0.00	0.00	0.10	0.00	n/s
Time	2.80	3.00	3.60	2.70	0.61	0.37	0.16	0.60	n/s
Ease	3.90	2.60	3.40	2.60	0.10	0.45	0.40	0.58	n/s
Convenience	4.00	3.80	3.20	3.00	0.00	0.13	0.39	0.53	n/s
Space	0.80	0.60	1.00	0.70	0.53	0.40	0.52	0.47	n/s
Know-how	3.80	3.00	3.60	3.80	0.13	0.52	0.16	0.13	n/s
Alternatives	2.15	2.23	2.35	2.45	0.94	0.80	0.90	0.92	0.04
Reduce	1.20	1.70	1.90	2.10	0.44	0.45	0.53	0.64	n/s
Reuse	3.40	2.90	3.50	3.90	0.40	0.43	0.17	0.10	n/s
Surplus Store	0.00	0.30	0.00	0.00	0.00	0.30	0.00	0.00	n/s
Garbage	4.00	4.00	4.00	3.80	0.00	0.00	0.00	0.13	n/s

Table 5.6: Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Where	20.74	35.56	0.90	0.39	1.32	0.38	n/s
Residence Hall	0.00	22.22	0.22	0.15	0.78	0.43	n/s
Location on Campus	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Location in Residence Hall	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Dining/Concessions	11.10	55.56	0.56	0.34	1.89	0.61	n/s
Sports Venues	0.00	22.22	0.11	0.11	0.78	0.52	n/s
Residential Dining	0.00	33.33	0.11	0.11	1.11	0.56	n/s
International Center Food Court	11.11	33.33	0.44	0.34	1.00	0.50	n/s
Sparty's Cafes	11.11	22.22	0.56	0.44	0.78	0.43	n/s
Campus and Academic Buildings	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Location on Campus	88.89	100.00	3.67	0.33	4.00	0.00	n/s
Location in the Building	88.89	100.00	3.67	0.33	4.00	0.00	n/s
Campus-owned Apartments	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location in Complex	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Location on Campus	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Processing Facility	0.00	22.22	0.11	0.11	0.78	0.52	n/s
What	36.23	40.10	1.32	0.21	1.49	0.19	n/s
Fibers	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Fabric	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Paper	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Magazines	66.67	88.89	2.67	0.67	3.11	0.42	n/s
White Paper	100.00	100.00	4.00	0.00	3.78	0.15	n/s
Pre-Consumer	0.00	11.11	0.00	0.00	0.33	0.33	n/s
Post-Consumer	44.44	77.78	1.78	0.70	2.89	0.56	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	100.00	100.00	4.00	0.00	3.67	0.17	n/s
Junk Mail	22.22	0.00	0.78	0.52	0.00	0.00	n/s
Newspaper	100.00	88.89	3.89	0.11	3.56	0.44	n/s
Pre-Consumer	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Post-Consumer	11.11	55.56	0.44	0.44	2.22	0.70	0.046
Softbound Books	33.33	22.22	1.00	0.50	0.78	0.52	n/s
Cardboard	55.56	55.56	2.11	0.68	2.11	0.68	n/s
Non-Fibers "Containers"	88.89	77.78	3.11	0.42	3.22	0.43	n/s
Metals (Tin, Aluminum)	88.89	100.00	3.22	0.43	3.78	0.15	n/s
Scrap Metal	55.56	44.44	1.78	0.57	1.33	0.53	n/s
Food Cans	33.33	55.56	1.00	0.50	1.78	0.57	n/s
Pop Cans	100.00	88.89	3.78	0.15	3.44	0.44	n/s
Foil	11.11	44.44	0.33	0.33	1.44	0.58	n/s
Glass	88.89	77.78	2.89	0.39	2.67	0.53	n/s
Clear	66.67	44.44	2.11	0.54	1.33	0.53	n/s
Brown	44.44	33.33	1.33	0.53	1.00	0.50	n/s
Plastics	88.89	88.89	3.22	0.43	3.44	0.44	n/s
#1 PETE	66.67	66.67	2.56	0.65	2.56	0.58	n/s
#2 HDPE (Cloudy)	44.44	55.56	1.33	0.53	1.89	0.54	n/s
#2 HDPE (Colored)	0.00	22.22	0.11	0.11	0.78	0.43	n/s

