DETERMINING AND MEETING THE EDUCATIONAL NEEDS OF STUDENTS AND URBAN GARDENERS AND FARMERS ON URBAN SOIL QUALITY AND CONTAMINATION TOPICS

by

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Dedication

This Master's thesis is dedicated to Dorothy, my patient, sage, and loving mother who inspires me every day.

Chapter 1 - Needs Assessment Survey of Urban Gardeners and Farmers on Urban Soil Contamination Topics

Abstract

Interest and participation in urban agriculture is growing in many cities throughout the United States. Urban gardeners and farmers produce food on various types of urban lands. Nearly 450,000 brownfields exist in the United States, some of which are utilized for urban agriculture. Common soil contaminants of brownfields and other urban areas limit the amount of land on which food may safely be grown. The objective of this study was to assess the informational and technical assistance needs of urban gardeners and farmers throughout the United States on the topics of urban soil quality and contamination. A needs assessment survey of urban gardeners and farmers was conducted in four communities; Tacoma and Seattle, Washington, Kansas City, Kansas and Missouri, Manhattan, Kansas, and Gary, Indiana. Two versions of the survey were distributed from summer 2010 to summer 2011; a paper version completed by hand and an electronic version completed online. Surveys were returned by 121 respondents from all communities. The survey generated information about what urban gardeners and farmers know, think they know, and want to know about urban soil quality and contamination. Eighty-eight percent of respondents indicated that they do not have knowledge of the best management practices to minimize health risks involved when growing food crops on soils contaminated with lead, cadmium, arsenic or organic contaminants. Our results suggest that urban gardeners and farmers require and want information and guidance on soil testing for common contaminants, interpretation of testing results, and best management practices for growing food on mildly contaminated soils.

Introduction

Urban agriculture in the United States

Urban agriculture is defined as growing and distribution of fruits, vegetables, herbs, and animal products through cultivation in cities and suburbs (Bailkey and Nasr, 2000). Gardening and farming in urban environments throughout the United States has grown in popularity over the last 40 years. Currently 250 cities and towns in the United States and Canada have government and/or non-profit organizations operating garden program including an estimated 18,000 community gardens (ACGA, 2011). The number of farmers markets in the United States has grown from approximately 1755 in 1994 to nearly 6132 in 2010 (USDA, 2011).

Urban food production is not a new notion; however the reasons for establishing urban gardens and farms have changed. During World War II, community gardens functioned to supplement diets during war-time rationing and were prevalent in many American cities and towns (Bassett, 1981; Hynes and Howe, 2002). The desire for urban agriculture in today's cities is a change from the necessity of war-time gardens and farms. An increase in consumer demand for locally produced foods, for sustainable cities, and for nutritious and fresh foods in inner-city food deserts has encouraged urban agriculture throughout the United States (Alaimo et al., 2008). Today, urban gardens and farms function to benefit communities in many ways, including: improved community food security, access to nutritious foods, physical activity, recreation, community cohesiveness, as well as improved aesthetic appeal of neighborhoods and property values (Armstrong, 2000; Blair et al., 1991; Glover, 2004; Relf, 1992; Saldivar-Tanaka and Krasny, 2004; Twiss et al., 2003; USEPA, 1995).

Urban populations are growing rapidly and that trend is predicted to continue over the next century. The United States Census Bureau (2011) reported that 83.7 percent of the U.S. population was living in urban areas in 2010. The United Nations predicts that the world population will increase from 6.1 billion in 2000 to 8.3 billion in 2030 (Bailkey and Nasr, 2000; United Nations, 2008), and its projected that by 2030, an estimated 5 billion people will be living in urban areas (United Nations, 2007). With the vast majority of the world's population in urban areas, urban agriculture's impacts will directly affect a greater number of individuals.

Brownfields sites in the United States

Despite the increase in urban populations, much land lies vacant and underutilized within U.S. cities (USEPA, 1995). Pagano and Bowman (2000) found that approximately 15% of land in the of the 83 U.S. cities surveyed, or nearly 4,500 acres per city, was considered vacant or abandoned. Many U.S. cities such as Chicago, New York, Philadelphia, etc. have tens of thousands vacant lots (Bailkey and Nasr, 2000). As urban populations have transitioned to suburbs surrounding cities, inner-city businesses, houses, parking lots, etc. have been abandoned or razed leaving open, vacant lots. Publically and privately owned vacant lands in many U.S. cities are quickly being converted to urban gardens and farms by individuals, families, neighborhoods, schools, nonprofit organizations, and many others. More and more urban dwellers are coming into direct contact with urban soils through these gardening and farming activities; this poses a potential human health risk if the land being cultivated is a brownfield site. A brownfield is an underutilized commercial or industrial site which potentially has environmental contamination (USEPA, 1995). The United States has an estimated 450,000 brownfields sites (USEPA, 1995), many of which are these vacant lots within cities. Brownfields can potentially be safely used for agricultural proposes, however soil quality must first be assessed.

Soil contamination in urban environments

Natural and urban derived soils vary considerably. Urban soils are often highly disturbed and/or contaminated due to human activities (Bullock and Gregory, 1991; Craul, 1999; Reimann and De Caritat, 2000). Urban soils are more physically, chemically, and biologically heterogeneous than naturally derived soils, posing unique management issues (Craul, 1984). Previous land use and human activities on and around an urban site (e.g. industries, automobile emissions, leaded paint, mining, and use of man-made products) can lead to increased accumulation of trace elements and organic compounds, or soil contamination (Boyd et al., 1999; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1979; Nriagu, 1996; USDA-NRCS, 2000). Lead (Pb), Cadmium (Cd), and Arsenic (As) are the most common contaminants in urban environments (USDA-NRCS, 2000). Trace elements are found naturally in many soils, however, urban soils often contain elevated concentrations of these elements and compounds due to human activities (Finster et al., 2004). Soils are a sink for many trace element contaminants, and most of these urban soil contaminants are persistent, immobile, and non-biodegradable (Boyd et al., 1999; Finster et al., 2004; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1988; Watt et al., 1993). Contaminated urban soils require unique management techniques due to their heterogeneity and potential contamination in order to reduce exposure pathways and any human health risks. Past and unseen sources of contamination, razing of aboveground materials, and soil mixing of urban soils can lead to sites with variably distributed contamination making understanding and minimizing human health risks difficult (Craul, 1984).

Exposure pathways and human health risks related to gardening on contamination urban soils

Urban soils are an important pathway for human exposure to trace elements and organic contaminants (Boyd et al., 1999; Gallacher et al., 1984; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1988; Watt et al., 1993). This is troublesome because common urban contaminants (e.g. Pb, Cd, As) are toxic to humans, especially children (Boyd et al., 1999; Finster et al., 2004; Hettiarachchi et al., 2004; Mielke et al., 1999; Mielke and Reagan, 1998). Gallacher et al. (1984) found that residents living in areas with highly contaminated soils had higher blood lead levels than residents of areas with minimally contaminated or uncontaminated soils. Humans may be exposed to soil contaminants through three main pathways: ingestion, inhalation, and dermal (Boyd et al., 1999; Mielke et al., 1999; Mielke and Reagan, 1998).

The two main exposure pathways affecting urban dwellers, especially gardeners and farmers, are ingestion of soil dust and ingestion of food grown in contaminated soil (Cambra et al., 1999; Hawley, 1985; Hettiarachchi et al., 2004). Direct ingestion of soil dust may be from pica behavior, which is common for children, or from soil dust adhered to produce, hands, and clothing. Root crops grown directly in the soil and crops that grow close to the soil such as spinach often have soil dust adhered to the tissue when harvested (Finster et al., 2004). Simply washing produce with water and mild detergent can remove most adhered soil particles. Ingestion of food grown in contaminated soil also may pose a risk to human health if the bioavailability of the contaminant is high and if translocation of the contaminant from soil to the edible portion of the plant has occurred (Finster et al., 2004; Purves and Mackenzie, 1970). The bioavailability of an individual contaminant impacts the plant uptake and translocation of the contaminant from soil into the roots, from the roots to shoots, and shoots to fruiting bodies. Hettiarachchi et al. (2004) defined bioavailability is the percentage of a soil contaminant that is available for absorption into an organism.

Due to the growing urban populations and increased interest and participation in urban agriculture, a greater portion of the population is coming into direct contact with urban soil. Individuals whom are in direct contact with urban soil should be aware of urban soil quality and soil contamination issues to minimize environmental and human health risks associated with soil contamination. But what does this growing group of urban growers know about these urban soil contamination topics? Therefore, we designed our research survey as a needs assessment to determine the answer to this question, and is the objective of this project.

Needs assessments in extension research

When extension began most of the U.S. population lived in rural communities and on farms (Brown, 1965). Today, the majority of Americans live within urban and suburban areas. As population dynamics change, so must the extension programming change to suit the needs of the public it serves. The goal of extension is to realize and fulfill the informational needs of the population it serves (Beckley & Smith, 1985; Decker et al., 1989; Rogers, 1995). Needs assessment methods are tools used to reach this goal to meet the needs of the intended population (Berkowitz and Nagy, 2011; McCaslin and Tibezinda, 1997). Berkowitz & Nagy (2011) and McCaslin & Tibezinda (1997) define a needs assessment as the process of gathering specific information on a focal population or community, setting priorities, and making decisions about the development of a particular extension program based on the needs identified. A needs assessment should also differentiate between the needs, wants, and interests of the focal population (McCaslin & Tibezinda, 1997).

Several techniques exist for conducting a needs assessment in extension including: individual and group interviews, phone questionnaires, observations and personal correspondence, and paper and web-based surveys (Barron, 2009; Berkowitz & Nagy, 2011; Blaine et al., 2008; Bowe et al., 1999; Caravella, 2006; Etling, 1995; Israel & Ilvento, 1995; Mahler et al., 2010; McCaslin & Tibezinda, 1997; Muhammed et al., 2009; Pokopy et al., 2010; Raab & Grobe, 2005). Prior to the 1970s, surveys of a population of interest were conducted through face-to-face interviews, either individually or as a group. Telephone questionnaires then became the most widely utilized survey method. Today, however, self-administered survey methods such as mail and internet surveys are gaining in popularity as easy, economic, and less intrusive methods of surveying the public (Enright, 2006; Dillman, 1999 & 2000). Several extension needs assessments recently conducted in various disciplines across the U.S. have used self-assessment techniques to collect data on the population of interest (Barron, 2009; Blaine et al., 2008; Bowe et al., 1999; Hazen, 2004; Mahler et al., 2010; Prokopy et al., 2010). The ease of contacting respondents, rapidly collecting and analyzing data, and the low costs has made internet surveys an even more popular extension needs assessment method in recent years (Dillman et al., 1999; Israel, 2010; O'Neill, 2004).

Survey techniques

We used paper and web-based survey throughout our needs assessment research, therefore we will focus on these two survey methods throughout this article. Paper and web-based survey techniques are two examples of self-assessment methods. Self-assessment survey methods have many advantages for needs assessment research, as well as some weaknesses that should be considered. We are defining paper surveys as those which are printed as a booklet and can be handed directly to respondents at an event or mailed to the respondents' home or business. The advantages of paper surveys are that these are inexpensive, do not require access to the internet, and are minimally intrusive. The weaknesses of a paper survey are that these take more time to receive responses, require addresses and return postage if mailed (and limited databases exist of urban growers' postal addresses), and limit the number of responses from those with inadequate literacy.

Web-hosted surveys are those which are available on the Internet. Invitations to complete a web-hosted survey and a link to access the survey may be distributed to respondents online through personal emails, email listservs or website, as well as by print through a mass-mailed newsletter or individual postal letter. The advantages of the web-based surveys are that these are rapidly distributed and received, inexpensive, and if distributed by email are easier to send reminder messages to improve response rates (Archer, 2003; Davis, 1997; Dillman, 1999 & 2000; Enright, 2006; Witt, 1998). The limitations of the web-based surveys are that not everyone has access to the internet, there are extremely few publically available email directories for urban growers, and the decision to not respond to a web-based survey is made much more quickly than with other methods (Archer, 2003; Dillman, 2000). A Pew internet usage survey (2010) of adults found that 77% of all adults in the U.S. use the internet. On average 79% of American adults living in urban and suburban areas use the internet compared to 68% of rural residents. Individuals with lower educational levels, minorities, elders, and rural residents were found to have less access to the internet (Horrigan, 2008; Pew, 2010).

Many extension studies have reported higher response rates with phone or mailed surveys compared to internet surveys, however a greater number of extension needs assessments are being conducted using the internet. Israel (2010) found no significant difference between respondents of a paper survey compared to respondents who were given a choice to complete a paper or a web-hosted survey. Israel (2010) also determined that extension respondents did respond to web-hosted surveys, however, more respondents completed the mailed/paper survey. Dillman et al. (2009) stated that mail and mixed mode surveys in extension research historically obtain higher response rates than web-hosted surveys.

Sources of error in survey research

Four sources of survey error exist: sampling, coverage, measurement, and nonresponse error (Dillman, 2000; Groves, 1989). Sampling and coverage error are a consequence of not including all individuals of the population of interest in the survey procedure. Measurement error results from an unclear or inaccurate question from which answers cannot be used in the overall analysis and results. The final type of survey error is nonresponse error, which occurs when the individuals whom responded to the survey differ from individuals whom did not respond to the survey (Dillman, 2000). Considerable research has been done to identify methods to reduce error and increase the participation in surveys. The first step to reducing error in survey research is to follow the previously researched design methods, such as Dillman's Tailored Design Method (TDM) for mail and internet surveys, when creating a cover letter and survey questionnaire. Dillman's TDM consists of procedures designed to reduce the four types of survey error and to increase participation in mail and internet surveys (Dillman, 2000). Survey error, especially nonresponse error, can be also be improved through incentives (monetary or otherwise) and by reducing the "cost" or effort required by the respondent to complete the survey (Dillman, 2000. Miller and Smith, 1983). Any weaknesses in a mail or internet survey design may lead to any of the four survey errors, but most often leads to nonresponse error (Dillman, 2000; Israel, 2010).

Methods for reducing error in survey research

Dillman (1978) and Miller and Smith (1983) describe multiple methods for reducing error, specifically nonresponse error, in survey research. They suggest using incentives, personalization of the survey cover letter, identifying a relevant sponsor, and repetitive distribution to non-respondents to boost survey response rates. Lindner et al. (2001) suggest three methods for handling nonresponse error after survey distribution has concluded. These methods are comparing the early respondents to the late respondents, using days for response in statistical analyses, and to compare respondents with non-respondents. Although research has shown the merit of utilizing these methods to reduce nonresponse error in survey research, Lindner et al. (2001) report that most published social science survey research in recent history does not address the issue of nonresponse error.

Study Objectives

The purpose of the study described here was to determine the informational needs of urban farmers and gardeners throughout the communities of Kansas City, KS and MO, Tacoma and Seattle, WA, and Gary, Indiana on the topics of urban soil contamination and urban soil quality. Our objectives were to determine the following:

1. What do urban gardeners and farmers know about, and what are their experiences with, urban soil contamination?
2. What do urban gardeners and farmers want to know about urban soil contamination?
3. What do urban gardeners and farmers need to know about urban soil contamination?

The purpose of this article is to discuss the knowledge gaps and informational needs of urban farmers and gardeners on the subject of urban soil contamination.

Materials and Methods

Populations surveyed

The communities of Kansas City, Kansas and Missouri; Tacoma and Seattle, Washington; and Gary, Indiana; each have growing populations of urban dwellers participating in urban agriculture, whether its community or backyard gardening, Community Supported Agriculture farms (CSA's), or market farms. Field research is currently being conducted (by other researchers at Kansas State University and collaborating institutions) within these communities to determine potential best management practices, as well as the human health risks associated with growing food crops on mildly contaminated urban soils. These specific communities were chosen for this field research study due to the presence of common urban soil contaminants on current and future urban agriculture sites, as well as for the residents' increasing interest and participation in urban agriculture. The results of this needs assessment survey will serve as a guideline for the development of extension programing to address the identified needs of the urban gardeners and famers within these communities.

Each of these communities possesses well-established urban agriculture organizations which assist gardeners and farmers in creating and maintaining urban gardens and farms. These urban agriculture organizations played a vital role in our needs assessment process, as each organization assisted with contacting and distributing the survey to urban growers in these communities. Cultivate KC of Kansas City, KS/MO, P-Patch Community Gardens and Trust of Tacoma and Seattle, Washington, and Groundwork Gary of Gary, Indiana each contribute to the development and growth of urban agriculture in these communities. All three of these urban agriculture organizations indicated that they would benefit from the information gathered from our needs assessment survey, and were willing to assist us with our research efforts.

In Kansas City, KS/MO, Cultivate KC is a nonprofit organization (formerly Kansas City Center for Urban Agriculture) established in 2005 that organizes community events and educational outreach programs for urban gardeners and farmers. Cultivate KC has also started 37 farms in the KC area since 2005, and has assisted over 50 urban growers throughout Kansas City to solve urban agriculture related problems. Nearly 150 urban growers attend their annual Farmer's Meeting each year in Kansas City to brainstorm solutions to the most pressing urban agriculture problems in Kansas City. Cultivate KC's partnership with universities, community schools, municipalities, and community-outreach groups gives this organization breadth and credibility in the Kansas City urban agriculture community.

The P-Patch Trust consists of twelve board members whose mission it is to support the development of community gardens called, P-Patch Gardens, on Trust land throughout the Tacoma/Seattle area. The P-Patch Community Garden Program was established in 1973 and consists of over 75 different gardens on 23 acres of land throughout Tacoma and Seattle. Nearly 4,400 gardeners maintain plots within the P-Patch Community Garden Program (Seattle Department of Neighborhoods, 2011). Participation in urban agriculture has increased significantly in these communities over the last 40 years due in part to the efforts of the P-Patch Trust as evidenced by the rapid growth in the number of gardens as well as the number of participants in these gardens. In the 1970's nine P-Patch gardens were in operation, and today nearly 75 gardens are maintained by urban residents. The Seattle Department of Neighborhoods (2010) reports that 77% of the gardeners in the P-Patch program do not have gardening space where they live. Urban residents desire to garden within these communities is very evident as over 1,900 residents are on the waiting list to garden at one of the P-Patch sites (Seattle Department of Neighborhoods, 2011).

Groundworks is an outreach organization established in Great Britain in 1981 to assist urban communities in safely utilizing urban land and brownfields for gardening. In 1996, Groundworks began working in the United States with the assistance of U.S. Environmental Protection Agency Brownfields Program (Groundworks, 2011). Groundworks begin its work in Gary, Indiana in 2003 and since that time has provided educational and technical assistance to Gary's urban youth, gardeners, and farmers who are using urban land and brownfields to grow food. Groundwork's mission within communities emphasizes educating urban growers on the feasibility of converting underutilized urban land and brownfields to grow food.

These communities are of greatest interest to us and the focus of our needs assessment survey because these communities have mildly contaminated urban soils on which gardeners and farmers are currently producing food crops for their own and others' consumption. A needs assessment of urban gardeners and farmers, pertaining specifically to urban soil quality and soil contamination, has not previously been done. Surveys of urban agriculturalists have previously been conducted to determine the preferred information sources (Varlamoff, 2002), demographics of gardeners (Blaine et al., 2010), dietary choices and dietary changes (Alaimo et al., 2008; Blair et al., 1991), as well as the many social and economic benefits of participating in urban agriculture (Bellows et al., 2003; Blaine et al., 2010; Blair et al., 1991; Glover et al., 2004; Hynes & Howe, 2004; Patel, 1991; Teig e al., 2009), but none focused on knowledge of soil contamination topics.

Survey samples

Our population for this needs assessment survey was urban gardeners and farmers in the municipalities described in the preceding section. Urban farmers and gardeners were defined, for the purpose of this study, as those individuals that produce fruits, vegetables, row crops, livestock, dairy, flowers, and/or herbs on any size plot of land within a city or suburb, on a Brownfield site, or on any potentially contaminated soil, for personal consumption, to give away, or to sell. This definition includes backyard or recreational gardeners, community or neighborhood gardeners, market farmers, and commercial producers. The survey sample, or individuals drawn from the overall population of urban gardeners and farmers within these cities, was derived from established email lists, listservs, and mailing lists of the well-established urban agriculture organizations within each city: Cultivate KC, P-Patch, and GroundworksGary.

We also selected the following cities/urban growers to participate in the survey because professional contacts within these communities facilitated further distribution: Manhattan, Kansas; Lawrence, Massachusetts; and Cincinnati, Ohio.

Survey Design Methods

Our survey was designed in the spring of 2010, and approved (#5531) by the Institutional Review Board of Kansas State University in July of 2010. With our study objectives in mind, our survey consisted of 61 questions composed of a combination of open and closed format questions including: multiple-choice, Likert scale, short answer, true-false, and yes-no. Appendix A contains the paper copy of the survey distributed throughout our survey research. Table 1.1 contains a comprehensive list of all the survey questions with corresponding question numbers. The paper survey was designed as a booklet with short, simply-worded questions, as suggested by Dillman (2000). The web-based survey was designed to resemble the paper survey and was created using Axio, a free web-based survey and reporting tool through Kansas State University (Axio Learning, Manhattan, KS). Each surveyed location was assigned a unique link. Throughout the design of the survey, consistency between the paper and web-based surveys was of greatest importance. Both the paper and web-based versions of our survey contained the same questions, question design, question order, opportunity to comment, and opportunity to not to answer any question throughout the survey. A cover page was included and briefly outlined the purpose of the survey, graciously thanking respondents for their participation, and indicated a valid sponsor. Designed using Dillman's Tailored Design Method principles for mail and internet surveys, the cover letter was intended to increase respondents' sense of personal reward and validation (Dillman, 2000).