Table 5.6 (continued): Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Other	88.89	77.78	3.44	0.44	3.00	0.58	n/s
Fly Ash	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Construction Waste	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Tires	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Toner	11.11	22.22	0.44	0.44	0.89	0.59	n/s
Tennis Shoes	0.00	22.22	0.00	0.00	0.78	0.52	n/s
Electronic Waste	44.4	55.56	1.56	0.63	1.89	0.61	n/s
Biological	0.00	55.56	0.00	0.00	2.11	0.68	n/s
Leaves	0.00	11.11	0.00	0.00	0.44	0.44	n/s
Grass	0.00	11.11	0.00	0.00	0.56	0.44	n/s
Branches	0.00	0.00	0.00	0.00	0.11	0.11	n/s
Food Waste	0.00	11.11	0.00	0.00	0.44	0.44	n/s
Manure	0.00	22.22	0.00	0.00	0.89	0.59	n/s
Hazardous Waste	11.11	0.00	0.44	0.44	0.00	0.00	n/s
Pallets	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Batteries	33.33	11.11	1.22	0.62	0.44	0.44	n/s
Ink-Jet Cartridges	44.44	33.33	1.56	0.63	1.33	0.67	n/s
Florescent Light Bulbs	22.22	0.00	0.78	0.52	0.00	0.00	n/s
How	52.14	58.97	1.95	0.27	2.09	0.21	n/s
Quality Control	100.00	88.89	3.89	0.11	3.33	0.33	n/s
Proper Sorting	100.00	88.89	3.89	0.11	3.33	0.33	n/s
Signs	55.56	44.44	2.22	0.70	1.56	0.63	n/s
Removing Impurities	33.33	88.89	1.33	0.55	3.11	0.31	n/s
Clean	33.33	44.44	1.33	0.55	1.78	0.57	n/s
Remove Caps	22.22	33.33	0.78	0.52	1.33	0.53	n/s
Processing Facility	0.00	22.22	0.00	0.00	0.78	0.52	n/s
Pick-up	55.56	44.44	2.11	0.61	1.44	0.58	n/s
Self-Sorting	100.00	100.00	4.00	0.00	3.78	0.15	n/s
Non-Fibers "Containers"	88.89	88.89	3.11	0.42	3.22	0.43	n/s
Plastics	88.89	77.78	3.11	0.42	2.89	0.56	0.046
#1 PETE	44.44	66.67	1.67	0.67	2.22	0.57	n/s
#2 HDPE (Cloudy)	22.22	44.44	0.78	0.52	1.33	0.53	n/s
#2 HDPE (Colored)	0.00	22.22	0.00	0.00	0.67	0.44	n/s
Metals (Tin, Aluminum)	77.78	77.78	2.78	0.55	2.89	0.56	n/s
Glass	66.67	66.67	2.44	0.63	2.33	0.60	n/s
Brown	22.22	33.33	0.67	0.44	1.00	0.50	n/s
Clear	33.33	44.44	1.11	0.56	1.33	0.53	n/s
Paper	100.00	100.00	3.78	0.15	3.67	0.17	n/s
Magazines	44.44	44.44	1.67	0.67	1.56	0.63	n/s
Softbound Books	0.00	22.22	0.00	0.00	0.78	0.52	n/s
White Paper	100.00	88.89	3.78	0.15	3.22	0.43	n/s
Paperboard	0.00	0.00	0.00	0.00	0.00	0.00	n/s
Mixed Paper	88.89	100.00	3.33	0.44	3.44	0.18	n/s
Newspaper	55.56	55.56	2.11	0.68	1.78	0.57	n/s
Cardboard	22.22	44.44	0.89	0.59	1.56	0.63	n/s

Table 5.6 (continued): Mean levels of understanding for 116 concept areas comparing faculty working in academic buildings judged to be "recycling friendly" (F) and "recycling unfriendly" (U). Means were compared using chi-square tests at the p=0.05 significance level.

Concept	% Correct		Friendly		Unfriendly		P
	F	UF	$\bar{x}$	SE	$\bar{x}$	SE	
Why	51.28	61.54	1.89	0.33	2.26	0.37	n/s
Environmental Benefits	100.00	100.00	3.78	0.15	4.00	0.00	n/s
Water	0.00	33.33	0.00	0.00	1.00	0.50	n/s
Land	66.67	88.89	2.56	0.65	3.11	0.42	n/s
Air	11.11	33.33	0.44	0.44	1.00	0.50	n/s
Energy	44.44	44.44	1.56	0.63	1.44	0.58	n/s
Economic Benefits	77.78	100.00	3.00	0.50	3.89	0.11	n/s
Monetary Incentive	77.78	100.00	2.89	0.56	3.89	0.11	n/s
Deposit	77.78	88.89	2.78	0.55	3.44	0.44	n/s
Garbage Fees	44.44	11.11	1.56	0.63	0.33	0.33	n/s
Jobs	22.22	44.44	0.89	0.59	1.56	0.63	n/s
Tipping Fees	11.11	22.22	0.33	0.33	0.67	0.44	n/s
Social Benefits	66.67	66.67	2.44	0.56	2.56	0.58	n/s
Awareness	66.67	66.67	2.33	0.60	2.56	0.58	n/s
Why Not	61.11	72.22	2.39	0.52	2.74	0.43	n/s
Disincentives	100.00	100.00	4.00	0.00	4.00	0.00	n/s
Time	44.44	55.56	1.67	0.67	2.22	0.70	n/s
Ease	66.67	66.67	2.56	0.65	2.33	0.60	n/s
Convenience	88.89	88.89	3.44	0.44	3.44	0.44	n/s
Space	11.11	33.33	0.44	0.44	1.11	0.56	n/s
Know-how	55.56	88.89	2.22	0.70	3.33	0.44	n/s
Alternatives	61.11	75.00	2.39	0.64	2.89	0.44	n/s
Reduce	22.22	55.56	0.89	0.59	2.22	0.70	n/s
Reuse	66.67	100.00	2.44	0.63	3.67	0.17	n/s
Surplus Store	55.56	44.44	2.22	0.70	4.00	0.67	n/s
Garbage	100.00	100.00	4.00	0.00	0.33	0.00	n/s