Survey Distribution Methods

Our survey was conducted during late summer 2010 and early spring 2011 (post/pre-harvest). However, this timing could have been improved upon as Pennings et al. (1999) reported that farmers are more likely to complete a survey during the winter months of December-February. The survey distribution method varied based on the community. Samples of urban gardeners and farmers in the cities of Seattle and Tacoma, WA, Kansas City, KS and MO, and Gary, IN, as well as Manhattan, KS, Lawrence, MA, and Cincinnati, OH was derived with the help of university extension personnel, United States Environmental Protection Agency (USEPA) researchers, community leaders, and especially urban agriculture and gardening organizations including: P-Patch (Tacoma and Seattle, WA), Cultivate KC (Kansas City, MO and KS), and Gary Groundwork (Gary, IN). Selection of survey distribution method depended on the growers' accessibility, existence of a local urban agriculture network or organization, and our relationship with community leaders. We will describe the distribution method for each of the locations and our motives for choosing each method.

We distributed our survey three times in the Kansas City, KS and MO communities. In late summer of 2010, distribution of the web-hosted survey began in Kansas City, MO and KS. An article in the Urban Grown (Harms, 2010), an online and print newsletter published by Cultivate KC and distributed to hundreds of urban growers throughout Kansas City, encouraged readers to follow a web link to participate in our web-hosted survey (Harms, 2010). In early fall 2010 our second distribution effort in Kansas City, KS and MO consisted of an email invitation containing a direct link to our web-hosted survey. The email invitation was distributed directly to urban growers' personal emails through the Growing Growers listserv associated with Cultivate KC. A follow-up email encouraging non-respondents to reconsider participating in our web-hosted survey was sent in late Fall 2010 through the Growing Growers listserv again. Our third distribution effort focused on reaching urban gardeners and farmers that do not have access to a computer or the internet. Paper surveys with self-addressed stamped envelopes were handed out directly to 95 urban gardeners and farmers at the Annual Farmer's Meeting in Kansas City, MO in January 2011. This meeting of urban agriculture leaders, community leaders, and urban gardeners and farmers to discuss issues related to urban agriculture in their community, provided a unique opportunity to speak with over 100 urban gardeners and farmers about our survey efforts. Completed surveys were collected at the end of this meeting, as well as collected by mail later in the late winter of 2011. Overall, our three distribution efforts in Kansas City, KS and MO yielded 30 completed survey responses.

Distribution of the web-hosted survey began fall of 2010 in Tacoma and Seattle, WA with the direct assistance of community leaders and the community garden organization, P-Patch. The online link to our web-hosted survey was distributed to urban gardeners and farmers of Tacoma and Seattle through listservs associated with the P-Patch organization, community garden groups, and the Washington State University. Urban agriculture leaders within these two communities contacted urban farmers and gardeners by email with a request to respond to our web-hosted survey. Due to so many people disseminating the survey link throughout the community, a response rate is difficult to calculate. We estimate that approximately 1,000 growers were contacted in the Seattle and Tacoma, WA region. A total of 81 survey responses were collected from these two communities.

Requests to further distribute the survey in other communities continued throughout the fall of 2010 and spring of 2011. Individuals working closely with urban agriculture throughout the country requested that the survey be completed within their communities, and emphasized that the gathered information would be valuable for their communities. The USEPA also assisted in written and web-based distribution at farmers markets and community meetings in Cincinnati, Ohio. A copy of the paper survey and a link to the web-hosted survey was also made available to the public via the USEPA Brownfields and Land Revitalization website in January of 2011. A total of seven responses were gathered from Gary, IN, Lawrence, MA, and Cincinnati, OH.

Data analysis methods

The data were analyzed statistically by applying analysis of variance (ANOVA) to compare mean response of each demographic question to mean response of each knowledge-based question using Proc GLIMMIX with a binary (non-normal) response and an alpha value of 0.05 in SAS 9.2 (SAS Institute, 2008, Version 9.2). GLIMMIX modeled the probability that the response equals 0 (yes). Our null hypothesis is that the explanatory variable or demographic response (Q 52, Q55, or Q56) has no effect on knowledge-based response (Q 15-36). Comparisons for each location's data were analyzed in 36 Type III F-tests of fixed effects. P-values and F statistics are reported in Tables 1.2 and 1.3 for the determination of statistical significance. If a p-value of greater than 0.05 is reported, then we fail to reject the null hypothesis, indicating that we do not have enough data to conclude that the demographic response affects the knowledge-based response. For example, a comparison of Q52 (years of experience growing) and Q23 (knowledge of how to manage a soil contaminated with lead to mitigate health risks) yielded a p-value of 1.00, which is much greater than our alpha value (0.05). We fail to reject the null hypothesis, meaning that we do not have enough evidence to conclude that the response of years of experience affects response of knowledge of BMPs for lead contaminated soils. All of our comparison analyses yielded insignificant results indicating that we do not have enough evidence to conclude that responses on years of experience, number of consumers of their produce, and percent of their diet that's grown in their plots, affect the responses to knowledge-based questions.

The number of respondents who answered the demographic questions was so few, and the responses to questions 15-36 were so homogeneous, that the analysis did not determine significant differences in responses for the different demographic groups. The differences in the comparisons do not outweigh the variability of the data, therefore no significant differences were found. No valuable results were obtained from the analysis of variance, therefore we will report only the summary statistics obtained.

Response rates

In total, 121 surveys were returned (111 from Tacoma/Seattle, WA and Kansas City, KS/MO), 50 of which were entirely complete. This response is normally considered very low, however, given the research constraints of time, funding, proximity to respondents, distribution limitations with current databases and regional contacts, and respondents hesitation to participate we believe that the responses offer a sufficient foundation for developing the intended extension program. Response rate, as defined by Wiseman (2003) is the number of completed surveys over the number of surveys distributed or eligible for completion. For our study response rates are difficult to calculate due to the selected distribution methods. We do not know the exact number of respondents contacted because survey requests were distributed by numerous individuals and organizations in each city. A total of 121 urban gardeners and farmers completed surveys, and ouroverall estimated response rate is roughly equal to 8%.

The low overall response rate requires a careful review of the potential for non-response error. Non-response error occurs when only a small portion of the population responds to the survey, which means that a large portion of the population of interest was potentially excluded from the survey results. Non-response error is an issue if there is a difference between those individuals who respond and those who do not respond. To test for non-response error it is recommended to compare the general demographic characteristics of late-respondents to early-respondents at each location (Miller and Smith, 1983), or to compare the characteristics (such as demographic information) of those that respond to those who do not respond. In our case, there are so few responses and minimal additional information about this population that we were not able to test for non-response error. The responses were received periodically over several months and therefore early- and late-respondents could not be differentiated. We will assume that non-response error has occurred in our research due to the low response rates at all location, because of this error we cannot generalize about the overall population of urban gardeners and farmers in the study locations based on the completed sample (Dooley and Lindner, 2003; Landner et al., 2001; Radhakrishna and Doamekpor, 2008; Wiseman, 2003). Based on our results, due to the low response rate and nonresponse bias, we can only make statements about the respondents themselves, not the overall populations of gardeners/farmers in these communities.

Results and Discussion

Due to the insufficient response rates from survey efforts (9 surveys were collected) in Gary, Indiana, Manhattan, Kansas, Lawrence, Massachusetts, and Cleveland, Ohio, we will not be reporting the survey results of these communities. Results from Tacoma/Seattle, Washington and Kansas City, Kansas/Missouri will be reported. Due to the small sample size, nonresponse error, and low response to demographics questions we will report on each locations results separately.

Comparisons of demographics data (fixed effects) to knowledge-based questions (random effects) were analyzed to determine the probability that a respondent will answer a knowledge-based question a particular way given a specific demographic characteristic/response. Our goal was to determine if a respondent's years of gardening/farming experience (and other demographics characteristics) are a good predictor of that respondent will answer a knowledge-based question correctly. Comparisons of demographics responses on years of experience, number of garden/farm consumers, percent of personal diet from garden/farm (Questions 52, 55, 56) to knowledge-based responses (Questions 15, 20-27, 31, 32, 36) yielded no significant correlations. This may be due to the low response rate to the demographics questions (13 responses in Kansas City, KS/MO and 30 responses in Tacoma/Seattle, WA). Therefore we cannot conclusively say whether these demographics characteristics of respondents' indicate their level of knowledge on urban soil contamination issues.

We will first discuss the demographics of the respondents from both locations. Then, we will outline respondents' experience with urban soil contamination, what they already know about urban soil contamination, what they want to know, and finally what they need to know.

Demographics

Demographics information on the surveyed individuals was collected to better identify our audience, as well as to conduct a correlation analysis with knowledge-based question results. The results presented in Table 1.4 show that most respondents (67% Kansas City, 61% Tacoma/Seattle) are between the ages of 38 and 57 years old, with a range of 25 to 68 years old. Figure 1.1 shows that participation in urban gardening tends to increase with age in these two locations until the 48-57 age group. We found that 83% of Kansas City, KS/MO and 100% of Tacoma/Seattle, WA respondents had at least a college degree or higher (Table 1.5). It may be speculated that the results of these individual demographics are evidence of nonresponse error in our survey results due to the small proportion of respondents who completed the demographics questions (40-50 respondents depending on the question) compared to the total respondents who returned the survey (111 respondents).

The results displayed in Table 1.6 show that 100% of Kansas City, KS/MO respondents and 70% of Tacoma/Seattle, WA respondents are the primary gardener or farmer of their plot and have control over gardening/farming management decisions. Almost all of Kansas City, KS/MO respondents (92%) indicated that their garden/farm plot was family/individual owned (Table 1.7). Less than half (47%) of Tacoma/Seattle, WA respondents indicated that their plot was family/individual owned, and another 47% indicated that their plot was on a community owned space. Primary gardener and owner status may be important if BMPs are to be implemented to mitigate human health risks. The results in Table 1.8 and Figure 1.2 show the size of each urban garden/farm on which respondents' grow. All Tacoma/Seattle, WA respondents reported growing on plots less than 0.1 acres in size, whereas most Kansas City, KS/MO respondents' reported growing on plots greater than 0.1 acres in size. A much greater proportion of Tacoma/Seattle respondents than Kansas City, KS/MO indicated that they grow on community plots less than 0.1 acres which may be due to the fact that the P-Patch community gardens are so prevalent throughout the Tacoma/Seattle, WA area.

Nearly all respondents at both locations reported that they primarily produce vegetables (100% Kansas City, KS/MO and Tacoma/Seattle WA) and fruits (62% Kansas City, KS/MO and 72% Tacoma/Seattle WA), with lesser numbers also producing livestock, dairy, row crops, and herbs (Table 1.9). It is important to note that most urban growers are producing vegetables because vegetables such as leafy greens and root crops often have greater quantities of soil and/or contaminants adhered to the surface than other common garden crops, and may pose a greater risk of ingestion of soil dust and/or contaminants if not handled properly.

The next two questions addressed issues of consumption of produce grown by the respondents' in urban environments. Figure 1.3 shows the percent of respondents' diet that is produced on their urban garden/farm plot. A large proportion of Tacoma/Seattle, WA respondents' (57%) indicated that only 10% of less of their diet is from what is produced in their urban plots. We could speculate that the smaller reported plot size of respondents' in Tacoma/Seattle, may result in less produce harvested and thus contributing less to their diet. The number of people consuming from respondents' urban plots, as well as the relationship of the consumers to the producers (family, friend, stranger, etc.) is an important piece of information because it could indicate how many people could potentially be impacted by any health risks associated with growing food on mildly-contaminated urban soil. Table 1.10 displays the respondents' reports on how many people consume the produce they grow. About half of respondents (54% of Kansas City, KS/MO and 47% of Tacoma/Seattle, WA) indicated that they utilize the produce grown on their urban plot within their close family and friends (less than 10 people). The other half (approximately) of respondents on both locations indicated that they give away or sell produce to more than 10 people.

Respondents' personal experiences with urban agriculture and soil contamination

The following questions were developed to assess the growers' previous personal experience with urban agriculture and urban soils contamination. More than a third (39% of Kansas City, KS/MO and 43% of Tacoma/Seattle, WA) of respondents' have less than 5 years of experience growing in an urban environment (Figure 1.4). As indicated previously, participation in urban agriculture has grown in these cities over the last ten to forty years, especially in more recent years due in part to the efforts of Cultivate KC and P-Patch Trust to create more and more urban agriculture areas in their municipalities. The higher number of novice growers in our sample may be due in part to this recent increase in participation in urban agriculture in these cities.

The data in Table 1.11 indicates that a third or more of respondents to our survey (41% of Kansas City, KS/MO and 33% of Tacoma/Seattle, WA) have encountered soil contamination of some sort during their time gardening/farming in an urban area. A greater percentage of Tacoma/Seattle respondents (35%) indicated that they didn't know if they had ever encountered soil contamination during their time gardening/farming in an urban area. Urban growers in these two communities are encountering soil contamination which is a strong indication that informational resources on BMPs when soil contamination is present may be useful. Additionally, for the proportion of respondents who were unsure about whether they had encountered soil contamination throughout their urban gardening/farming experiences informational resources on determining the presence of soil contaminants (e.g., soil testing) may be needed.

Respondents who indicated that they had encountered soil contamination throughout their work in urban agriculture were asked to identify which contaminants were present (Figure 1.5). Respondents wrote in many different answers which were grouped into like categories: lead, rubble, heavy metals, arsenic, gasoline or oil, pathogens, organic contaminants, or pesticides. A couple of these categories overlap content, however to preserve respondents' choice of terminology we have kept these categories separate. Contaminants that respondents most frequently reported encountering were lead, heavy metals, rubble, and pesticides (Figure 1.6). Figure 1.6 displays a word cloud of the respondent comments in which the most frequent respondent-reported terms are displayed in the largest fonts (Wordle, 2011). Educational and technical assistance materials created with these respondents in mind should especially contain information BMPs for soils containing those specific contaminants.

Respondents indicated how they determined the presence of those contaminants. Responses varied and included: soil testing, asking extension and EPA personnel, searching historical records, and visual observations (Table 1.12). The majority of respondents in both Kansas City, KS/MO (70%) and Tacoma/Seattle, WA (75%) indicated that they conducted soil testing or contacted the extension service for technical assistance. Respondents also indicated how they mitigated any environmental or human health risks associated with the contaminants they determined present. Answers were again variable and respondents stated the following methods: the removal of the soil, selection of different crops, raised bed production, addition of compost, stop growing on the site, wash produce, etc. (Table 1.13). These are all valid methods for determining the presence and mitigating the risks of certain contaminants in urban environments, but respondents' written responses were vague and indicated only a superficial understanding of the recommended methods. Further instruction on the technical details of methods may be of benefit to these respondents.

Respondents who indicated that they had not encountered soil contamination throughout their urban agriculture experience were asked hypothetical questions similar to the previous two experiential questions. How might you determine if a contaminant is present on a site? (Table 1.14) What precautions might you take if a contaminant was present? (Table 1.15) Most respondents that indicated they had never encountered soil contamination stated that they would conduct soil testing, contact the extension service, or search historical records to determine the presence of a contaminant (Table 1.14). However, 18% of Kansas City, KS/MO and 10% of Tacoma/Seattle, WA respondents indicated that they did not know what they should do to determine if a soil contaminant is present on their urban site. Most respondents that indicated they had never encountered soil contamination stated that they would build raised beds, select different crops, add compost, stop growing on a site, remove soil, or wash produce as precautions against any risks associated with soil contamination (Table 1.15). Sixty-seven percent of Kansas City, KS/MO and 14% of Tacoma/Seattle, WA respondents wrote that they would stop growing on the site entirely and 18% of Tacoma/Seattle, WA respondents wrote that they didn't know how to mitigate potential risks from soil contaminants.

Questions 15, 16, 17, and 18 further address the respondents personal experiences with soil contamination on the urban site on which they grow. Figure 1.7 displays the results of Question 15: I have knowledge of whether or not the soil in which I produce is contaminated. A greater number of the Kansas City, KS/MO respondents reported knowing the contamination status of their soil, whereas a greater number of the Tacoma/Seattle, WA respondents reported not knowing the contamination status of their soil. Table 1.16 displays the results of Question 18: I am aware of the historical use of the land on which I produce. The majority of both the Kansas City, KS/MO (76%) and Tacoma/Seattle, WA (68%) respondents reported knowing the historical use of the land on which they grow.

Respondents' interest in soil contamination issues

When asked what the five most vital pieces of information about farming/gardening in an urban environment that they would like to gain an understanding of to successfully operate their farm/garden, respondents wrote dozens of different answers, many unrelated to soil contamination. Responses to this question (Q1) ranged from how to keep thieves from stealing their produce and how to collect rain water from roofs, to where to send their soil for testing and how to compost food waste. The short answer responses to Q1 were categorized and tallied, and the results are displayed in Table 1.17. It was determined that five categories of interests were reported by respondents: production practices; soil health, testing, and composting; marketing and public relations issues; municipal regulations, codes, and land use; and finally contaminants in soil and water. Respondents most often reported wanting more information on production practice (crop selection, water collection, weed control, etc.) and soil health, soil testing, and composting practices (Figure 1.8).

Questions 10 through 13 asked respondents if they had interest in knowing more about soil contamination, soil testing, safe gardening on mildly contaminated soils, and urban land use. Results of these questions are displayed in Figure 1.8. Greater than 80% of respondents at both location reported that they have interest in knowing about all four of these urban soil contamination related topics. The results of this section reveal that the respondents of our survey want to know more about urban soil quality, soil contamination, soil testing, and other management issues related to growing food within cities. The majority (92.0% of Kansas City, KS/MO and 81.2% of Tacoma/Seattle, WA) indicated that they would like to know more about soil contamination specifically.

Respondents' knowledge of soil contamination issues

Respondents answered several true/false questions designed to assess their knowledge and basic understanding of urban soil contamination topics. Respondents were given the option to answer "true" or “false”, as well as “I don’t know”. We have simplified these findings to report whether the respondents answered the question correctly and know the information or answered the question incorrectly or don’t know the information. Tables 1.18 through 1.22 display the results of the “true/false”, knowledge-based questions. The results in Table 1.18 show that most of the respondents (79% of Kansas City, KS/MO and 81% of Tacoma/Seattle, WA) do not know that ingestion of soil dust is the major pathway of contaminated exposure in urban environments. The results of Table 1.19 show that a large portion of the survey respondents (67% of Kansas City, KS/MO and 77% of Tacoma/Seattle, WA) do not know which crops are more likely to accumulate common urban soil contaminants, however the results in Table 1.20 show that most respondents (83% of Kansas City, KS/MO and 81% of Tacoma/Seattle, WA) are aware that contaminants vary in how they move into and through the various tissues of crops. Many survey respondents (58% of Kansas City, KS/MO and 66% of Tacoma/Seattle, WA), correctly indicated that the handling of produce grown on urban contaminated soil can impact consumers’ risk of contaminant exposure (Table 1.21). However, results of question 20 (Table 1.22) indicate that the majority of respondents (83% of Kansas City, KS/MO and 90% of Tacoma/Seattle, WA) are not aware of the recommended handling procedures for produce grown on contaminated urban soils. Results of questions 31, 32, 33, 34 and 20 indicate that respondents may require educational and technical assistance on the exposure pathways of urban soil contaminants, as well as the proper handling procedures to reduce human consumption of soil dust and soil contaminants.

Questions 34 through 39 were also designed to assess respondents’ knowledge and basic understanding of urban soil contamination topics. Tables 1.23 through 1.26 display the results of the remaining “true/false”, knowledge-based questions of the survey. The results in Table 1.24, 1.25, and 1.26 demonstrate respondents’ knowledge about sources of urban soil contamination. Greater than 81% of respondents at both locations correctly answered questions (35, 38 and 39) indicating that they understand that the source of common urban soil contaminants may be historical or current, and may not always be visible or immediately evident.

The results of Table 1.26 demonstrate the respondents’ knowledge of remediation of contaminated soils. Approximately half of respondents (50% of Kansas City, KS and 52% of Tacoma/Seattle, WA) did not know that the addition and incorporation of compost into contaminated soil is one potential remediation method (Table 1.26). Overall respondents’ knowledge of key soil contamination concepts is highly variable; however, it is evident that respondents’ do require additional educational resources and technical assistance on remediation methods to mitigate risks associated with gardening/farming in contaminated soils.

Respondents' self-reported knowledge of soil contamination issues

The following questions (21-30) were developed to assess the growers' self-reported knowledge of soil contamination, as well as their personal confidence in their understanding of key soil contamination concepts. Although a large proportion of respondents correctly answered the knowledge-based questions (35, 38, 39) previously reported, greater than one third of respondents (35% of Kansas City, KS/MO and 41% of Tacoma/Seattle, WA) reported that they are not familiar with potential sources of contaminants in urban areas (Table 1.27). A large proportion of respondents (75% of Kansas City, KS/MO and 57% of Tacoma/Seattle, WA) confirmed their lack of knowledge on soil remediation concepts, when they indicated that there are not familiar with the soil remediation processes (Table 1.28).

Seventy-five percent of respondents at both locations indicated that they are not familiar with the concepts of bioavailable concentrations and total concentrations of soil contaminants (Figure 1.9). When asked if they were familiar with potential human health risks associated with contaminants in urban environments, a large portion of respondents (52% of Kansas City, KS/MO and 68.1% of Tacoma/Seattle, WA) reported that they were familiar with these health risks (Table 1.29)

Greater than 58% of Kansas City, KS/MO and 70% of Tacoma/Seattle, WA respondents reported that they don't know how to detect the presence of soil contaminants (Table 1.30), and nearly half of all respondents (44% of Kansas City, KS/MO and 54% of Tacoma/Seattle, WA) reported that they don't know where to send their soil samples for analysis of soil contaminants, or who to contact for assistance (Table 1.31).

Respondents were asked to report their confidence in their ability to manage a soil contaminated with lead (Pb), arsenic (As), cadmium (Cd), and organic contaminants to minimize human health risks. Overall, respondents reported that they had low confidence in their abilities to manage contaminated soils (Figure 1.10). Greater than 80% of all respondents at both locations reported that they did not have confidence in their ability to manage soil to mitigate human health risks associated with Pb, As, Cd, and organic contaminants (Table 1.32). These results indicate that the vast majority of respondents require additional informational resources and technical assistance on the BMPs for contaminated soils and for growing food crops on soil contaminated with Pb, As, Cd, and organic contaminants.

Respondent's use of informational resources on soil contamination issues

Lastly, respondents reported on their use of different resources for information on urban soil contamination issues. Question 40-52 required respondents to indicate whether they have ever used an extension agent, government resource, university resource, nonprofit organization, and/or the internet to answer their questions on urban soil, urban agricultural, or contamination. Results of these questions can be found in Tables 1.33, 1.34, 1.35, 1.36 and 1.37. The majority (greater than 68%) of all Kansas City, KS/MO respondents indicated that they had utilized all of these resources at one time or another in their work in urban gardening and farming (Figure 1.13). A large percentage of these respondents (64%) reported that the nonprofit organization was a “very useful” resource for them. A lesser percent of the Tacoma/Seattle, WA respondents reported that they had utilized each of the resources at one time or another in their work in urban agriculture and farming.

Conclusions

The urban gardeners and farmers of Kansas City, KS/MO and Tacoma/Seattle, WA who participated in our needs assessment survey have minimal knowledge of, or confidence in, their abilities to manage contaminated urban soils. These urban growers expressed interest in urban agriculture issues from water resources and city codes to soil amendments and crop selection. Although it was clear that these urban gardeners and farmers have a lot on their minds, they clearly expressed an interest in and a need for informational resources and technical assistance on urban soil contamination topics, specifically: how to determine the presence of common urban contaminants, how to soil sample in urban areas, where to send soil samples for testing, and the BMPs and protocols for gardening and farming on mildly contaminated urban soils. Information such as: soil remediation techniques, crop selection, and produce handling techniques to reduce any potential human health risks would also be beneficial information for these urban growers, as many were not knowledgeable about these topics. The internet, nonprofit organizations in the community, extension agents, and university resources are all information sources utilized by growers in these communities, and would be relevant educational avenues for extension outreach to these urban gardeners and farmers on soil contamination topics. A Kansas State University Research and Extension video was developed on the topic of urban soil testing in an effort to meet some of the informational needs mentioned previously (Harms et al., 2011).

Tables

Table 1.1 Survey questions and number identifiers.

ID	Survey questions
1	What are the five most vital pieces of information about farming/gardening in an urban environment that you would like to gain an understanding of to successfully operate your farm or garden?
2	Have you encountered soil contamination of any kind throughout your work in urban agriculture?
3	If yes, what type of contaminant was present?
4	How did you determine the presence of the contaminant?
5	What was done to minimize the risks of exposure to that contaminant?
6	Other comments?
7	If no, how might you go about determining if soil contaminants are present on a site?
8	What precautions might you take if the soil on a site is found to be contaminated?
9	Other comments?
10	I have interest in knowing more about soil contamination in urban environments.
11	Do you have interest in knowing more about soil testing?
12	Do you have interest in knowing more about safe gardening/farming on mildly contaminated urban soils?
13	Do you have interest in knowing more about urban land use?
14	Do you have interest in knowing more about any other urban soil quality topic(s)? If yes, please specify.
15	I have knowledge of whether or not the soil in which I produce is contaminated.
16	I have changed my production practices over time in response to soil contaminant concerns.
17	I know how to determine the historical use of the land on which I

produce.

18 I am aware of the historical use of the land on which I produce.

19 Individual gardening/farming practices can impact plant uptake of soil contaminants.

20 I am aware of the proper handling recommendations for produce grown in contaminated environments.

21 I am familiar with the difference between the total concentration and the bioavailable concentration of a contaminant.

22 I know how to detect the presence of soil contaminants in an urban environment.

23 If my soil were determined to be contaminated with lead, I feel confident that I would know how to manage my soil to minimize health risks.

24 If my soil were determined to be contaminated with arsenic, I feel confident that I would know how to manage my soil to minimize health risks.

25 If my soil were determined to be contaminated with cadmium, I feel confident that I would know how to manage my soil to minimize health risks.

26 If my soil were determined to be contaminated with an organic contaminant, I feel confident that I would know how to manage my soil to minimize health risks.

27 I know where to send my soil samples for analysis (or who to contact for assistance) if I suspected contamination.

28 I am familiar with the potential sources of contamination in urban environments.

29 I am aware of the potential risks to human health of the various contaminants commonly found in urban environments.

30 I am familiar with the process of soil remediation.

31 Ingestion of soil dust is the major pathway of soil contaminant exposure in urban environments.

32 Fruiting crops, such as tomatoes and peppers, tend to absorb more contaminants from the soil than leafy vegetables, such as lettuce.

33 Food handling can impact the amount of soil dust and soil contaminants that are ingested by the producer and consumer of urban produce.

34 Contaminants vary in how they move into and through different crops' roots, shoots, and fruits.

35 Historical and current pesticide use can contaminate soils and pose risk to human health.

36 One method of soil remediation is the addition and incorporation of compost material into the contaminated soil.

37 Contaminants such as lead can be eliminated from the soil after one or two growing seasons through the process of phytoremediation.

38 Sources of soil contaminants in a site could be current, historical, direct and/or indirect sources.

39 Contaminants and their sources can always be observed without soil testing at an urban site.

40 In the time that you have been involved in urban agriculture, have you ever used an extension agent as a source of information on urban agriculture/soil?

41 How useful was this source of information to you in your decision making process?

42 In the time that you have been involved in urban agriculture, have you ever used government resources as a source of information on urban agriculture/soil?

43 How useful was this source of information to you in your decision making process?

44 In the time that you have been involved in urban agriculture, have you ever used university resources as a source of information on urban agriculture/soil?

45 How useful was this source of information to you in your decision making process?

46 In the time that you have been involved in urban agriculture, have you ever used a nonprofit organization as a source of information on urban agriculture/soil?

47 How useful was this source of information to you in your decision making process?

48 In the time that you have been involved in urban agriculture, have you ever used the internet as a source of information on urban agriculture/soil?

49 How useful was this source of information to you in your decision making process?

50 In the time that you have been involved in urban agriculture, have you ever used any other resources as sources of information on urban agriculture/soil?If yes, please specify in the text box below.

51 How useful was this source of information to you in your decision making process?

52 How many years have you been gardening/farming in the urban environment?

53 What crops do you produce?

54 How big is the plot on which you grow?

55 How many people consume from your garden/farm? Please select one category that best describes your situation.

56 Approximately what percent of your household food consumption is from your own production?

57 Which category best describes how the urban garden/farm in which you produce is organized? Please select a single category that best describes your role.

58 Which category best describes your involvement with the garden/farm in which you produce? Please select a single category that best describes your role.

59 What is the five digit zip-code of the urban garden/farm in which you produce?

60 What is your age?

61 What is the highest level of education you have completed?

Table 1.2 P-values of correlations of demographics responses and knowledge responses from Kansas City, KS/MO respondents.

	Kansas City, KS/MO					
Question	**52**		**55**		**56**	
	F Value	Pr>F	F Value	Pr>F	F Value	Pr>F
15	0.00	1.0000	0.00	0.9870	0.00	1.0000
20	0.00	1.0000	0.00	0.9890	0.00	1.0000
21	0.00	1.0000	0.00	0.9755	0.00	0.9998
22	0.00	1.0000	0.00	0.9833	0.00	0.9999
23	0.00	1.0000	0.00	0.9890	0.00	1.0000
24	0.00	1.0000	0.00	1.0000	0.00	1.0000
25	0.00	1.0000	0.00	1.0000	0.00	1.0000
26	0.00	1.0000	0.00	1.0000	0.00	1.0000
27	0.00	1.0000	0.00	0.9870	0.00	1.0000
31	0.00	1.0000	0.00	1.0000	0.00	0.9999
32	0.00	1.0000	0.00	0.9870	0.00	1.0000
36	0.00	1.0000	0.00	0.9870	0.00	1.0000

Table 1.3 P-values of correlations of demographics responses and knowledge responses from Tacoma/Seattle, WA respondents.

	Tacoma/Seattle, WA					
Questions	52		55		56	
	F Value	Pr>F	F Value	Pr>F	F Value	Pr>F
15	0.16	0.9565	1.58	0.2222	0.07	0.9323
20	0.19	0.9400	1.34	0.2601	0.03	0.9670
21	0.00	1.0000	1.01	0.3255	0.00	0.9998
22	0.46	0.7671	0.57	0.4602	0.31	0.7394
23	0.30	0.8770	0.00	0.9640	0.05	0.9548
24	0.00	1.0000	0.00	0.9859	0.00	1.0000
25	0.00	1.0000	0.00	0.9855	0.00	0.9998
26	0.00	1.0000	0.81	0.3785	0.00	0.9998
27	0.56	0.6913	0.42	0.5227	1.56	0.2325
31	0.66	0.6265	0.00	0.9678	0.40	0.6726
32	0.26	0.9011	0.00	0.9639	0.12	0.8840
36	0.06	0.9930	1.01	0.3253	0.00	0.9958

Table 1.4 Age distribution of respondents.

Q60: What is your age?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Age (years)	Response Percent	Response Count	Response Percent	Response Count
18-37	25.0	7	16.7	2
38-57	60.7	17	66.7	8
Greater than 58	14.3	4	16.7	2
answered question		28		12
skipped question		53		18

Table 1.5 Educational level of respondents.

Q61: What is the highest level of education you have completed?

Educational level	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Less than a high school degree	0.0	0	0.0	0
High school diploma	0.0	0	16.7	2
Some college	0.0	0	0.0	0
College degree	64.3	18	75.0	9
Graduate degree	35.7	10	8.3	1
answered question		28		12
skipped question		53		18

Table 1.6 Involvement of respondents.

Q58: Which category best describes your involvement with the garden/farm in which you produce?				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Primary gardener/farmer; Control garden/farm management	70.0	21	100.0	12
Assist with garden/farm; Do not control garden/farm management	30.0	9	0.0	0
answered question		30		12
skipped question		51		18

Table 1.7 Ownership and organization of respondents' plot.

Q57: Which category best describes how the urban garden/farm in which you produce is organized?

Ownership	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Family or individually owned	46.7	14	92.3	12
Community or neighborhood	46.7	14	0.0	0
Nonprofit	3.3	1	7.7	1
Corporate	3.3	1	0.0	0
Other	0.0	0	0.0	0
answered question		30		13
skipped question		51		17

Table 1.8 Respondents' plot size.

Q54: How big is the plot on which you grow?

Plot size	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Less than 20ft x 20ft	53.3	16	23.1	3
20ft x 20ft to 30ft x 30ft	20.0	6	0.0	0
30ft x 30ft to 0.1 acre	26.7	8	15.4	2
Greater than 0.1 acre	0.0	0	61.5	8
answered question		30		13
skipped question		51		7

Table 1.9 Respondents' crop production .

Q53: What do you produce in your garden/farm?

Crop	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Fruits	72.4	21	61.5	8
Vegetables	100.0	29	100.0	13
Row crops	24.1	7	15.4	2
Livestock	13.8	4	30.8	4
Dairy	0.0	0	0.0	0
answered question		29		13
skipped question		52		17

Table 1.10 Number of consumers from respondents' plot.

Q55: How many people consume from your garden/farm?

Consumers	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Self only	11.8	2	15.4	2
Self and family; Less than 10 people	35.3	6	38.5	5
Self, family, and friends; More than 10 people	41.2	7	15.4	2
Any of the above and CSA or Famers Market	11.8	2	30.8	4
answered question		17		13
skipped question		64		17

Table 1.11 Respondents' personal experience with soil contamination.

Q2: Have you encountered soil contamination of any kind throughout your work in urban agriculture?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answers	Response Percent	Response Count	Response Percent	Response Count
Yes	32.5	26	40.7	11
No	32.5	26	44.4	12
I don't know	35.0	28	14.8	4
answered question		80		23
skipped question		1		7

Table 1.12 Respondents' methods for determining the presence of soil contaminants.

Q4: How did you determine the presence of the contaminant?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answers	Response Percent	Response Count	Response Percent	Response Count
Soil testing	75.0	8	40.0	8
Extension Services	20.0	4	30.0	3
Historical records	10.0	3	20.0	2
I don't know	10.0	2	0.0	0
Other	10.0	2	0.0	0
Observation	0.0	2	0.0	0
EPA	0.0	1	20.0	2
answered question		23		10
skipped question		3		1

Table 1.13 Respondents' methods for mitigating risks associated with contaminants present.

Q5: What was done to minimize the risks of exposure to that contaminant?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answers	Response Percent	Response Count	Response Percent	Response Count
Removed the soil/material of concern	26.1	6	0.0	0
Selected different crops	21.7	5	22.2	2
Built raised beds	17.4	4	22.2	2
Stopped growing on the site	8.7	2	33.3	3
Added compost	8.7	2	33.3	3
Washed the produce	8.7	2	0.0	0
Concentration was not of concern	8.7	2	11.1	1
answered question		23		9
skipped question		3		2

Table 1.14 Respondents' methods for determining the presence of a hypothetical soil contaminant.

Q7: If no, how might you go about determining if soil contaminants are present on a site?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answers	Response Percent	Response Count	Response Percent	Response Count
Soil testing	75.0	15	54.6	6
University Extension	20.0	4	27.3	3
Historical records	10.0	2	27.3	3
I don't know	10.0	2	18.2	2
Other	10.0	2	9.1	1
answered question		25		11
skipped question		1		1

Table 1.15 Respondents' hypothetical methods for mitigating risks associated with soil contaminants.

Q8: What precautions might you take if the soil on a site is found to be contaminated?				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answers	Response Percent	Response Count	Response Percent	Response Count
Build raised beds	27.3	6	22.2	2
I don't know	18.2	4	0.0	0
Select different crops	13.6	3	11.1	1
Add compost	13.6	3	33.3	3
Stop growing on the site	13.6	3	66.7	6
Bioremediation	9.1	2	11.1	1
Wash the produce	9.1	2	0.0	0
Remove the soil/material of concern	4.6	1	0.0	0
answered question		22		9
skipped question		4		3

Table 1.16 Respondents' knowledge of the historical use of the land on which they produce.

Q18: I am aware of the historical use of the land on which I produce.

Answer	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Yes	67.6	48	76.0	19
No	32.4	23	24.0	6
answered question		71		25
skipped question		10		5

Table 1.17 Most vital informational needs reported by respondents.

Q1: What are the five most vital pieces of information about farming/gardening in an urban environment that you would like to gain an understanding of to successfully operate your farm or garden?

Common Written Responses	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Count
Production practices	36	161
Soil health, testing, composting	19	66
Marketing and public relations	9	35
Regulations, codes, land use	17	23
Contaminants in soil and water	11	7
answered question	69	24
skipped question	12	6

Table 1.18 Respondents' knowledge of exposure pathways on urban soil contaminants.

Q31: Ingestion of soil dust is the major pathway of soil contaminant exposure in urban environments. Correct response: True

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer	Response Percent	Response Count	Response Percent	Response Count
Correct response	18.8	13	20.8	5
Incorrect response or I don't know	81.2	56	79.2	19
answered question		69		24
skipped question		12		6

Table 1.19 Respondents' knowledge of crop uptake of urban soil contaminants.

Q32: Fruiting crops, such as tomatoes and peppers, tend to absorb more contaminants from the soil than leafy vegetables, such as lettuce. Correct response: False

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer	Response Percent	Response Count	Response Percent	Response Count
Correct response	23.2	16	33.3	8
Incorrect response or I don't know	76.8	53	66.7	16
answered question		69		24
skipped question		12		6

Table 1.20 Respondents' knowledge of crop uptake and transport of soil contaminants.

Q34: Contaminants vary in how they move into and through different crops roots, shoots, and fruits. Correct response: True

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Correct response	85.1	57	83.3	20
Incorrect response or I don't know	14.9	10	16.7	4
answered question		67		24
skipped question		14		6

Table 1.21 Respondents' knowledge of the impacts of produce handling on soil contaminant exposure of consumers.

Q33: Food handling can impact the amount of soil dust and soil contaminants that are ingested by the producer and consumer of urban produce. Correct response: True

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer	Response Percent	Response Count	Response Percent	Response Count
Correct response	66.2	45	58.3	14
Incorrect response or I don't know	33.8	23	41.7	10
answered question		68		24
skipped question		13		6

Table 1.22 Respondents' knowledge of the proper handling recommendations for produce grown in contaminated soils.

Q20: I am aware of the proper handling recommendations for produce grown in contaminated environments.

Answer	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Yes	10.1	7	16.7	4
No	89.9	62	83.3	20
answered question		69		24
skipped question		12		6

Table 1.23 Respondents' knowledge of historical and current contaminant sources.

Q35: Historical and current pesticide use can contaminate soils and pose risk to human health. Correct response: True

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Correct response	95.5	64	100.0	24
Incorrect response or I don't know	4.5	3	0.0	0
answered question		67		24
skipped question		14		6

Table 1.24 Respondents' knowledge of persistence of urban soil contaminants.

Q38: Sources of soil contaminants in a site could be current, historical, direct and/or indirect sources. Correct response: True

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Correct response	95.5	64	91.7	22
Incorrect response or I don't know	4.5	3	8.3	2
answered question		67		24
skipped question		14		6

Table 1.25 Respondents' knowledge of visual detection of soil contaminants.

Q39: Contaminants and their sources can always be observed without soil testing at an urban site. Correct response: False

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Correct response	80.6	54	91.7	22
Incorrect response or I don't know	19.4	13	8.3	2
answered question		67		24
skipped question		14		6

Table 1.26 Respondents' knowledge of compost additions as a remediation method for contaminated soils.

Q36: One method of soil remediation is the addition and incorporation of compost material into the contaminated soil. Correct response: True

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Correct response	47.8	32	50.0	12
Incorrect response or I don't know	52.2	35	50.0	12
answered question		67		24
skipped question		14		6

Table 1.27 Respondents' reported familiarity with the potential sources of contamination in urban environments.

Q28: I am familiar with the potential sources of contamination in urban environments.				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	59.4	41	65.2	15
No	40.6	28	34.8	8
answered question		69		23
skipped question		12		7

Table 1.28 Respondents' reported familiarity with the process of soil remediation.

Q30: I am familiar with the process of soil remediation.				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	43.3	29	25.0	6
No	56.7	38	75.0	18
answered question		67		24
skipped question		14		6

Table 1.29 Respondents' reported awareness of the potential risks to human health of urban soil contaminants.

Q29: I am aware of the potential risks to human health of the various contaminants commonly found in urban environments.				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	68.1	47	52.2	12
No	31.9	22	47.8	11
answered question		69		23
skipped question		12		7

Table 1.30 Respondents' reported knowledge of how to detect urban soil contaminants.

Q22: I know how to detect the presence of soil contaminants in an urban environment.

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Yes	29.6	21	41.7	10
No	70.4	50	58.3	14
answered question		71		24
skipped question		10		6

Table 1.31 Respondents' reported knowledge of where to send soil samples for analysis if they suspected the presence of contaminants.

Q27: I know where to send my soil samples for analysis (or who to contact for assistance) if I suspected contamination.

Answer Options	Tacoma/Seattle, WA Response Percent	Tacoma/Seattle, WA Response Count	Kansas City, KS/MO Response Percent	Kansas City, KS/MO Response Count
Yes	46.4	32	56.5	13
No	53.6	37	43.5	10
answered question		69		23
skipped question		12		7

Table 1.32 Respondents' reported confidence in their personal ability to manage soil contaminated with lead (Pb), arsenic (As), cadmium (Cd), and organic contaminants to mitigate potential human health risks.

Q23: If my soil were determined to be contaminated with the following contaminants, I feel confident that I would know how to manage my soil to minimize health risks.

Lead (Pb)

	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Yes	13	9	12.5	3
No	87	60	87.5	21
	answered question	69		24
	skipped question	12		6

Arsenic (As)

	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Yes	10.3	7	12.5	3
No	89.7	61	87.5	21
	answered question	68		24
	skipped question	13		6

Cadmium (Cd)

	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Yes	6.1	4	12.5	3
No	93.9	62	87.5	21
	answered question	66		24
	skipped question	15		6

Organic contaminants

	Tacoma/Seattle, WA		Kansas City, KS/MO	
	Response Percent	Response Count	Response Percent	Response Count
Yes	13.6	9	20.8	5
No	86.4	57	79.2	19
	answered question	66		24
	skipped question	15		6

Table 1.33 Respondents' reported use of extension agents as informational resources on urban soil contamination issues.

Q40: In the time that you have been involved in urban agriculture, have you ever used an extension agent as a source of information on urban agriculture/soil?				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	42.6	29	79.2	19
No	57.4	39	20.8	5
answered question		67		24
skipped question		14		6

Q41: How useful was this source of information to you in your decision making process?				
	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Not useful	0.0	0	0.0	0
Limited usefulness	7.4	2	11.1	2
Somewhat useful	33.3	9	50.0	9
Very useful	59.3	16	38.9	7
answered question		27		18
skipped question		2		1

Table 1.34 Respondents' reported use of government resources as informational resources on urban soil contamination issues.