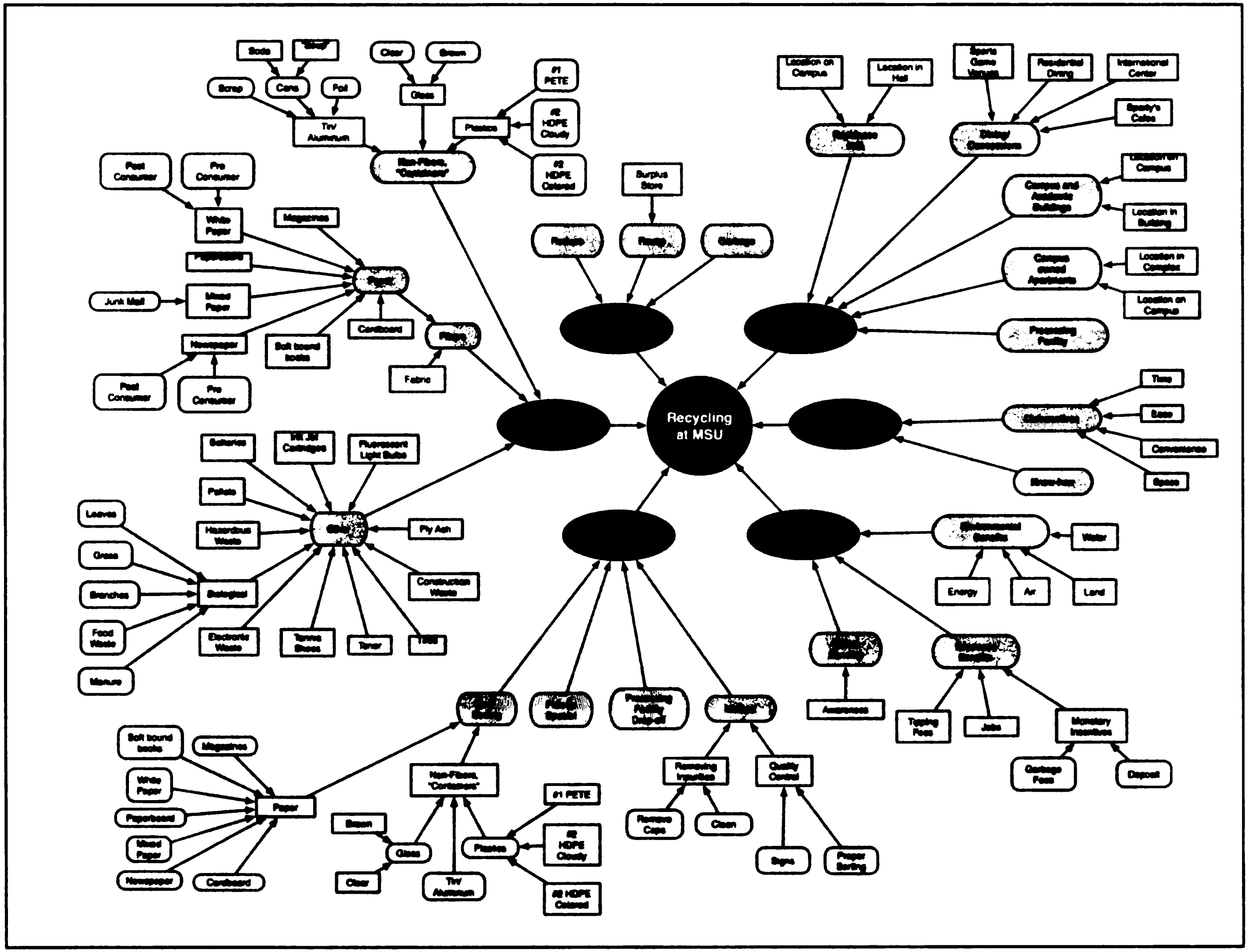

Figure 5.1: Expert mental model for recycling on the MSU campus.

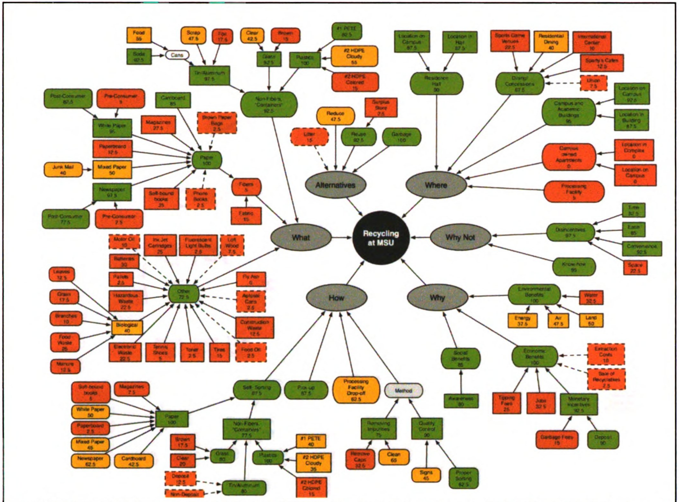

Figure 5.2. Comprehensive student mental model. Percent values indicate frequency of understanding across subjects. Hatched boxes indicate concepts mentioned by subjects that were not present in the expert model. This model employs a color-coding scheme to differentiate the levels of knowledge into three categories; the color red signifies 0-33% interviewed understood the subject, yellow signifies 34-66%, and green signifies 67-100%. Images in this thesis are presented in color.

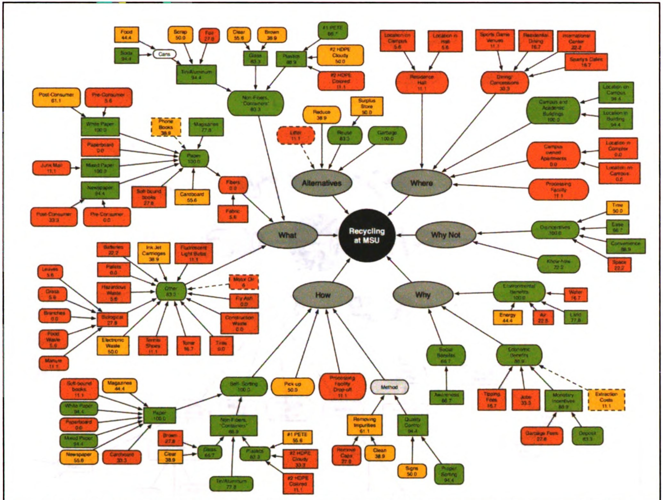

Figure 5.3. Comprehensive faculty mental model. Percent values indicate frequency of understanding across subjects. Hatched boxes indicate concepts mentioned by subjects that were not present in the expert model. This model employs a color-coding scheme to differentiate the levels of knowledge into three categories; the color red signifies 0-33% interviewed understood the subject, yellow signifies 34-66%, and green signifies 67-100%. Images in this thesis are presented in color.