Q42: In the time that you have been involved in urban agriculture, have you ever used government resources as a source of information on urban agriculture/soil?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	37.3	22	68.4	13
No	62.7	37	31.6	6
answered question		59		19
skipped question		22		11

Q43: How useful was this source of information to you in your decision making process?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Not useful	0.0	0	8.3	1
Limited usefulness	9.5	2	25.0	3
Somewhat useful	23.8	5	41.7	5
Very useful	66.7	14	33.3	4
answered question		21		12
skipped question		1		1

Table 1.35 Respondents' reported use of university resources as informational resources on urban soil contamination issues.

Q44: In the time that you have been involved in urban agriculture, have you ever used university resources as a source of information on urban agriculture/soil?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	44.6	25	68.4	13
No	55.4	31	31.6	6
answered question		56		19
skipped question		25		11

Q45: How useful was this source of information to you in your decision making process?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Not useful	0.0	0	0.0	0
Limited usefulness	0.0	0	8.3	1
Somewhat useful	34.8	8	50.0	6
Very useful	65.2	15	41.7	5
answered question		23		12
skipped question		2		1

Table 1.36 Respondents' reported use of nonprofit organizations as informational resources on urban soil contamination issues.

Q46: In the time that you have been involved in urban agriculture, have you ever used a nonprofit organization as a source of information on urban agriculture/soil?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	58.0	29	88.2	15
No	42.0	21	11.8	2
answered question		50		17
skipped question		31		13

Q47: How useful was this source of information to you in your decision making process?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Not useful	0.0	0	0.0	0
Limited usefulness	0.0	0	7.1	1
Somewhat useful	20.7	6	28.6	4
Very useful	79.3	23	64.3	9
answered question		29		14
skipped question		0		1

Table 1.37 Respondents' reported use of the internet as an informational resource on urban soil contamination issues.

Q48: In the time that you have been involved in urban agriculture, have you ever used the internet as a source of information on urban agriculture/soil?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Yes	85.4	41	88.9	16
No	14.6	7	11.1	2
	answered question	48		18
	skipped question	33		12

Q49: How useful was this source of information to you in your decision making process?

	Tacoma/Seattle, WA		Kansas City, KS/MO	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Not useful	0.0	0	0.0	0
Limited usefulness	10.3	4	14.3	2
Somewhat useful	48.7	19	28.6	4
Very useful	41.0	16	57.1	8
	answered question	39		14
	skipped question	2		2

Figures

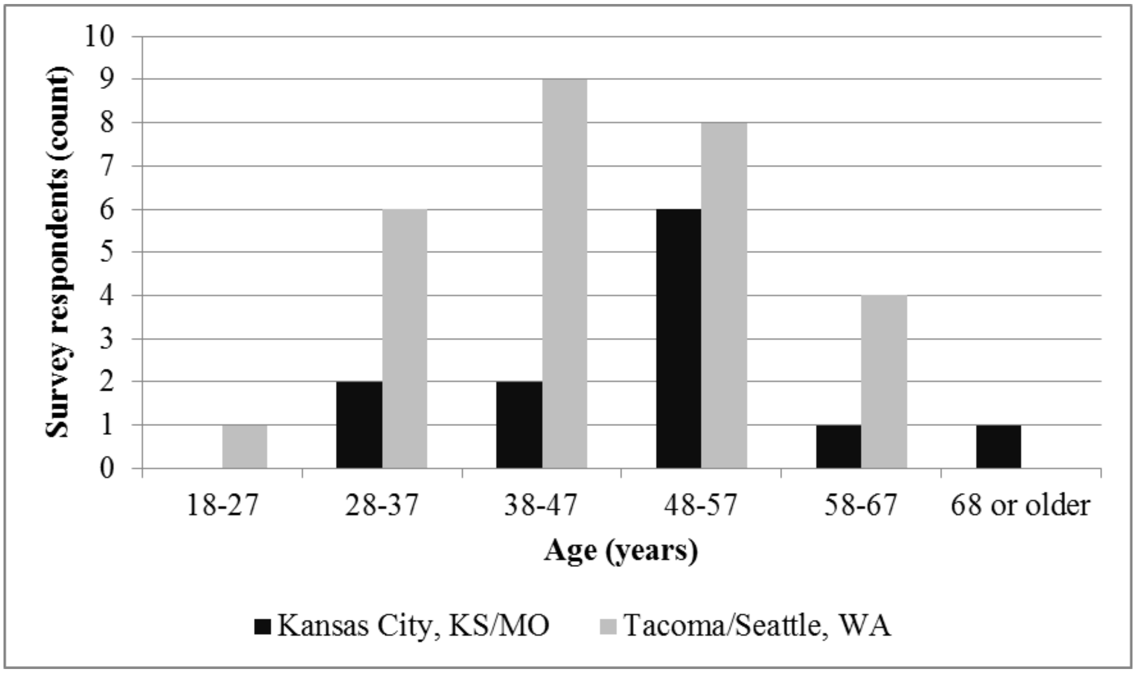

Figure 1.1 Age distribution of respondents (Question 60).

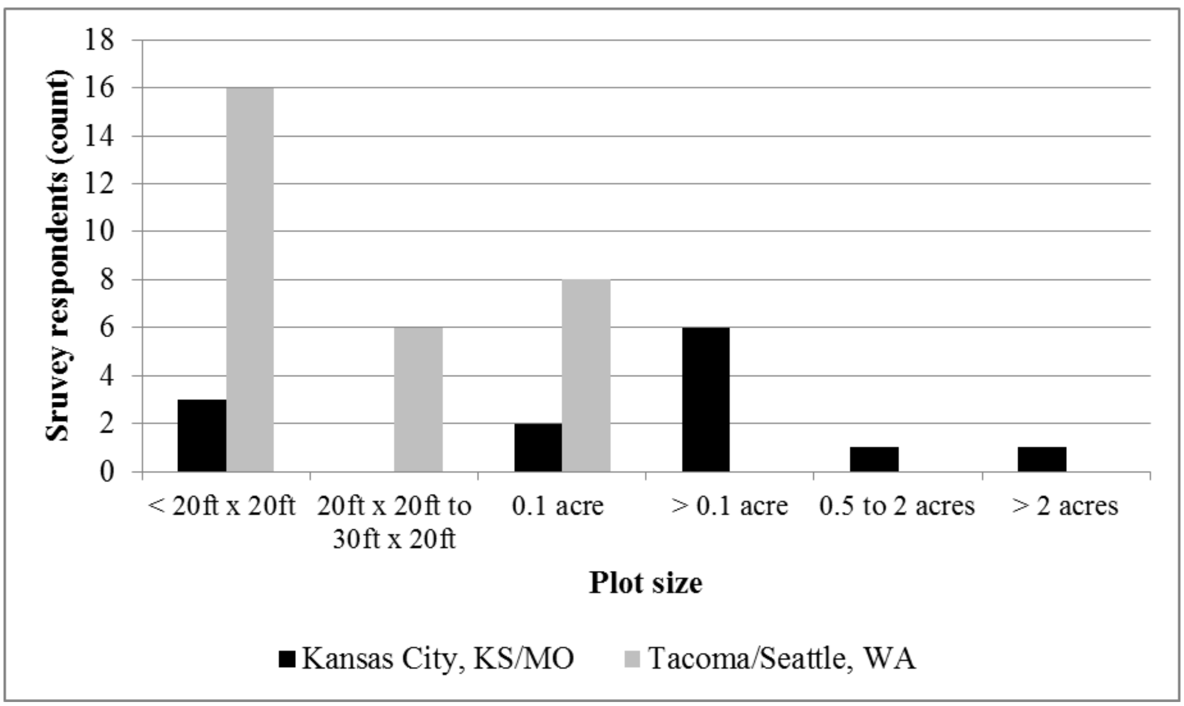

Figure 1.2 Respondents' plot size (Question 54).

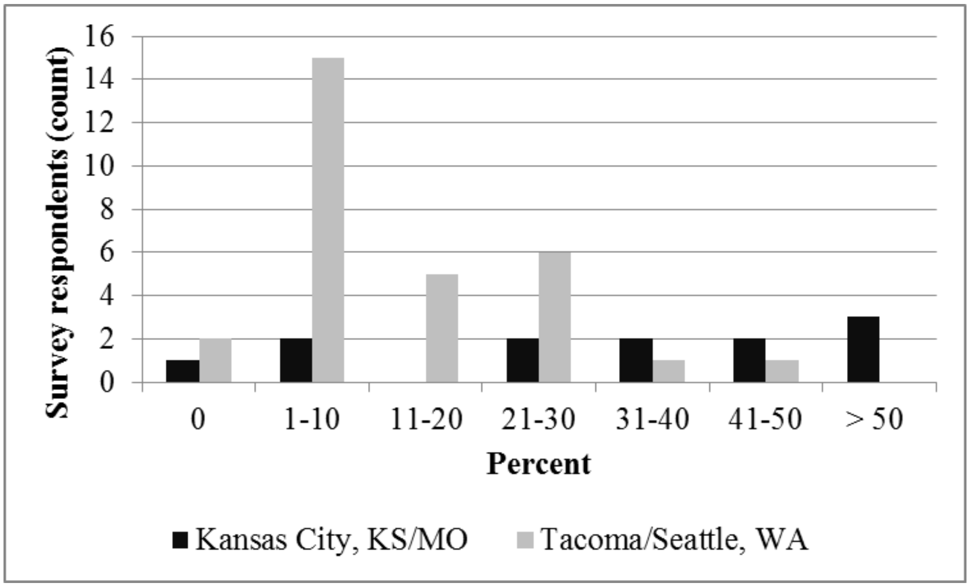

Figure 1.3 Percentage of respondents' diet that is produced on their urban garden/farm plot (Question 56).

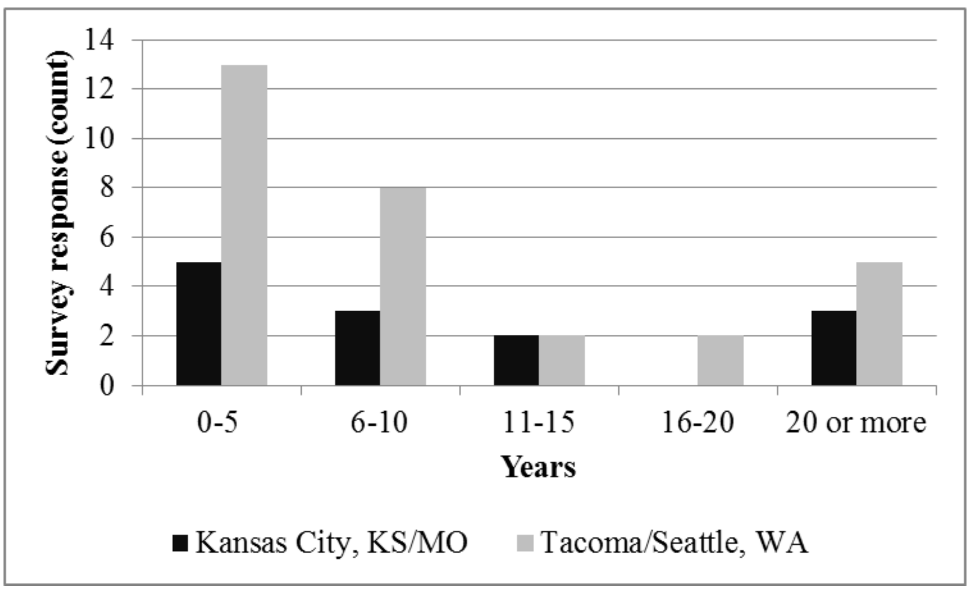

Figure 1.4 Respondents' years of urban agriculture experience (Question 52).

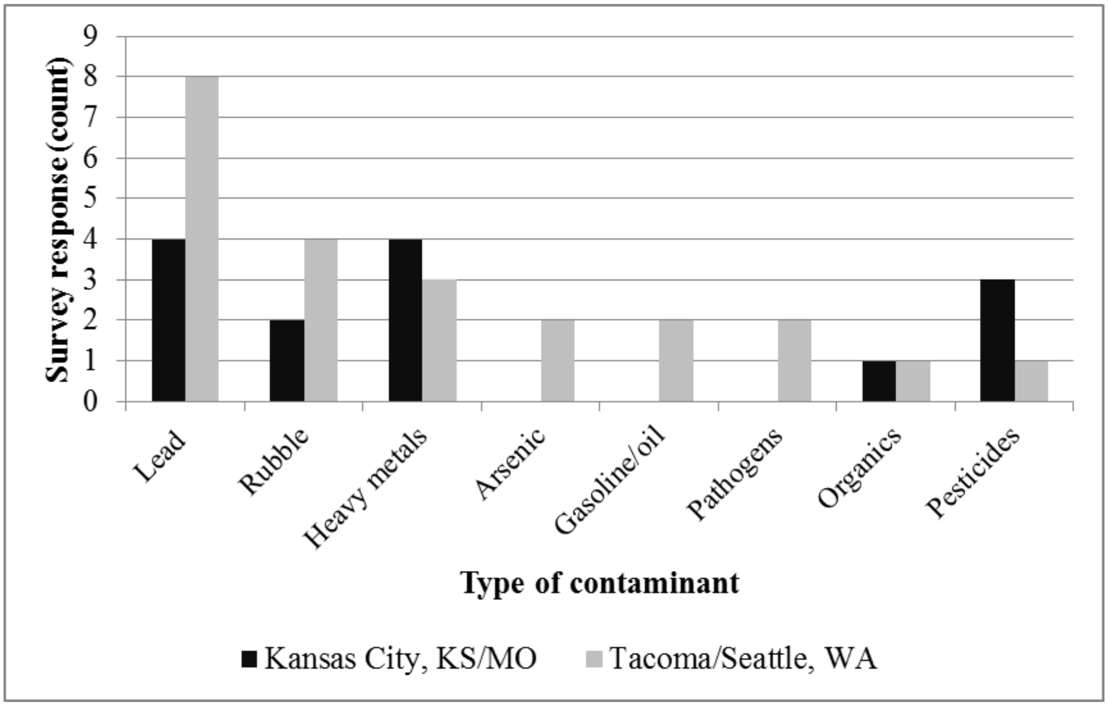

Figure 1.5 Types of contaminants respondents have encountered (Question 3).

Figure 1.6 Respondents' written comments on the contaminants they have encountered during their work in urban agriculture.

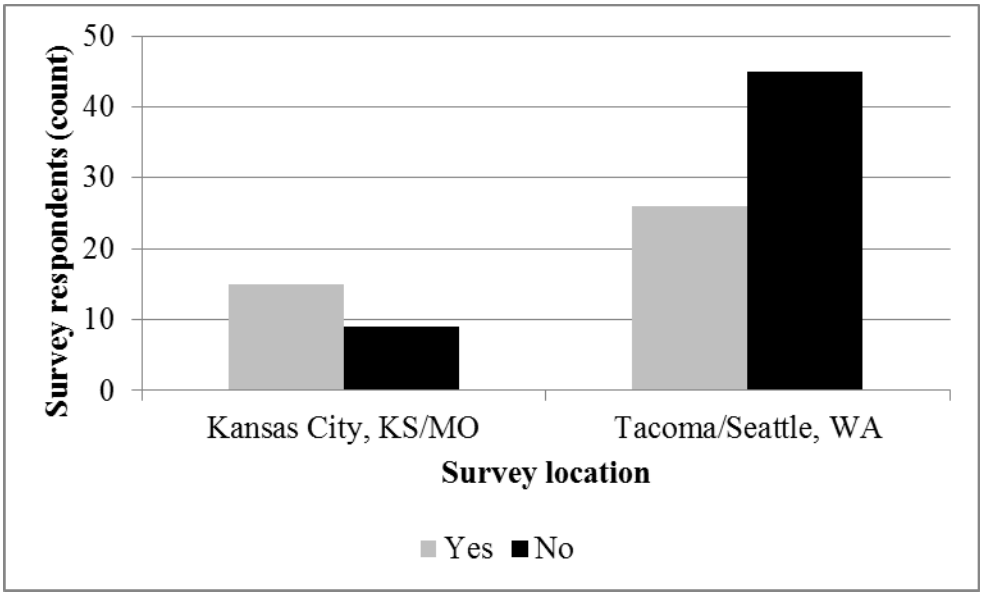

Figure 1.7 Respondents' reported knowledge of whether or not the soil in which they produce is contaminated (Question 15).

Figure 1.8 Respondents' written comments on the five most vital pieces of information they need to be more successful at gardening or farming in urban areas.

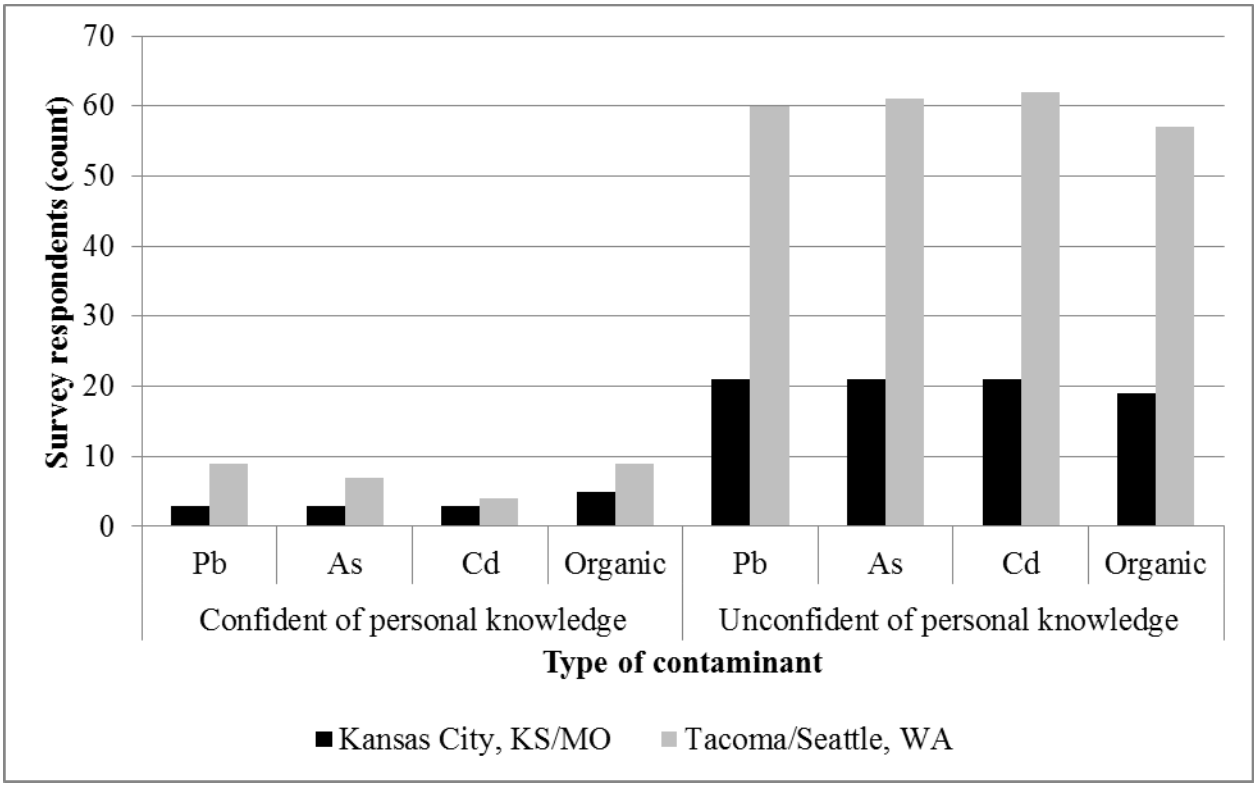

Figure 1.9 Respondents' reported confidence in their knowledge of how to manage soil to minimize human health risks associated with soil contamination by lead (Pb), arsenic (As), cadmium (Cd), and organic compounds (Questions 23-26).

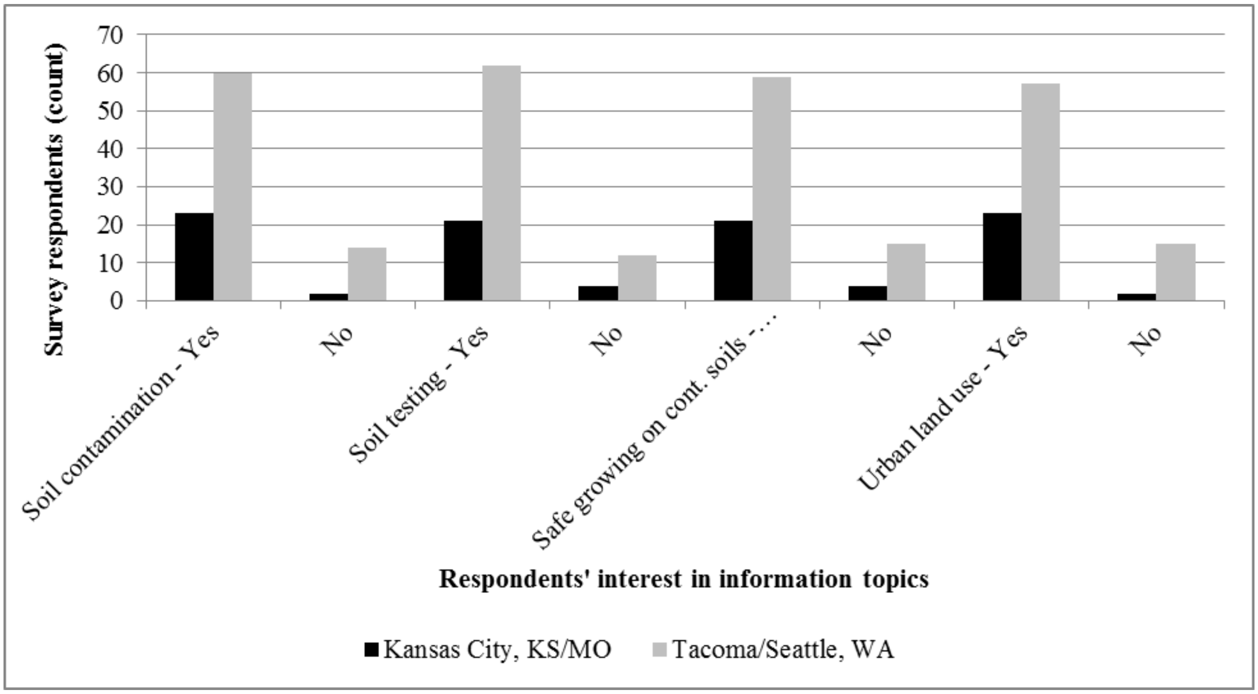

Figure 1.10 Respondents' reported interest in informational topics related to urban soil contamination (Question 1).

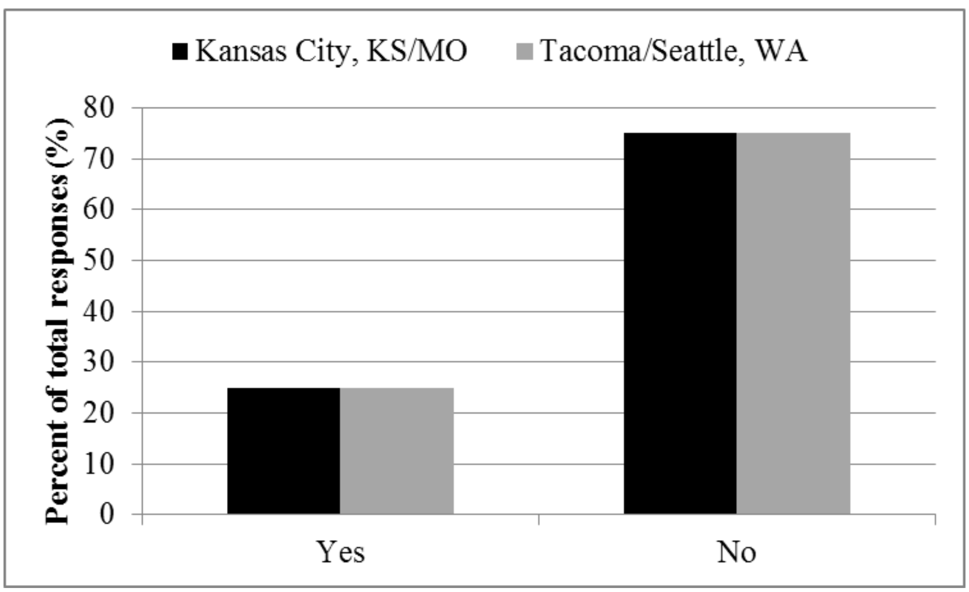

Figure 1.11 Respondents' reported familiarity with the concepts of total concentration and the bioavailable concentration of a contaminant.

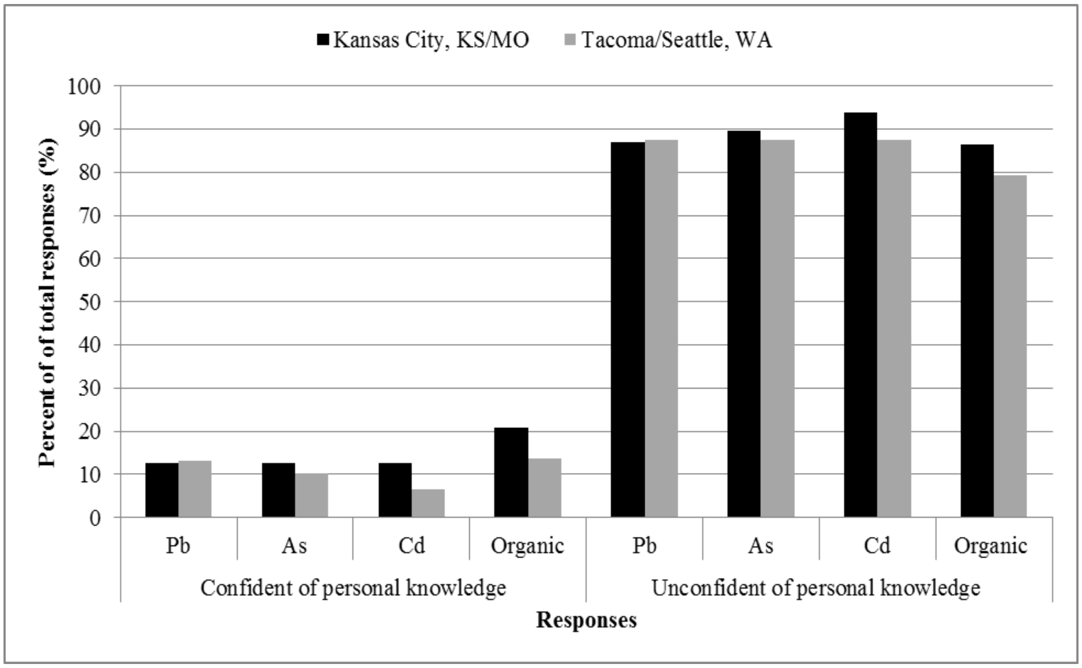

Figure 1.12 Respondents' reported confidence in their ability to manage soil contaminated by lead (Pb), arsenic (As), cadmium (Cd), and organic contaminants to mitigate potential human health risks.

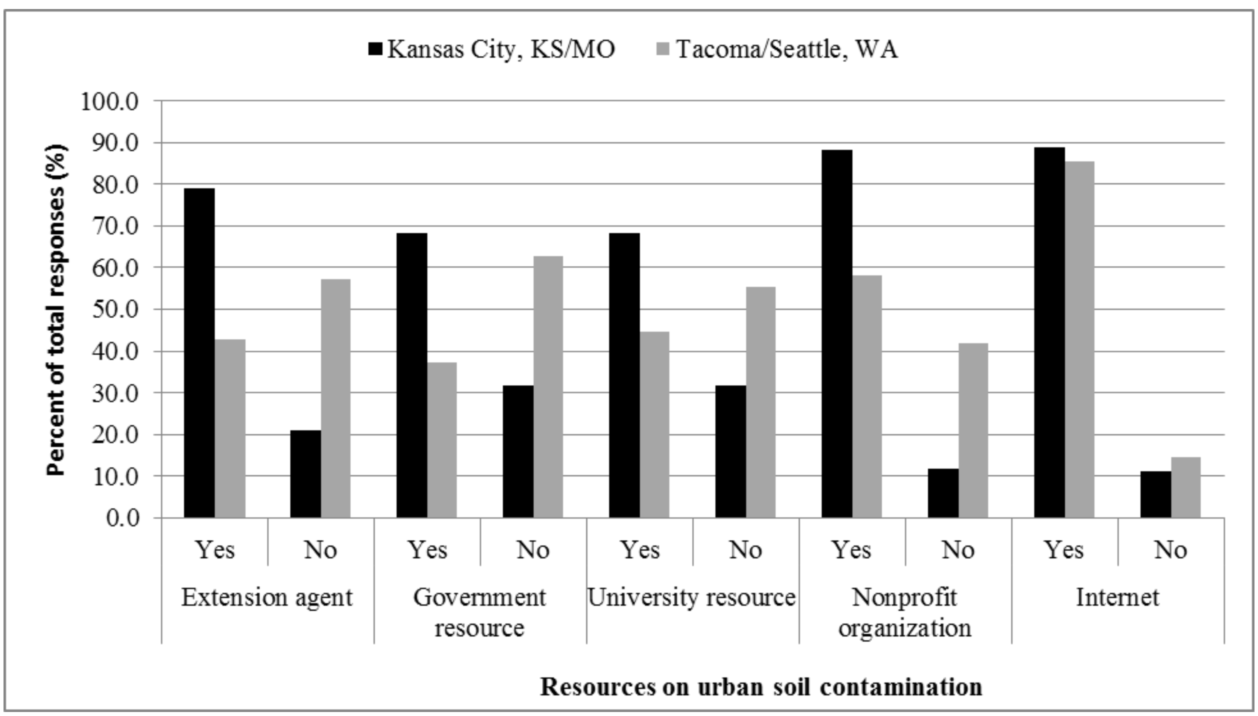

Figure 1.13 Respondents' reported use of resources on urban soil contamination issues.

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Appendix A

Example paper copy of the needs assessment survey of urban gardeners and farmers

DEAR URBAN GARDENER/FARMER,

Thank you for participating in our urban agriculture project survey. We want to understand you as an urban farmer/gardener and what you want to know more about in urban agriculture so that we can provide you and other urban gardeners and farmers with beneficial information in the future. This information will be used for a Master's thesis project and in the development of written and web materials for urban farmers/gardeners. Please take a few minutes to carefully complete our survey.

Your participation in this survey is strictly voluntary. If there are any questions that make you uncomfortable, please feel free to skip those questions. All of your answers are strictly confidential and will not be individually associated with you as a respondent. Please feel free to write any additional comments to the questions in the spaces provided or within the blank margins. All of your comments will be read and taken into account.

Upon completion of this survey, please place the survey into the stamped, self-addressed envelope. We anticipate that it will take 15 minutes to complete.

THANK YOU!

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Q1: What are the five most vital pieces of information about farming/gardening in an urban environment that you would like to gain an understanding of to successfully operate your farm or garden?

1 ______________________________

2 ______________________________

3 ______________________________

4 ______________________________

5 ______________________________

Q2: Other urban gardeners and farmers have expressed concern and interest in the following urban soil quality topics. Which of the following topics would you most benefit from knowing more about?

I have interest in knowing more about:			**Please specify**
Soil contamination in urban environments	☐ Yes	☐ No	
Soil testing	☐ Yes	☐ No	
Safe gardening/farming on mildly contaminated urban soils	☐ Yes	☐ No	
Urban land use	☐ Yes	☐ No	
Other	☐ Yes	☐ No	
Other	☐ Yes	☐ No	
Other	☐ Yes	☐ No	

Q3: For the following question please answer “Yes” or “No” to each of the statements. Please answer as honestly as possible. This is not a judgment of your gardening/farming abilities, but rather it will assist us in determining future informational needs.

1	I have knowledge of whether or not the soil in which I produce is contaminated.	☐ Yes	☐ No
2	I have changed my production practices over time in response to soil contaminant concerns.	☐ Yes	☐ No
3	I know how to determine the historical use of the land on which I produce.	☐ Yes	☐ No
4	I am aware of the historical use of the land on which I produce.	☐ Yes	☐ No
5	Individual gardening/farming practices can impact plant uptake of soil contaminants.	☐ Yes	☐ No
6	I am aware of the proper handling recommendations for produce grown in contaminated environments.	☐ Yes	☐ No
7	I am familiar with the difference between the total concentration and the bioavailable concentration of a contaminant.	☐ Yes	☐ No
8	I know how to detect the presence of soil contaminants in an urban environment.	☐ Yes	☐ No
9	If my soil were determined to be contaminated with lead, I feel confident that I would know how to manage my soil to minimize health risks.	☐ Yes	☐ No
10	If my soil were determined to be contaminated with arsenic, I feel confident that I would know how to manage my soil to minimize health risks.	☐ Yes	☐ No
11	If my soil were determined to be contaminated with cadmium, I feel confident that I would know how to manage my soil to minimize health risks.	☐ Yes	☐ No
12	If my soil were determined to be contaminated with an organic contaminant, I feel confident that I would know how to manage my soil to minimize health risks.	☐ Yes	☐ No
13	I know where to send my soil samples for analysis (or who to contact for assistance) if I suspected contamination.	☐ Yes	☐ No
14	I am familiar with the potential sources of contamination in urban environments.	☐ Yes	☐ No

Q4: Have you encountered soil contamination of any kind throughout your work in urban agriculture?

- ☐ Yes *If yes*, what type of contaminant was present?

  How did you determine the presence of the contaminant?

  What was done to minimize the risks?

  Other comments?

- ☐ No *If no*, how might you go about determining if soil contaminants are present on a site?

  What precautions might you take if the soil on a site is found to be contaminated?

  Other comments?

Q5. Please answer the following questions about soil contamination. The following questions are not a judgment of your gardening/farming abilities, but will assist us in developing future informational materials to benefit urban agriculturalists.

If you do not know the answer please do not guess, but mark the "I don't know" category.

Indicate whether the following statements are true or false.

1 Ingestion of soil dust is the major pathway of soil contaminant exposure in urban environments.

- ☐ True
- ☐ False
- ☐ I don't know.

2 Fruiting crops, such as tomatoes and peppers, tend to absorb *more* contaminants from the soil than leafy vegetables, such as lettuce.

- ☐ True
- ☐ False
- ☐ I don't know.

3 Food handling can impact the amount of soil dust and soil contaminants that are ingested by the producer and consumer of urban produce.

- ☐ True
- ☐ False
- ☐ I don't know.

4 Contaminants vary in how they move into and through different crops' roots, shoots, and fruits.

- ☐ True
- ☐ False
- ☐ I don't know.

5 Historical and current pesticide use can contaminate soils and pose risk to human health.

6 One method of soil remediation is the addition and incorporation of compost material into the contaminated soil.

- ☐ True
- ☐ False
- ☐ I don't know.

7 Contaminants such as lead can be eliminated from the soil after one or two growing seasons through the process of phytoremediation.

- ☐ True
- ☐ False
- ☐ I don't know.

8 Sources of soil contaminants in a site could be current, historical, direct and/or indirect sources.

- ☐ True
- ☐ False
- ☐ I don't know.

9 Contaminants and their sources can always be observed without soil testing at an urban site.

- ☐ True
- ☐ False
- ☐ I don't know.

Q6: Listed below are several sources of information for urban farmers and gardeners. In the time that you have been involved in urban agriculture, which of these resources have you utilized to answer your questions about urban agriculture issues? If you have used any of these resources, please indicate how useful it was for your decision making process.

Source	**Have you used these sources?**		**Usefulness of these sources?**			
Extension agents	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful
Government resources	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful
University resources	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful
Nonprofit organizations	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful
Internet	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful
Other:	☐ Yes	☐ No	☐ Not useful	☐ Limited usefulness	☐ Somewhat useful	☐ Very Useful

ABOUT YOU

Q7: How many years have you been gardening/farming in the urban environment?

_____ years.

Q8: What do you produce at your urban garden/farm?
Please select all categories that apply.

___ Fruits
___ Vegetables
___ Livestock
___ Row crops
___ Dairy
___ Other (Please explain): ____

Additional Comments: ____
____

Q9: How big is the plot on which you grow?
*Please select one category that **best** describes your situation.*

___ Less than 20' x 20'
___ Community garden - about 20' x 20' or 30' by 30'
___ Multiple plots - less than 1/10 acre or 20' x 50'
___ Up to 1/2 acre
___ 1/2 to 2 acres
___ Greater than 2 acres

Q10: How are your products utilized?
*Please select one category that **best** describes your situation.*

___ Self only
___ Self and family - up to 10 people
___ Self, family, and friends - 10 or more people
___ Any of the above, PLUS sell as CSA, farmers market, etc. - 25 or more people
Additional Comments: ____

Q11: What percent of your household food consumption is from your own production?

___ None
___ 1-10 %
___ 11-20%
___ 21-30%
___ 31-40%
___ 41-50%
___ Greater than 50%

Additional Comments: ____
____

Q12: Which category ***best*** describes your involvement with the garden/farm in which you produce?
Please select a single category that best describes your role.

____ Volunteer
____ Hired agricultural help
____ Primary gardener/farmer
____ Help with garden/farm
____ Other (Please explain) : ____

Additional Comments: ____
____

Q13: Which category ***best*** describes how the urban garden/farm in which you produce is organized?
Please select a single category that best describes your situation.
____ Family owned
____ Non-family partnership
____ Individual owned
____ Corporate
____ Community/Neighborhood
____ Nonprofit organization
____ Other (Please explain) : ____

Additional Comments: ____

Q14: What is the zip-code of the urban garden/farm in which you produce?

__ __ __ __ __ - __ __ __ __

Q15: What is your age?

_____ years

Q16: What is the highest level of education you have completed?

____ Less than a high school degree
____ High school degree
____ Some college
____ College degree
____ Graduate degree
____ Other : ____

Thank you for taking the time to complete this survey. We appreciate your participation, and we will take into account all of your answers throughout our project. This survey will contribute to a Master's thesis project and to the development of resources on urban agriculture and urban soil quality.

Through our project, the Urban Gardening Initiative at Brownfields sites, we expect to provide resources for producers, urban land managers, local and state government, and extension personnel, to implement proposed best management practices for the detection and mitigation of potentially harmful substances in soils on urban sites. This will include:

- Development of easy-to-use tools/protocols for laypeople to ascertain the suitability of a urban site for gardening/farming purposes (i.e. modified site assessments, soil sampling and testing techniques and parameters.
- Development of guidance in the selection of appropriate crops to be planted on specific urban sites
- Development of a data base on contaminants detrimental to gardening/farming and their associated plant uptake

THANK YOU!

Chapter 2 - Designing and Teaching an Urban Soils Laboratory for an Introductory Soils Course

Abstract

Most of the students in the Agronomy 305: Soils course are not Agronomy majors. Furthermore, an increasing number of Agronomy 305 students come from urban and suburban communities and/or have interest in working in urban environments upon completion of their undergraduate degree. An urban soils laboratory was developed in response to the future workforce demands as well as the demographics of students enrolled in the Agronomy 305 course. The urban soils curriculum was designed as a hands-on, semester-long, lab format. Two of the five laboratory course sections in the spring of 2011 and three of the five sections in the fall of 2011 were taught with an emphasis on urban soil quality issues at the Manhattan Community Garden (MCG) site in Manhattan, Kansas. Throughout the semester students evaluated the physical, chemical, and biological properties of a soil from this urban community garden. Some tests were conducted in the lab while others were completed at the urban garden site. Reaction of students to the new urban soils lab offering has been positive with 72% of students enrolled in the course reporting that they have interest and need in learning about the urban soil issues covered in the lab course. Overall, student responses about their learning experience in the urban soils laboratory course were positive, indicating that incorporating urban soil principles enhanced their soil science education.

Introduction

Background on urban soils in the soil science discipline

Referred to as urban, human-influenced, drastically-altered, disturbed or anthropogenic soils, the soils of urban environments are highly heterogeneous and difficult to precisely define. Several definitions exist in an attempt to precisely define the complex soils of urban environments. Craul (1992) defined urban soil as, "a soil material having a non-agricultural, man-made surface layer more than 50 cm thick that has been produced by mixing, filling, or by contamination of land surface in urban and suburban areas." Evans et al. (2000) defined anthropogenic soil simply as any human-altered soils, thus broadening the definition beyond urban areas. Lehmann and Stahr (2007) offered a definition of urban soil which included two groups of soils, the first of which they termed anthropogenic urban soil, defined as human-influenced soil in urban environments. The second group they termed urban soil, defined as including both human-influenced and natural urban soils. Human influence is the key concept present in each of these definitions of urban soils.

Human influences on urban soils' development and quality include: removing, burying, moving, mixing, compacting, shaping soils, etc.; altering water movement across a landscape and through soil profiles by raising or lowering the water table, irrigating, diverting water, impermeable surfaces/layers, etc.; addition of inorganic and organic artifacts such as building debris, trash, etc.; enrichment of inorganic and organic contaminants such as heavy metals (e.g. Pb, Cd, As, etc.), polycyclic aromatic hydrocarbons (PAH's) (e.g. incompletely combusted coal), persistent organic contaminants (POP's) (e.g. DDT and Chlordane), etc.; and removing or planting of native and nonnative vegetation. Because urban soils develop as a result of so many different potential human influences, it is difficult to define the exact characteristics of all of these soils. Variability of the physical, chemical, biological, and water properties of urban soils exist within a single pedon, as well as across even the smallest area. Irregular distribution of bulk density, organic matter content, pH, contaminants, debris, etc. are common in urban soils (Emerson et al., 1994; Pouyat et al., 2010; Strain and Evans, 1994).

Craul (1992) and Lehmann and Stahr (2007) suggest several characteristics which are somewhat common in anthropogenic urban soils due to the above mentioned human influences, including: presence of artifacts, irregular horizons and boundaries, alkalinity, variable organic matter and nutrient contents, elevated contaminant concentrations, high bulk density, low infiltration/drainage capacity, high soil temperature, and properties of the artificial parent material. However, these characteristics are not shared by all urban soils, and further research is required to better define these soils.

Although the first mention of urban anthropogenic soils was made in 1847 by Ferdinand Senft in his soils textbook, urban soils were not a focus in soil science until the past forty years (Lehmann and Stahr, 2007). Discussions began in the 1980's to properly address urban soils in soil taxonomy. In 2006, an issue of the World Reference Base incorporated the soil group Technosols to include anthropogenic urban soils. The interest in and importance of urban soils was also demonstrated at the 2011 ASA-CSSA-SSSA International Annual Meetings, where symposia were dedicated to the topics of urban soils. The Soil Science Society of America is also currently in the process of forming an urban soil task group.