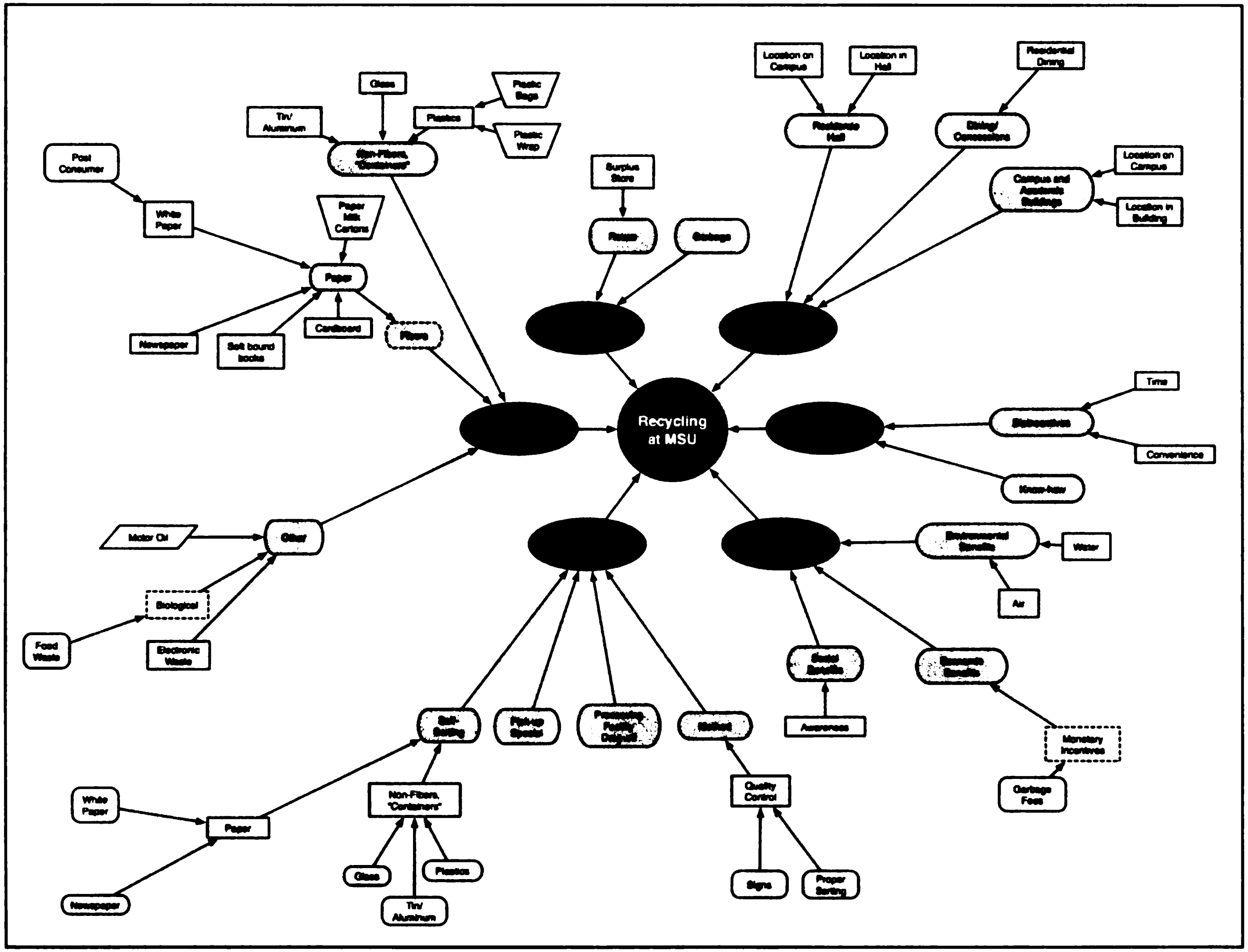

Figure 5.4. Example mental model elicited from a MSU undergraduate student.