Urban and suburban development and population growth has increased the land area within urban environments. The proportion of land developed increased twice as quickly as the population growth in the last twenty years (Lehmann and Stahr, 2007). According to Pouyat et al. (2010) this increased urban expansion directly impacts soil development and quality in urban environments by human disturbance and land management, and indirectly impacts urban soil development by even the slightest changes in the environment. Further research, discussions, and technical decisions will need to be made in the near future concerning our urban soil resources. Urban soils are a vital component of urban ecosystems as they provide many necessary, beneficial functions, such as groundwater recharge and infiltration to reduce surface runoff and flooding, urban agriculture, recreational areas, carbon sequestration, wildlife habitat, and retention and immobilization of contaminants (Lehmann and Stahr, 2007). The variability and indefinite nature of urban soils presents a challenge to urban land managers and growers. Current and future urban land managers, growers, residents etc. should have a firm recognition of the variability and necessity of urban soils, as well as a foundation of knowledge of the best management practices for urban soils.

Insert here a statement of purpose and goals for this section.

Background of students enrolled in Agronomy 305: Soils

The majority of students (75%) enrolled in Agronomy 305: Soils at Kansas State University in 2011 were enrolled in majors outside of Agronomy (Figure 2.1). These students represented various backgrounds ranging from farms/ranches to small Kansas towns to large cities throughout the United States. More AGRON 305: Soils students than ever before were from urban and suburban communities and/or had an interest or future of working in urban environments upon completion of their undergraduate degree. A greater proportion of students than ever before reported their future career goals to be in golf course management, urban agriculture and horticulture, natural resource communications, land planning, wildlife management, and many other non-agricultural based fields. For these students with backgrounds or future careers in nonagricultural areas, an applied knowledge of the nature and properties of urban soils will be necessary. These demographic data and comments demonstrate the students' educational needs pertaining to urban soils topics, and new learning outcomes were created to address these needs.

Background on Student Learning

Throughout the development of any new activities and lessons, teachers should be aware of how input, processing, and storage of new information occurs in the brain during the learning process. Student learning can be better guided when the teacher has recognition of Sousa's Information Processing Model, as well as the concepts of sense and meaning as they relate to students' learning processes (Sousa, 2001). Sousa developed the Information Processing Model (Fig. 2.2) to demonstrate how a learner's brain incorporates new information from its environment (e.g. listening to a lecture, talking to peers, walking on campus, reading a textbook, watching the new, etc.). Sousa emphasizes that the learner takes in information from their environment using all of their five senses. This is a key concept for laboratory instructors as the laboratory and field environments provide unique opportunities to guide student learning by stimulating their five senses during a single activity to improve the potential for the long-term storage of new material.

According to Sousa (2001) the learner stores these initial sensory observations of their environment and new information in their immediate memory, a short-term storage for new material. New information observed by the learner and determined to be important will be moved into the learner's working memory for immediate retrieval. However, for a learner to store new information in their long-term memory for retrieval in the more distant future, the material must make sense to and have meaning for the individual learner (Figure 2.3). According to Sousa (2001), sense refers to a learner's ability to make sense of the material based on their prior experiences and knowledge. Sousa suggests the question, "Does this make sense?" to assess if sense is present for the learner. Meaning refers to a learner's ability to identify personal relevance in the new material (Sousa, 2001). Sousa suggests the question, "Does this have meaning to me?" or perhaps, "Can I see the relevance or potential future relevance of this material for me?" Sense and meaning may be present for a learner separately or synchronously. When both sense and meaning are absent for a learner the probability is very low of the learner retaining the new material in their long-term memory. When either sense or meaning is present separately for the learner, the probability is moderate to high of the learner retaining the new material in their long-term memory. The ideal learning process would occur if both sense and meaning were present for the learner, when according to Sousa (2001), the learner has the highest probability of retaining the new material in their long-term memory where it could be retrieved in for future use.

Sousa suggests that teachers should use these basic concepts to guide teaching and learning in their classrooms, labs, field, and beyond. Sense and meaning should be a focus of activities and lessons to maximize student learning or students' long-term storage of new materials. Based on Sousa's model for learner information processing, effectiveness of an activity or lesson, as well as student learning in a course, could be measured by gathering information on the presence of sense and meaning for students' throughout the activities and lessons.

Bloom (1956) also offers a tool, Bloom's Taxonomy of the Cognitive Domain, to guide teacher development of learning outcomes, teaching methods, and learning assessment. Bloom's Taxonomy has been consistently used as a teaching-learning tool for decades, and can be implemented in any educational circumstance. The six levels of Bloom's Taxonomy in order of increasing complexity are knowledge, comprehension, application, analysis, synthesis, and evaluation. The first three taxonomic levels (knowledge, comprehension, and application) are referred to by Bloom as convergent thinking processes, meaning that the learner can recall or comprehend new facts or concepts. The last three taxonomic levels (analysis, synthesis, and evaluation) are referred to as divergent thinking processes, meaning that these more complex learning processes result in new insights or perceptions for learner that are beyond the basic, original information recall. These six taxonomic levels are cumulative, and each learner must master the least complex levels before continuing on to master the most complex levels of learning (Sousa, 2001). Bloom's Taxonomy can serve as a tool to guide teachers to help students gain learning abilities at all of the taxonomic levels, from least complex to most complex. Bloom's Taxonomy can also serve as a guide in the development of learning assessment techniques to evaluate student learning at all of the taxonomic levels of learning.

Hunter (1982) provides nine components of lesson design to guide the development of lessons and activities in teaching. Hunter's nine components include: anticipatory set, leaning objective, purpose, input, modeling, check for understanding, guided practice, closure, and independent practice (Table 2.1) Not all of the nine components must be included in the design of a lesson or activity, however, it is necessary to consider the value of each component in different educational circumstances. Sousa (2001) suggests that implementing Hunter's nine components of lesson design and Bloom's Taxonomy in new lesson/activity development can improve students' sense and meaning of new material.

Study Objectives

The objectives of this study were to: 1) Design new laboratory learning outcomes and activities pertaining to the unique physical, chemical, and biological properties of soils in urban environments in ways that address the realistic educational needs of today's AGRON 305: Soils students; 2) assess the student's prior knowledge of and interest in the urban soils concepts covered in the new/modified laboratory activities, and; 3) assess the impact of the new/modified laboratory activities on students' learning of urban soils concepts by evaluating whether sense and/or meaning, as well as intellectual curiosity, were present for students during each of the new or modified urban soils laboratory activities.

Materials and Methods

Student participation in Agronomy 305: Urban Soils laboratory

Students enrolled in AGRON 305: Soils attended three, one-hour lectures and one, two-hour hands-on laboratory each week. Student enrollment in AGRON 305: Soils was 103 students in the spring 2011 semester and 86 in the fall 2011 semester. To accommodate the large number of enrolled students, five laboratory sections of approximately 18 students each were taught both semester. Two of the five laboratory sections in the spring of 2011, and three of the five sections in the fall of 2011 were taught with emphasis on the new urban soils learning outcomes and activities. A total of 41 students (66% non-agronomy majors) in the spring of 2011, and a total of 51 students (75% non-agronomy majors) in the fall of 2011 enrolled in the urban soils laboratory sections (Figures 2.4 and 2.5). A total of 92 students participated in the AGRON 305: urban soils laboratory for both the spring and fall semesters of 2011. Students were given no prior notice of their enrollment in the urban soils laboratory course section as opposed to the conventional soils section until they arrived to the first class period of the semester. Students were given the option to transfer out of the urban soils lab and into another section if they saw fit, however only three students transferred out of the urban soils section during both semesters.

Designing and Teaching an Agronomy 305: Urban Soils laboratory

Some activities from the original AGRON 305: Soils lab sections, as well as some modified or some entirely new activities comprised the AGRON 305: urban soils lab (Table 2.2). The new and modified activities were designed to guide student learning on the following urban soils concepts: urban soil development, risk assessment and management of an urban site, composting, assessment of urban soil quality and gardening in urban environments, detection of soil trace element concentrations using an X-Ray Fluorescence Spectrophotometer, and impact of soil contamination on soil microbes. Upon completion of their semester in AGRON 305: urban soils laboratory, students were expected to be able to:

1. recognize the unique physical, chemical, water, and biological properties of urban soils,
2. differentiate between anthropogenic urban and natural soils, and
3. evaluate the quality/health of urban soils.

All of the activities from the original AGRON: 305 Soils laboratory curriculum (with the exception of the Rangeland Ecosystems fieldtrip activity) were included in the AGRON: 305 urban soils laboratory curriculum. Lab activities that had, in previous semesters, been conducted over more than one laboratory period, were condensed into one period. This was done to make more efficient use of the entire two-hour laboratory period, as well as to give students the benefit of learning the conventional/agricultural soils material and activities also. Students enrolled in AGRON 305: urban soils laboratory were exposed to the same material as the students enrolled in the original AGRON 305: Soils laboratory, as well as the additional, newly developed urban soils material and activities.

Students enrolled in the urban soils laboratory sections attended the same AGRON 305: Soils lectures and completed the same reading assignments and exams as the students enrolled in the other Soils laboratory sections. Throughout both the spring and fall semesters of 2011, all students enrolled in the urban soils laboratory sections participated in the same hands-on activities, discussions, demonstrations, field trips, reading and writing assignments, and quizzes during lab periods. However, the order of activities throughout the semester varied slightly. Field trips occurred later in the semester in the spring and earlier in the semester in the fall.

The concepts of content and procedure guided the development of the urban soils laboratory, learning outcomes, lessons, activities, assignments, and assessments. Each laboratory period was designed to address the following two questions associated with content and procedure: 1) what do we want the students to learn? And 2) how will we help the students learn the material? What will the students do and what will the teacher do throughout the learning process in lab? These questions guided how the urban soils laboratory course was designed and taught, and Bloom (1952), Hunter (1982), and Sousa (2001) substantiated these design and teaching decisions.

The first step to designing the new urban soils lab activities was to answer the question, what do we want the students to learn by the end of the activity? Learning outcomes help us determine our own teaching expectations, as well as gives students clear expectations for their learning throughout each lab. Bloom's taxonomy (1952) is a widely used and verified model for classifying learning into observable knowledge and skills, and can be used to determine the level of complexity of learning occurring throughout an activity. The six levels of Bloom's taxonomy include knowledge, comprehension, application, analysis, synthesis, and evaluation in order of increasingly complex thought processes. Measurable verbs associated with each of the taxonomic levels can be used to guide observations of actions that can tell us something about the level of learning that is occurring within the brain.

Bloom's measurable verbs were used when designing all learning outcomes for each new/modified urban soils activity. Learning outcomes were designed to facilitate and assess student learning at the highest possible levels of Bloom's taxonomy of learning for each activity (Table 2.3). Because the activities were designed for an introductory course, many of the learning outcomes aim to facilitate and assess student learning at the first three levels of Bloom's taxonomy, knowledge, comprehension, and application. However, activities completed later in the semester allowed for higher levels of learning to be assessed because students had mastered the lower levels of learning in previous activities throughout the semester. In the section, I will report the learning outcomes for each new laboratory activity, and indicate in parentheses after each learning outcome which of Bloom's taxonomic levels the learning outcome is designed to facilitate and assess.

Once learning outcomes were designed for each lab activity, the teaching methods were designed. When designing the teaching methods we aimed to answer the question, how will we help the students learn the material and achieve the expected learning outcomes for each activity. Hunter (1982) provided a verified and widely-used method for instructional design. Hunter's original lesson design method consisted of seven components; however, Sousa (2001) offered an updated revision of nine components for lesson design. We have implemented Sousa's revised version of Hunter's original methods. The nine components of lesson design are as follows: 1. Anticipatory set, 2. Learning objective, 3. Purpose, 4. Input, 5. Modeling, 6. Check for understanding, 7. Guided practice, 8. Closure. Hunter and Sousa both emphasize that not all of the components must be present in a design of teaching methods, some components are more relevant than others for particular situations (Sousa, 2001).

Anticipatory set is a strategy the aims to focus students attention on the subject at hand. The anticipatory set should be relevant to the learning outcomes for the lesson and gain students' interest. At the beginning of the six new/modified lab activities I focused student attention on the learning outcomes for the day by providing a relevant quote, news article, factoid, or personal experience which the students then discussed. I then directed student discussion to their personal experience with the topic. If they didn't have prior knowledge of or experience with the topic, I then directed the discussion to encourage students to think of why the topic is or could be relevant to them personally. Discussing their prior knowledge of and the potential personal relevance of the material establishes purpose, another of lesson design components. Once I completed the anticipatory set and purpose components in each lab period, I then guided students through each of the learning outcomes (another of Hunter's lesson components) to establish the learning expectations with the students. The teaching methods for all of the six new/modified activities/lessons were designed to implement these three lesson components (anticipatory set, purpose and learning objective) in the manor described above. In the remainder of this section I will describe the teaching methods in which the remaining six lesson components were utilized differently in each new/modified laboratory activity.

Sousa established that implementing Bloom's taxonomy and Hunter's lesson components in teaching design increases the likelihood that the learner will attach both sense and meaning to the material. If a student can both make sense of the material and attach meaning to the new material, then there is a greater chance that the material will be learned. Throughout the design of each activity and lesson, we aimed to implement as many of Bloom's and Hunter's techniques to ensure that students attached sense and meaning to each new activity, thus increasing the likelihood that the students would store the new information in their long-term memory.

In the next six sections I will described how the principles of Bloom (1952), Hunter (1982), and Sousa (2001) were specifically implemented throughout the design of each urban soils activity. Overall, the design of each laboratory activity implemented Bloom's taxonomy throughout the design of the measureable learning outcomes which guided teaching content and evaluation of student learning. Hunter's components of lesson design guided the design of teaching methods or procedures implemented throughout each new/modified laboratory activity. As established by Sousa (2001), implementing Bloom's taxonomy to establish expected content and implementing Hunter's lesson design components to establish teaching procedure, increase the students likelihood that they will attach sense and meaning to the new material. Sousa established that this method of designing content and procedure increases the likelihood that the learner will store the new information in their long-term memory.

Activity 1: Urban soil development

The content of the urban soil development lab activity was defined by the following learning outcomes:

1. Define soil, anthropogenic soil, and urban soil. (Knowledge)
2. List and describe the six soil forming factors. (Knowledge)
3. Describe the observable differences between soils in urban and agricultural environments. (Comprehension)

4. Recognize the heterogeneity of urban soils. (Comprehension)
5. List several ways in which humans influence soils.(Knowledge)

The design of teaching methods incorporated each of nine modified lesson design components (Hunter, 1982; Sousa, 2011). Students observed soil monoliths, soil survey maps and descriptions, as well as images of various urban soil profiles. These images were compiled to demonstrate the heterogeneity of urban soils and the many human impacts on urban soil development. Students first observed the monoliths and images and wrote their own interpretations and observations on the differences between the soils they viewed. Students then compared and contrasted their observations amongst themselves. Finally, I guided an overall discussion of their observations and directed further observations. These activities were implemented in our teaching design for the purpose of input, modeling, and guided practice, substantiated by Hunter (1982). Finally, students analyzed a site history description of two different urban areas, and created models of the sites' soil profiles in glass cylinders using various materials (e.g. soils, various debris retrieved from the MCG site, concrete, gravel, plant materials, trash, etc.) provided to them in the lab (Appendix B) for the purpose of modeling substantiated by Hunter (1982). Students then sketched their urban soil profile models, compared their models to their peers' models, and recorded their observations. Once students were finished creating their models, each group presented their model to the class for the purpose of checking for understanding and closure/summary substantiated by Hunter (1982).

Activity 2: Urban Site Analysis – Risk Assessment and Management

Learning outcomes of Activity 2 directed students to implement the tools available through the Web Soil Survey (NRCS, 2011), historical records, and other resources, to assess the quality of the soil on the MCG site for use as a garden, as well as the potential human health and environmental risks of gardening on those urban soils (Appendices C and D). Learning outcomes for the Urban Site Analysis lab activity included:

1. Describe how soil properties relate to soil quality, use and management. (Comprehension)
2. Describe some of the unique soil properties of urban soils and explain how these properties impact soil quality for urban uses. (Comprehension)
3. Operate the tools of the Web Soil Survey with ease. (Application)
4. Interpret soil properties of an urban site using the Web Soil Survey and evaluate the potential risk and potential suitability of the urban soils present for a particular urban use or function. (Evaluation)
5. Propose a simple risk management option to address potential risks associated with urban land use. (Synthesis)

Learning outcomes 3-5 focused student learning in the highest levels of Bloom's taxonomy, which demonstrated critical thinking. Prior to student participation in Activity 2, students reviewed the concept of soil quality as it relates to soil use and function. Students then read and discussed the key principles of the Environmental Protection Agency's steps for Risk Assessment and Risk Management (EPA, 2011). I outlined a real-life example of a site analysis and the risk assessment and management steps taken by professionals throughout their site analysis. This step-by-step, real-life example was given to establish purpose and modeling, substantiated by Hunter (1982). As a class, students demonstrated their recognition of these basic site analysis concepts as they verbally worked through the steps of a simple site analysis example for the purpose of checking for understanding and guided practice, as substantiated by Hunter (1982).

Students then observed and practiced using the tools of the Web Soil Survey for site analysis during the laboratory period. A computer and projector, operated by the instructor, demonstrated to students the tools and information available to them on the Web Soil Survey. Students then practiced using the demonstrated tools themselves on their own computers. Finally, students employed the concepts and tools practiced in lab to compose their own site analysis reports on the MCG site. Students acted as soils consultants for the clients, the gardeners of the MCG, and each student composed a report for their clients in which they evaluated the quality of and risks associated with the soils of the MCG and recommended risk mitigation techniques and the Best Management Practices (BMPs) for their clients (Appendix E). The site analysis reported was assigned for the purpose of independent practice, substantiated by Hunter (1982), to help make the concepts/procedures more permanent in the students' brains.

Activity 3: Composting

The learning outcomes of Activity 3 directed student learning on the principles and practice of composting (Appendix F). The learning outcomes for the Composting activity included:

1. Define compost/composting. (Knowledge)
2. List the seven keys to composting. (Knowledge)
3. Explain how each of the seven keys to composting impact compost production. (Comprehension)
4. Practice the seven keys to composting - manage a compost bin in lab over the next several weeks. (Application)
5. Debate the unique challenges of producing compost in urban environments. (Analysis)

Before students began Activity 3 they received instruction via a short lesson on the seven keys to composting (Appendix G) (CWMI, 2005) for the purpose of input, purpose, and modeling substantiated by Hunter (1982). Students brought organic materials (e.g. food scraps, paper, cardboard, crop residues, leaves, grass clippings, etc.) to lab and began a compost bin as a lab group (Appendix H). Large plastic coffee cans (approximately 1-gallon) and buckets (3-gallon) contained each lab group’s compost. Students recorded the type, size, mass, and C:N ratios of the organic materials, the temperature of their materials, and volume of water added, prior to beginning the composting process. Students then maintained, observed, and kept records of temperature, moisture and consistency of their compost each week throughout the semester. Students were expected to implement the strategies for composting we discussed in class throughout the semester for the purpose of guided and independent practice as substantiated by

Hunter (1982). Photographs of the compost were taken periodically throughout the semester to track the composting progress. After the 14 composting period the laboratory groups composed a report on the status of their composting process. Students reflected on the following questions: “How did the compost observations change throughout the semester? – Describe your composts progress. Did you follow the seven keys to composting throughout the semester, why or why not? Did your composting efforts result in finished compost by the end of this semester? What did your group do correctly/incorrectly? What could you have done differently to improve your composting process?” Students reflected on their composting experience for the purpose of checking for understanding and closure as substantiated by Hunter (1982).

Following their first introduction to the principles of composting in this laboratory activity, students read a published, problem-based case study on composting of Municipal Solid Waste on their own prior to lab (MSW) (Autrey et al., 2006) and composed written responses to discussion questions prior to the following week’s lab period (Appendix I). This independent, out of class assignment was designed to implement Hunter’s independent practice. In the following lab period, time was set aside for in-class discussion of student questions, opinions, and conclusions on the MSW problem case. Students established a view point and debated the problem(s) posed in the case study for the purpose of guided practice and closure as substantiated by Hunter (1982).

Activity 4: Determining urban soil contamination using an X-Ray Fluorescence

In Lab Activity 4: Determination of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer (XRF), students observed a demonstration of how to operate the XRF, sketched how the XRF measures the elemental concentration in samples, and discussed how they would use the XRF to sample an urban site (Appendices J-L) (Beckhoff et al., 2006). The learning outcomes of Activity 4 directed student learning on the topics of urban soil contamination and measuring soil trace element concentrations. The learning outcomes of the XRF activity included:

1. Define FP XRF. (Knowledge)

2. Illustrate how a FP XRF instrument measures the presence and concentration of trace elements in a soil sample. (Application)
3. Explain how a FP XRF instrument can be utilized during an urban site analysis. (Comprehension)
4. Differentiate between the common trace element contaminants of urban soils (Pb, Cd, As), their sources, exposure pathways, and risks to human health. (Analysis)

Measurable verbs from varying levels of Bloom's taxonomy of thinking, from knowledge to analysis, were used in the design of the learning outcomes for this lab activity. More complex thought and learning is required of students learning about the process in which XRF measures trace elements in soil. Students must first master the lower, less complex levels of learning before they can master the high levels of thought on the subject matter such as analysis, as substantiated by Bloom (1952).

Students collected soil samples from the Manhattan Community Garden site and from the North Farm and brought the samples back to the lab to dry. Organic materials were removed from each sample. Students placed a 500gram subsample from each larger sample on a piece of brown paper in the lab. I first demonstrated these steps and then students repeated the methods on their own for the purpose of modeling and guided practice, as substantiated by Hunter (1982). As a class we then measured the trace element concentrations, specifically the lead, cadmium, and arsenic, of the agricultural soil. Students then recorded the measured concentrations. As a class we then measured the trace element concentrations of the urban soil. Students recorded the measured concentrations and compared and contrasted the measurements with the agricultural soils for the purpose of input, modeling, and guided practice. Students then discussed why the urban soils had higher concentrations of trace elements, if the concentrations were of concern for the urban garden use, and then concluded on the best management practices for both the soils given the contamination information. This student discussion was conducted to establish purpose and closure, as well as to check for understanding of the concepts and their applications.

Activity 5: Determining the impact of soil contamination on soil microbes

In Activity 5 students investigated the impact of gasoline contamination on soil microbial communities and the benefit and function of soil microbes in the overall soil ecosystem (Appendix M). The learning outcomes of Activity 5 included:

1. Diagram the relationship between the terms decomposition, mineralization, immobilization, nitrate depression, and C:N ratio. (Analysis)
2. State our two research hypotheses for the Microbial Decomposition experiment. (Knowledge)
3. Evaluate the validity of information sources. (Evaluation)
4. Assemble and interpret research results on the impact of gasoline contamination on soil microbial activity. (Analysis)
5. Demonstrate mastery of acid-bas titrations, soil extraction, and colorimetric analysis procedures. (Application)
6. Collect and prepare experimental data. (Application)
7. Construct graphs in Microsoft Excel of experimental data. (Synthesis)
8. Analyze experimental data and propose conclusions to our experimental hypotheses. (Analysis)
9. Apply results/conclusion from our experiment to a real-life situation in an agricultural and urban situation. (Application)

The learning outcomes designed for this lab activity include each of the six levels of Bloom's taxonomy. The experiment that students conduct throughout Activity 5 covers several lab periods. By the end of the activity, students are expected to have mastered the measureable skills and knowledge outlined in each of the learning outcomes: from # 1-2 and 6, designed to measure the least complex learning level to # 3-4, 7-9, designed to measure the most complex levels of learning (critical thinking).

Prior to beginning their experimental investigations, students practiced judging the validity of sources, interpreting scientific journal articles, and organizing information, then composed a review of the literature (Appendix N) for the purpose of input, purpose and checking for understanding, as substantiated by Hunter (1982). Throughout the research activity, students found and summarized new information, determine the relevance of the new information, and demonstrated their comprehension of the new material in a written report.

Students then performed an experiment to determine the impacts of gasoline contamination and C:N ratio of plant residues on soil microbial activity rates. Students conducted the experimental procedure for sample preparation, carbon dioxide analysis, nitrate analysis, and calculations as outlined by Thien and Graveel (2003) in Exercise 14: Microbial Decomposition of Organic Materials in Soil. However, we modified the treatment comparisons (Appendix K) to include two variables: 1) C:N ratio of residue (alfalfa and wheat) and 2) contamination of soil (gasoline contaminated and uncontaminated) (Appendix O). The temperature treatment indicated in the Thien and Graveel (2003) procedure was excluded to include the modified contamination treatments in which soils were contaminated with gasoline 1 week prior to commencement of the experiment. Each student group had a total of 6 treatment comparison to assist in the analysis of their experimental hypotheses.

Each lab period associated with Activity 5, began with a short review of the procedure and findings from the following week for the purpose of anticipatory set and checking for understanding. Once students showed an understanding of what was learned the previous week, we discussed and I modeled the laboratory procedure for the lab period. This discussion and demonstration was done for the purpose of input and modeling, as substantiated by Hunter (1982). Students conducted the procedure on their own with my supervision for the purpose of guided practice as substantiated by Hunter (1982).

Upon completion of the several-week experiment, students compiled their experimental data, created tables and graphs, analyzed their data, and interpreted their results on their own, for the purpose of independent practice and closure, substantiated by Hunter (1982). Finally students compiled their literature reviews, hypotheses, and experimental results, and composed a laboratory report in which they described the impacts of gasoline contamination and C:N ratio of residues on the rate of microbial decomposition of organic materials (Appendix P). This reported demonstrated students' measurable skills and knowledge associated with the learning outcomes. I assessed student learning from these written reports.

Activity 6: Assessing urban soil quality

In Activity 6: Assessment of Urban Soil Quality, students practiced and demonstrated mastery of soil sampling and field soil testing techniques on a field trip to the MCG site (Appendix Q). Prior to the field trip students were expected to read a document on gardening in urban environments (EPA, 2011a), then answer a problem-based question (Appendix R) to address purpose, input, and checking for understanding, substantiated by Hunter (1982). Upon arrival to the MCG on the field trip, students were greeted by gardeners and leaders of the MCG and heard a history of the site and the garden, as well as a description of the recent land management issues. Students were encouraged to ask any questions that might help them better assess the soil quality and potential risks of the garden site.

I first demonstrated the proper procedures for measuring soil quality with each of the tools provided in their urban soils test kit for the purpose of input and modeling, substantiated by Hunter (1982). Students then utilized the tools provided in the urban soil test kits (Appendix S) to sample for: soil texture, temperature, bulk density, water content, pH, infiltration rate, microbial activity, presence and concentration of selected trace elements, presence of artifacts and other evidence of human disturbance. Students practiced their soil testing skills for the purpose of guided practice, as substantiated by Hunter (1982). Students recorded all measurements, observations, and answers to their individual questions. Upon completion of soil sampling/testing, exploration of the garden, and questions for gardeners/leaders, students were asked to make a conclusion about the soil quality and any potential risks of the urban garden site for the purpose of independent practice and closure, as substantiated by Hunter (1982).

For example, students used the X-Ray Fluorescence Spectrophotometer to determine the total soil arsenic (As) concentration in a garden plot 5 meters from the railroad tracks (20 mg/kg As) and then measured the soil As concentration in a garden plot 20 meters from the railroad tracks (0 mg/kg). Students discussed their ideas of potential sources of As contamination and concluded with suggestions on the BMP's for gardeners of these plots.

Overall, the design of each laboratory activity implemented Bloom's taxonomy throughout the design of the measureable learning outcomes which guided teaching content and evaluation of student learning. Hunter's components of lesson design guided the design of teaching methods or procedures implemented throughout each new/modified laboratory activity. As established by Sousa (2001), implementing Bloom's taxonomy to establish expected content and implementing Hunter's lesson design components to establish teaching procedure, increase the students likelihood that they will attach sense and meaning to the new material. Sousa established that this method of designing content and procedure increases the likelihood that the learner will store the new information in their long-term memory.

Survey assessment of the urban soils lab activities

Survey assessments of the urban soils lab activities were conducted over two semesters (spring and fall of 2011). Throughout both semesters, students participated in the same hands-on activities, reading and written assignments, field trips, discussions, and quizzes. After completing the new/modified urban soils laboratory activities students were asked to complete a written survey at the beginning of the following lab period. Student responses were anonymous and confidential, and students were advised that it was not a requirement of the course to participate in the surveys. An oral introduction detailed the instructions for each survey assessment prior to student survey participation.

In the spring of 2011, students responded to a total of 40 questions on the 6 new/modified laboratory activities and overall urban soils lab course in three evaluations throughout the semester (Appendix T and Table 2.4). In the fall of 2011, students responded to a total of 45 questions on the 6 new/modified activities and overall Urban Soils lab course in six evaluations throughout the semester (Appendix U and Table 2.4). The number of completed surveys varied from survey to survey (Table 2.5). Survey questions directed students to respond with either yes or no or make a choice from one of two Likert scales (1. strongly disagree, disagree, neither agree nor disagree, agree, strongly agree or 2. very low, low, medium, high, very high). Students were instructed on the definition and application of Sousa's terms, sense and meaning, during the first week's laboratory period and subsequent discussions of sense and meaning reinforced these concepts throughout the semester.

Respondents of the survey assessments were asked questions that assessed the following: their prior interest in and knowledge of each activity/topic, how the activity impacted their intellectual curiosity of the learning outcomes, and finally whether sense and meaning were present for them throughout the activity (Appendices T and U). Prior knowledge may impact a learner's ability to make sense and meaning out of a new topic. Prior knowledge indicates a learner's knowledge base which is important when determining whether sense is present because we can ask the learner if it "fits in with their prior knowledge base". The greater the background knowledge of a concept that a learner has, the greater the likelihood that sense will be present for the learner. A learner's interest in a new concept can impact their motivation to learn, or intellectual curiosity. If a learner has high intellectual curiosity, then they may require less direction to acquire sense and meaning from new material.

Survey questions pertaining to students' prior knowledge and interest and intellectual curiosity remained the same in the spring and fall survey assessments. Survey questions pertaining to sense and meaning were different in survey assessments of the spring and fall semesters of 2011. In the spring students were asked the following two questions to assess sense and meaning respectively: 1) The activity improved my comprehension of the learning outcomes for this lab (Students were verbally asked to think about whether the activity made sense to them when answering this question.) and 2) The activity was relevant to me. Students were asked to respond to these questions using the Likert scale of "strongly disagree", "disagree", "neither agree nor disagree", "agree", "strongly agree".

Upon completion of the spring semester, amendments to these questions were required due to a large number of nonresponse answers (neither agree nor disagree). The response of "neither agree nor disagree" contributed no useful answer to the question because sense and meaning are individually present or not present, therefore we needed a definite response (yes /no) from students. Due to the poor design of these questions, amendments were made and new questions were asked in the fall 2011 semester to assess sense and meaning. In fall 2011, students were asked to respond “yes” or “no” to the following two questions to assess sense and meaning respectively: 1) Did the activity make sense to you? and 2) Did the activity have meaning for you? Was it relevant to you? Students’ definite responses allowed for ease of analysis and more relevant data.

Data Analysis

Categorical data were compiled and summary statistics analyzed using Microsoft Excel. Due to the anonymity of survey responses (and the fact that answers were coming from different student populations?), it was not possible to detect the level of significance between survey responses.

Results and Discussion

Survey assessment responses indicated that students’ prior knowledge varied from concept to concept or activity to activity (Figure 2.6). The majority of students (74.6%) reported “very low” or “low” prior knowledge of the concepts covered in all six new/modified activities (Figure 2.7 and Table 2.6). Activities 1 and 4 had the highest proportion (87%) of students that reported “very low” or “low” prior knowledge of the concepts (urban soil development and determining soil contamination using an XRF). These results indicated that students had not mastered the concepts covered in the new/modified activities and had minimal knowledge base, prior to participation in the urban soils laboratory. Several students wrote comments next to these questions indicating that they had not heard the terms/concepts before in their educational careers, further indicating the educational needs of these students. Activity 3 had the lowest proportion (51%) of students that reported “very low” or “low” prior knowledge of the concepts (composting), indicating that more students (approximately half) had previously been exposed to the concepts of composting prior to taking the urban soils Lab.

Student-reported interest in urban soils was positive. Nearly 72% of students in the spring and fall semesters reported “medium”, “high” or “very high” interest in learning about urban soils (Figure 2.8). Of the fall semesters students, 76% reported that they anticipated a need/use for urban soils knowledge in their futures (Figure 2.9). High proportions of students reported an interest or a need for knowledge of urban soil in their lives, which supported our idea (hypothesis?) that the urban soils lab could fulfill education needs of students.

Student-reported interest in the concepts covered in each of the six new/modified urban soils laboratory activities, indicated that students’ interest varied between activities/concepts (Figure 2.10). This is not unexpected because of the diverse backgrounds of students enrolled in the course. However, student disinterest in Activities 4, 5, and 6 was greater than student interest in Activities 1, 2, and 3 (Figure 2.11). Over 57% of students reported a “very low” or “low” level of interest in the concepts covered in Activities 4, 5, and 6, and only 27% of students reported “very low” or “low” levels of interest in the concepts covered in Activities 1, 2, and 3 (Table 2.7). Activities 4, 5, and 6 focused on soil contaminants and soil quality issues associated with urban agriculture, whereas Activities 1, 2, and 3 focused on urban soil development, urban site and risk assessment, and composting. These results indicate that perhaps students have less initial interest in soil contamination concepts.

The reported impact of each activity on students’ intellectual curiosity of the concepts covered varied from activity to activity (Figure 2.12). Overall, more than 65% of the total student responses indicated that the activities had either a “high” or “very high” impact on their intellectual curiosity of the learning outcomes concepts for each activity (Figure 2.13 and Table 2.8). Activity 3 (composting) had the largest percentage (80.5%) of student responses indicating either a “high” or “very high” impact on their intellectual curiosity of composting concepts. Activities 1, 4 and 5, had the lowest reported impact on students’ intellectual curiosity, in which only 51.7, 58.1, and 56.4% of students’ reported that the activities had “high” or “very high” impact on their intellectual curiosity.

Overall, students enrolled in the spring of 2011, indicated that each of the six activities improved their comprehension (sense) of the material (Figure 2.14 and Table 2.9). Of the total student responses to the questions assessing the impact of the activities on students' sense of the material, 79% of the total student responses indicated that they "Agreed" with the following statement pertaining to each of the new/modified activities: "The activity increased my comprehension of the material. (The material made sense to me.)" Students reported the lowest levels of agreement when asked about the Activity 1: Urban Soil Development Model, with only 64.1% of students indicating that they "Agree" or "Strongly agree" that this activity increased their comprehension (sense) of the material. It is also important to note that 18.9% of the student responses to these questions pertaining to sense were "neither agree nor disagree" (Table 2.9). This non-answer, response provides little insight into whether sense was or was not in fact present for those particular students, however it may indicate that those students lacked a firm grasp of the concept of sense.

Overall, students enrolled in the spring of 2011, indicated that each of the six activities improved the relevance of the material for them personally (Figure 2.15 and Table 2.10). The majority of responses indicated that the six new/modified activities improved the meaning/relevance of the material for students (Figure 2.15). Of the total student responses to the questions assessing the impact of the activities on the meaning of the material for students, 71.4% of the total student responses indicated that they either "Agreed" or "Strongly agreed" with the following statement pertaining to each of the new/modified activities: "The activity increased the relevance of the material for me. (The activity was relevant to me.)" Students reported the lowest levels of agreement when asked about the Activity 1: Urban Soil Development Model, with only 48.7% of students indicating that they either "Agree" or "Strongly agree" that Activity 1 increased the material's relevance (meaning) for them. It is also important to note that 24.4% of total student responses to these questions pertaining to meaning were "neither agree nor disagree" (Table 2.9). This non-answer, response provides little insight into whether meaning was or was not in fact present for those particular students, however it may indicate that those students lacked a firm grasp of the concept of meaning.

Overall, the majority of students indicated ("Agree" or "Strongly agree") that both their sense and meaning of the learning outcomes concepts were improved by Activities 2-6 (Figure

2.16). Students' sense and meaning of Activity 1 was lower than the other five activities, indicating that the activity should be amended to help students achieve sense and meaning of the concepts. Student comments on Activity 1 included: "The activity was kind of boring." (only one comment?) Ideally, in Activity 1 students would complete the hands-on model activity but then view a soil pit in an urban environment. Real-world, hands-on examples may improve student sense and meaning of the urban soil development concepts taught in Activity 1.

The majority of students enrolled in the fall of 2011 indicated that sense was present throughout the six new/modified activities (Figure 2.17). Students were asked, "Was sense present for you in the activity? Did the activity/concepts make sense to you?" Of the total student responses to these questions, 94% indicated that sense was present throughout the Activities (Table 2.11). For each of the six Activities, at least one student responded that sense was not present throughout the activity. However, for all Activities (except Activity 4), the number of students who reported "No" was less than 3 (6.4%). Six students (12.8%) in the three Urban Soils laboratory sections in the fall of 2011 indicated that Activity 4: Determining Soil Contamination using an XRF, did not make sense to them.

The majority of students enrolled in the fall of 2011 indicated that meaning was also present throughout the six new/modified activities (Figure 2.18). Students were asked, "Was meaning present for you in the activity? Was the activity relevant to you?" Of the total student responses to these questions, 94.2% indicated that sense was present throughout the Activities (Table 2.12). For each of the six Activities, at least one student responded that sense was not present throughout the activity. However, for all Activities (except Activity 4), the number of students who reported "No" was less than 3 (6.4%). Five students (10.6%) indicated that Activity 4: Determining Soil Contamination using an XRF, did not having meaning for them.

The majority of students enrolled in the fall of 2011 indicated that both sense and meaning were present for them throughout the six Activities (Figure 2.19). A total of 91.4% of all responses indicated that both sense and meaning were present for students. A greater proportion of fall 2011 students than spring 2011 students reported that sense and meaning were present for them in the six new/modified urban soils laboratory activities. This may be due to an improvement in the teaching techniques of the instructor (such as?).

Upon completion of the urban soils laboratory course, students were also asked to comment about which of the Activities they enjoyed the most. While student comments varied, most indicated that they enjoyed Activity 3: Composting and Activity 6: Urban Soil Quality Assessment- MCG field trip, because these activities were the most “hands-on” and “fun”. A word cloud of student comments illustrates these key summary points (Figure 2.20).

Conclusions

Six new and/or modified laboratory activities and associated learning outcomes were developed, implemented, and assessed in the spring and fall semesters of 2011. Survey results indicated that in a majority of students prior knowledge of the urban soils concepts taught in the six new and/or modified activities was very low/low. Evidently an educational need pertaining to urban soils concepts existed for the students enrolled in AGRON 305: Soils. Overall, students had a high interest in learning about urban soils concepts but a low interest in learning about soil contamination concepts.

Students reported that Activities 1 and 4 did little to increase their intellectual curiosity or desire to learn the concepts. Numerous variables can impact an individual’s intellectual curiosity including personal motivation, interest in the topic, learning skills, etc. It is difficult to pin-point a specific reason why these particular activities did not increase the students’ intellectual curiosity. Students also had the lowest prior knowledge of the concepts covered in Activities 1 and 4 than in any of the other six urban soils activities which may have made learning the new material more laborious.

The survey assessment determined that, in general, sense and meaning were present for students throughout the urban soils laboratory activities in the spring and fall of 2011. Activities 2, 3, 5, and 6 succeeded in that in both spring and fall 2011 thye increased students’ intellectual curiosity, sense, and meaning of the concepts detailed in the activities’ learning outcomes.

Although students reported lower interest in learning about urban soil contamination concepts, the students still reported that sense and meaning were present for them throughout Activities 5 and 6. Students reported less interest in learning about, prior knowledge of, and less intellectual curiosity for the concepts of Activity 4. Several students also indicated that sense and/or meaning was/were not present for them throughout Activity 4. Amendments should be made to Activity 4: Determining Urban Soils Contamination Using an XRF to improve students' knowledge base prior to beginning the activity, interest and intellectual curiosity of the concepts, as well as to ensure that sense and meaning are both present for a greater proportion of the students.

Activity 4 involves use of a field portable XRF that is expensive, fragile, and not highly available for routine soil analysis. Several students commented, "I will never use that equipment again." Although many students will not use the XRF in their future careers, students should recognize the importance of determining the potential risks associated with the presence of soil contaminants. Soil contamination and X-Ray Fluorescence spectrophotometry analysis are advanced concepts for an introductory course, and different teaching methods/more effort may be required to help students make sense of this material. Students' sense of the material may improve if Activity 4 is amended to include a prelab reading assignment or more thorough lecture/discussion prior to conducting the activity to build a knowledge base for students to build from. Students' sense of the material may also be improved upon by including more hands-on student involvement in the activity itself. Students' meaning of the material may improve if Activity 4 is amended to include more relevant examples of how soil contamination issues may impact students. This could be accomplished if students researched real-world examples of soil contamination that interested them. Students would then give a short presentation in the following lab period explaining to the other students the contaminant present, source of the contaminant, risk associated with the contamination, and what is/was being done to mitigate risk. Allowing students to research their own specific scenario pertaining to a broader topic would give them the chance to establish sense and, especially, meaning.

Overall, the survey assessment of the AGRON 305: Urban Soils laboratory indicated that students gained valuable sense and meaning of the new concepts taught in each of the six new and/or modified activities. Due to the high proportion of students that indicated that sense and meaning were present for them throughout all of the activities, it is our assumption and expectation that the concepts learned in the activities were transferred into their brains' long-term storage. If this is indeed the case, then the educational needs of the future land managers and natural resource advocates enrolled in AGRON 305: Urban Soils laboratory were partially met through the development of the Urban Soils lab curriculum.

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Tables

Table 2.1 Components to consider in designing educational lesson (Hunter, 1982). Retrieved from (Sousa, 2001, p. 279).

Lesson Component	Purpose
Anticipatory Set	Focuses student on the learning objective.
Learning Objective	Identifies what is to be learned by the end of the lesson.
Purpose	Explains why it is important to accomplish the objective.
Input	Gives students the information, sources, and skills they will need to accomplish the objective.
Modeling	Shows the process or product of what students are learning.
Check for Understanding	Allows instructor to verify if students understand what they are learning.
Guided Practice	Allows the students to try the new learning under teacher guidance.
Closure	Allows students time to mentally summarize and internalize the new learning.
Indpendent Practice	Students try new learning on their own to develop fluency.

Table 2.2 Modified, new, and reincorporated activities taught in Agronomy 305: Urban Soils laboratory course during the spring and fall of 2011.

Activity Number	Modified or new laboratory activities
1	Urban soil development model
2	Risk assessment and management of an urban site
3	Composting
4	Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)
5	Impact of soil contamination on soil microbes
6	Assessment of urban soil quality (Manhattan Community Garden Field Trip)
	Incorporated original laboratory activities
7	Determination of soil texture
8	Soil erosion and USLE
9	Properties of cultivated soils, North farm field trip
10	Water movement in soil

Table 2.3 Learning outcomes designed for the Agronomy 305: Urban Soils laboratory course.