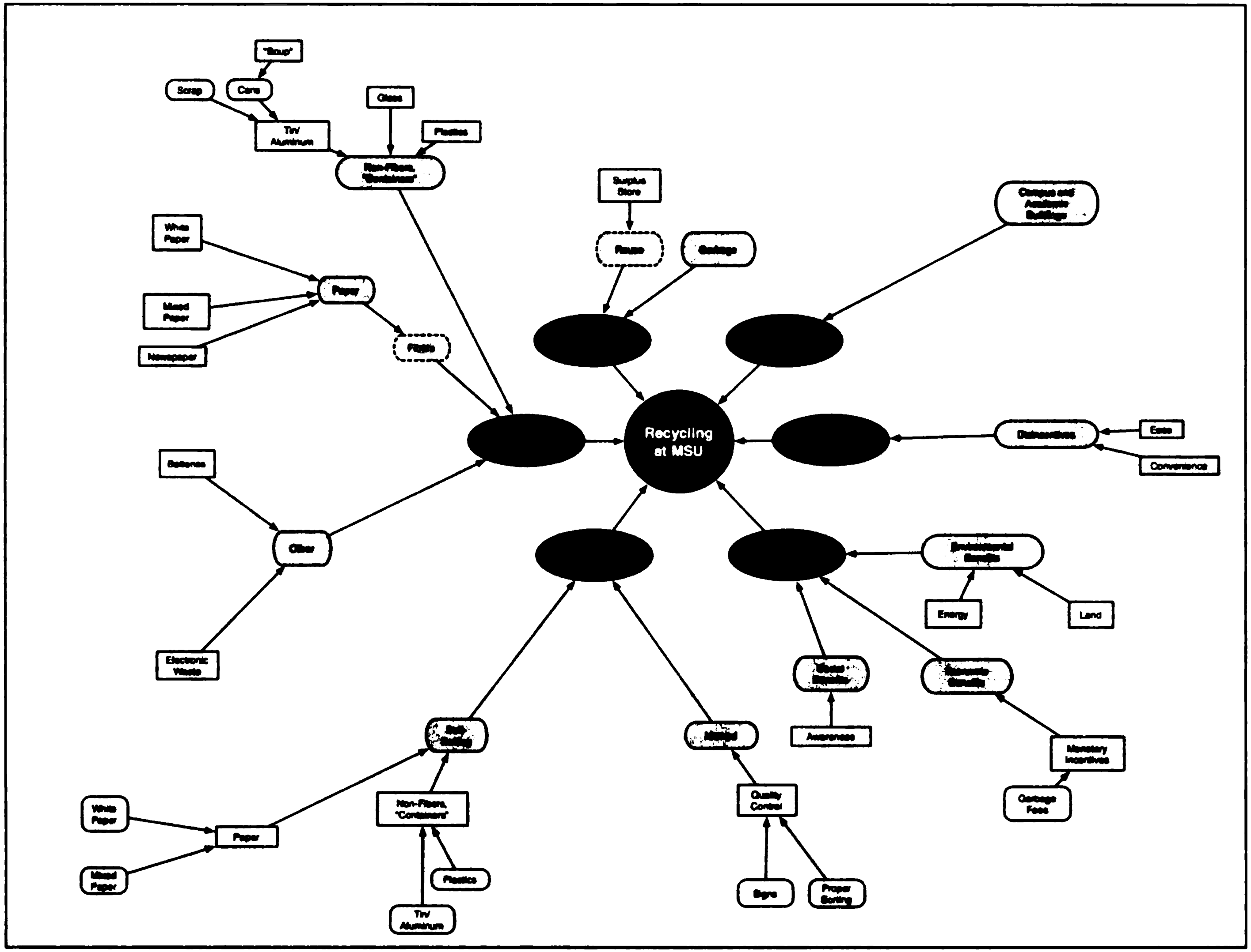

Figure 5.5. Example mental model elicited from a MSU faculty member.

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