Number	Modified or new activity	Learning outcomes
1	Urban soil development diorama	1. Define soil, anthropogenic soil, and urban soil. 2. List and describe the *six* soil forming factors. 3. Describe the *observable* differences between soils in urban and agricultural environments. 4. Recognize the heterogeneity of urban soils. 5. List several ways in which humans influence soils.
2	Risk assessment and management of an urban site	1. Describe how soil properties relate to soil quality, use and management. 2. Describe some of the unique soil properties of urban soils and explain how these properties impact soil quality for urban uses. 3. Operate the tools of the Web Soil Survey with ease. 4. Interpret soil properties of an urban site using the Web Soil Survey and evaluate the potential risk and potential suitability of the urban soils present for a particular urban use or function. 5. Propose a simple risk management option to address potential risks associated with urban land use.
3	Composting	1. Define compost/composting. 2. List the seven keys to composting. 3. Explain how each of the seven keys to composting impact compost production. 4. Practice the seven keys to composting - manage a compost bin in lab over the next several weeks. 5. Debate the unique challenges of producing compost in urban and rural environments (Autrey et al., 2006).
4	Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer	1. Define FP XRF. 2. Illustrate how a FP XRF instrument measures the presence and concentration of trace elements in a soil sample. 3. Explain how a FP XRF instrument can be utilized during an urban site analysis. 4. Differentiate between the common trace element

	(XRF)	contaminants of urban soils (Pb, Cd, As), their sources, exposure pathways, and risks to human health.
5	Impact of soil contamination on soil microbes	1. Diagram the relationship between the terms decomposition, mineralization, immobilization, nitrate depression, and C:N ratio. 2. State our two research hypotheses for the Microbial Decomposition experiment. 3. Evaluate the validity of information sources. 4. Assemble and interpret research results on the impact of gasoline contamination on soil microbial activity. 5. Demonstrate mastery of acid-bas titrations, soil extraction, and colorimetric analysis procedures. 6. Collect and prepare experimental data. 7. Construct graphs in Microsoft Excel of experimental data. 8. Analyze experimental data and propose conclusions to our experimental hypotheses. 9. Apply results/conclusion from our experiment to a real-life situation in an agricultural and urban situation.
6	Assessment of urban soil quality (Manhattan Community Garden Field Trip)	1. Demonstrate mastery of soil sampling and field soil testing techniques. Sample soils in urban environments and measure the following key soil properties using the soil testing kits: bulk density, soil temperature, texture, infiltration rate, pH, vegetative cover, microbial activity, macrofauna community structure, taxonomic order, presence of heavy metal contaminants, and extent of human disturbance. 2. Propose a best management practice (BMP) based on your soil testing for the urban gardeners of the Manhattan Community Garden to mitigate their risks associated with gardening in urban soils.

Table 2.4 Number of survey questions on each of the new/modified Urban Soils lab activities.

	Spring 2011	Fall 2011
Activity Number	**Survey Questions (n)**	
Overall course	4	3
1	6	7
2	6	7
3	6	7
4	6	7
5	6	7
6	6	7
Total	40	45

Table 2.5 Number of student responses to survey assessments in the spring and fall semesters of 2011.

	Spring 2011	Fall 2011
Survey Assessment	**Number of student responses (n)**	
1	39	50
2	41	48
3	41	48
4	-	47
5	-	44
6	-	47
Total	121	332

Table 2.6 Total number of student responses (spring and fall 2011) reporting "Very low", "Low", "Medium", "High", or "Very high" level of students' prior knowledge of concepts taught in each of the six new/modified urban soils activities.

	Very low	Low	Medium	High	Very high	Total
Activity 1	38[1] (42.7)[2]	40 (44.9)	10 (11.2)	1 (1.1)	0 (0.0)	89 (17.2)
Activity 2	49 (56.3)	23 (26.4)	8 (9.2)	7 (8.0)	0 (0.0)	87 (16.8)
Activity 3	8 (9.2)	36 (41.4)	35 (40.2)	7 (8.0)	1 (1.1)	87 (16.8)
Activity 4	44 (51.2)	31 (36.0)	10 (11.6)	1 (1.2)	0 (0.0)	86 (16.6)
Activity 5	23 (27.7)	30 (36.1)	25 (30.1)	3 (3.6)	2 (2.4)	83 (16.1)
Activity 6	31 (36.5)	32 (37.6)	17 (20.0)	5 (5.9)	0 (0.0)	85 (16.4)
Activities 1-6 Total	193 (37.3)	192 (37.1)	105 (20.3)	24 (4.6)	3 (0.6)	517 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.7 Total number of student responses (spring and fall 2011) reporting "Very low", "Low", "Medium", "High", or "Very high" level of students' interest in learning the concepts taught in each of the six new/modified urban soils activities.

	Very low	Low	Medium	High	Very high	Total
Activity 1	7[1] (7.9)[2]	18 (20.2)	45 (50.6)	18 (20.2)	1 (1.1)	89 (17.1)
Activity 2	5 (5.7)	19 (21.8)	41 (47.1)	20 (23.0)	2 (2.3)	87 (16.8)
Activity 3	4 (4.6)	19 (21.8)	33 (37.9)	24 (27.6)	7 (8.0)	87 (16.8)
Activity 4	18 (20.9)	39 (45.3)	24 (27.9)	4 (4.7)	1 (1.2)	86 (16.6)
Activity 5	17 (20.5)	21 (25.3)	31 (37.3)	12 (14.5)	2 (2.4)	83 (15.9)
Activity 6	18 (20.7)	34 (39.1)	24 (27.6)	9 (10.3)	2 (2.3)	87 (16.8)
Activities 1-6 Total	69 (13.3)	150 (28.9)	198 (38.2)	87 (16.8)	15 (2.9)	519 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.8 Total number of student responses (spring and fall 2011) reporting "Very low", "Low", "Medium", "High", or "Very high" level of impact that the six new/modified urban soils activities had on students' intellectual curiosity of the concepts taught.

Activity Number	Very low	Low	Medium	High	Very high	Total
Activity 1	1[1] (1.1)[2]	6 (6.7)	36 (40.4)	36 (40.4)	10 (11.2)	89 (18.8)
Activity 2	0 (0.0)	6 (6.9)	22 (25.3)	44 (50.6)	15 (17.2)	87 (18.4)
Activity 3	0 (0.0)	1 (1.1)	16 (18.4)	43 (49.4)	27 (31.0)	87 (18.4)
Activity 4	2 (2.3)	10 (11.6)	24 (27.9)	35 (40.7)	15 (17.4)	86 (18.2)
Activity 5 (Spring only)	3 (7.7)	1 (2.6)	13 (33.3)	18 (46.3)	4 (10.3)	39 (8.2)
Activity 6	0 (0.0)	3 (3.5)	21 (24.7)	42 (49.4)	19 (22.4)	85 (17.9)
Activities 1-6 Total	6 (1.30	27 (5.7)	132 (27.9)	218 (46.1)	90 (19.0)	473 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.9 Total number of students' responses (spring 2011) reporting a "Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", or "Strongly agree" rating on each of the six new/modified urban soils laboratory activities' improvement of students comprehension or sense of the concepts taught.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total
Activity 1	0[1] (0.0)[2]	1 (2.6)	13 (33.3)	23 (59.0)	2 (5.1)	39 (16.4)
Activity 2	0 (0.0)	2 (5.1)	5 (12.8)	22 (56.4)	10 (25.6)	39 (16.4)
Activity 3	0 (0.0)	0 (0.0)	8 (20.5)	23 (59.0)	8 (20.5)	39 (16.4)
Activity 4	0 (0.0)	0 (0.0)	7 (17.1)	27 (65.9)	7 (17.1)	41 (17.2)
Activity 5	0 (0.0)	1 (2.6)	5 (12.8)	30 (76.9)	3 (7.7)	39 (16.4)
Activity 6	0 (0.0)	0 (0.0)	7 (17.1)	28 (68.3)	6 (14.6)	41 (17.2)
Activities 1-6 Total	0 (0.0)	4 (1.7)	45 (18.9)	153 (64.3)	36 (15.1)	238 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.10 Total number of students' responses (spring 2011) reporting a "Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", or "Strongly agree" rating on each of the six new/modified urban soils laboratory activities' improvement of students meaning or personal relevance of the concepts taught.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total
Activity 1	0[1] (0.0)[2]	3 (7.7)	17 (43.6)	17 (43.6)	2 (5.1)	39 (16.4)
Activity 2	0 (0.0)	2 (5.1)	6 (15.4)	24 (61.5)	7 (17.9)	39 (16.4)
Activity 3	0 (0.0)	1 (2.6)	8 (20.5)	24 (61.5)	6 (15.4)	39 (16.4)
Activity 4	0 (0.0)	2 (4.9)	8 (19.5)	27 (65.9)	4 (9.8)	41 (17.2)
Activity 5	1 (2.6)	0 (0.0)	11 (28.2)	20 (51.3)	7 (17.9)	39 (16.4)
Activity 6	0 (0.0)	1 (2.4)	8 (19.5)	22 (53.7)	10 (24.4)	41 (17.2)
Activities 1-6 Total	1 (0.4)	9 (3.8)	58 (24.4)	134 (56.3)	36 (15.1)	238 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.11 Total number of students' responses (fall 2011) reporting "Yes" or "No" on whether each of the six new/modified urban soils laboratory activities made sense to them.

	Yes	No	Total
Activity 1	48[1] (96.0)[2]	2 (4.0)	50 (20.8)
Activity 2	47 (97.9)	1 (2.1)	48 (20.0)
Activity 3	46 (95.8)	2 (4.2)	48 (20.0)
Activity 4	41 (87.2)	6 (12.8)	47 (19.6)
Activity 5	-	-	-
Activity 6	44 (93.6)	3 (6.4)	47 (19.6)
Activities 1-6 Total	226 (94.2)	14 (5.8)	240 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Table 2.12 Total number of students' responses (fall 2011) reporting "Yes" or "No" on whether each of the six new/modified urban soils laboratory activities had meaning for them.

	Yes	No	Total
Activity 1	49[1] (98.0)[2]	1 (2.0)	50 (20.8)
Activity 2	46 (95.8)	2 (4.2)	48 (20.0)
Activity 3	45 (93.8)	3 (6.3)	48 (20.0)
Activity 4	42 (89.4)	5 (10.6)	47 (19.6)
Activity 5	-	-	-
Activity 6	44 (93.6)	3 (6.4)	47 (19.6)
Activities 1-6 Total	226 (94.2)	14 (5.8)	240 (100.0)

[1] Numerals without ( ) indicate the total number of student responses for each rating.
[2] Numerals with ( ) indicate the percentage of student responses for each rating.

Figures

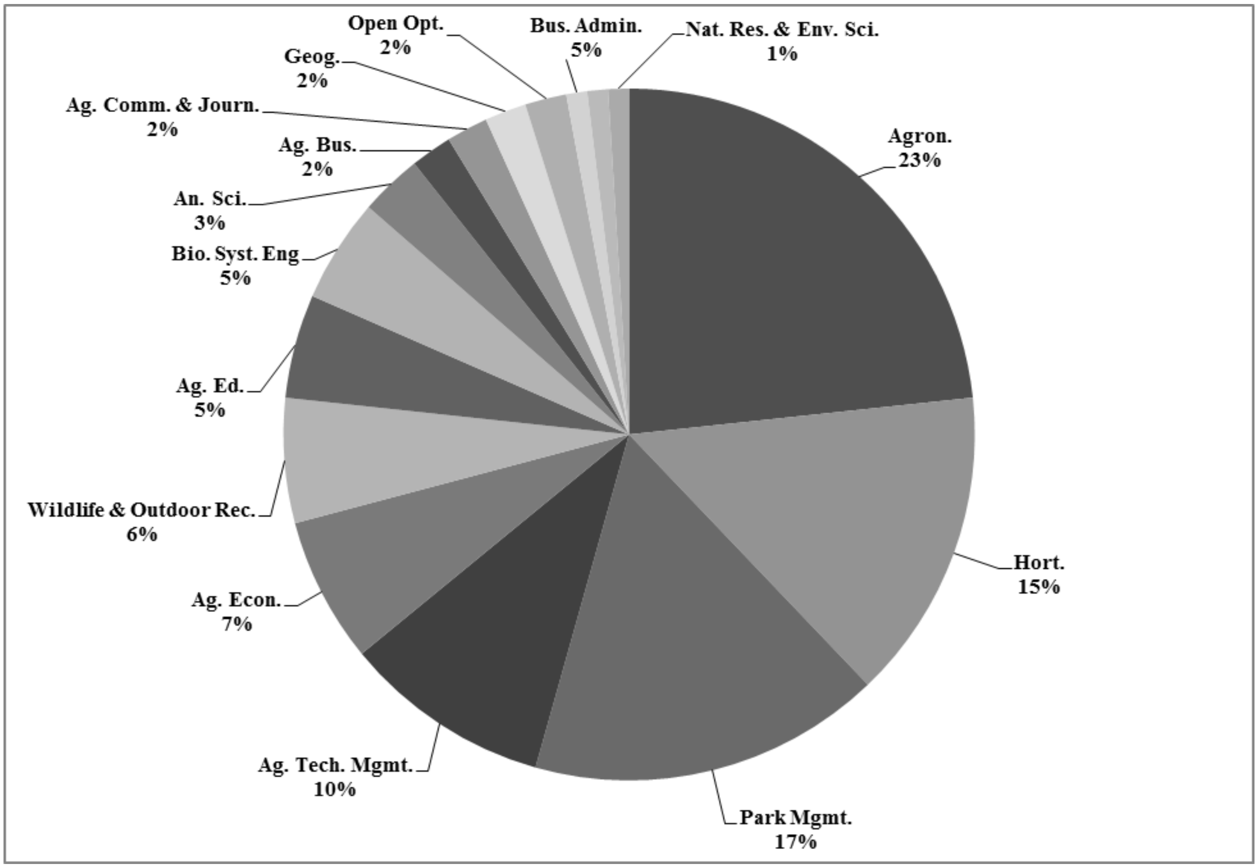


Figure 2.1 Majors of Agronomy 305: Soils students enrolled in the spring and fall of 2011.

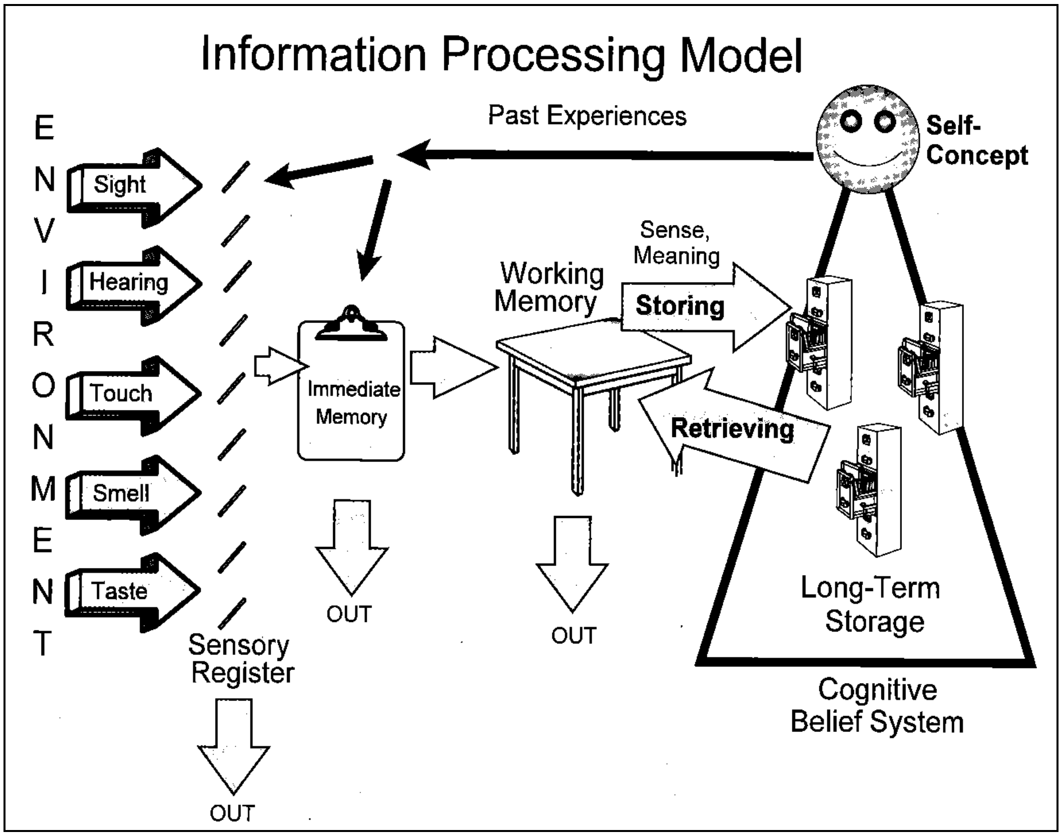


Figure 2.2 The Information Processing Model illustrates how the brain processes information from the learner's environment (Sousa, 2001, p. 38).

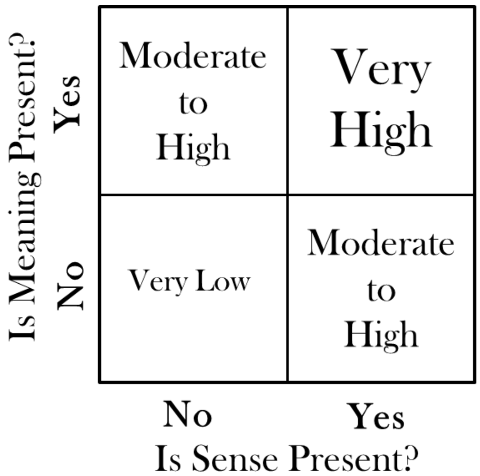


Figure 2.3 The probability of a learner retaining new information in their long-term memory depends on whether sense and/or meaning are present for that learner (Sousa, 2011, p. 47)

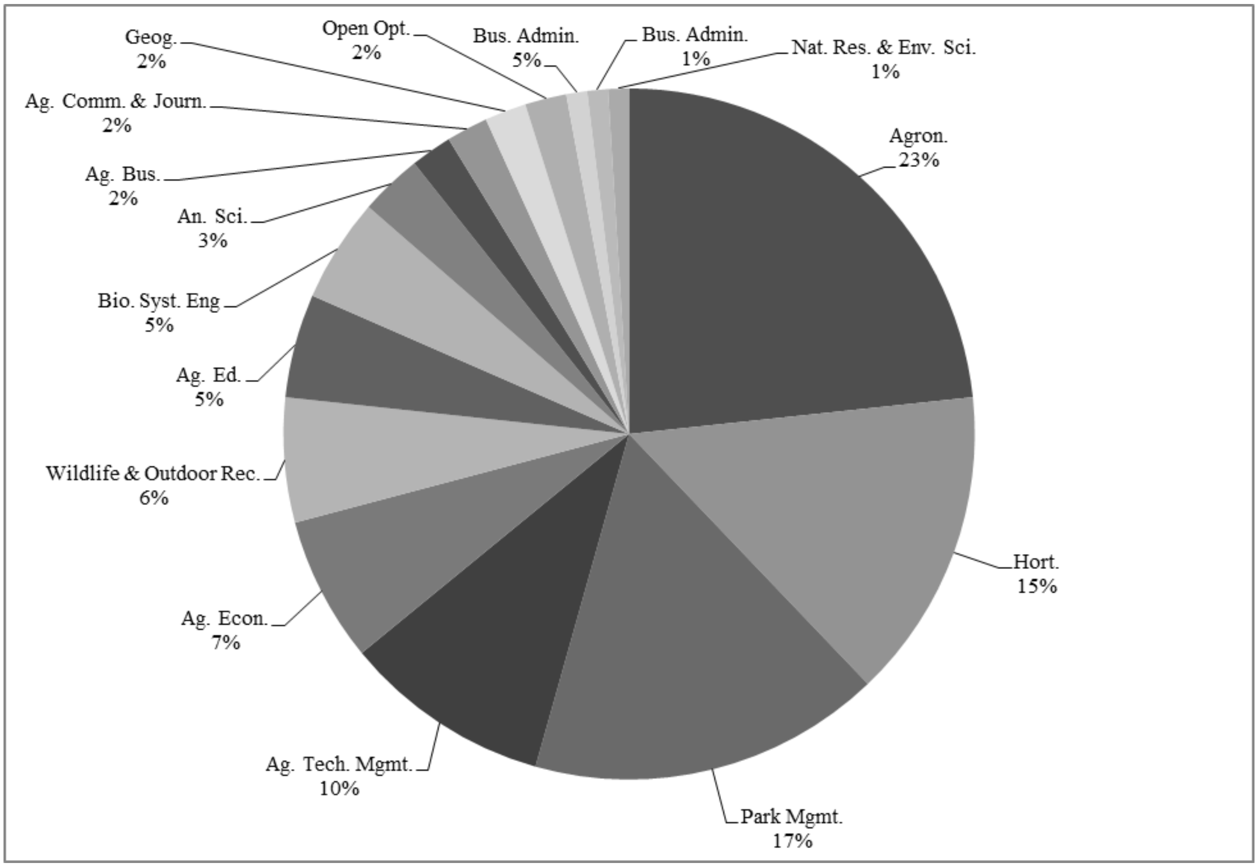


Figure 2.4 Majors of students enrolled in Agronomy 305: Urban Soils laboratory in the spring of 2011.

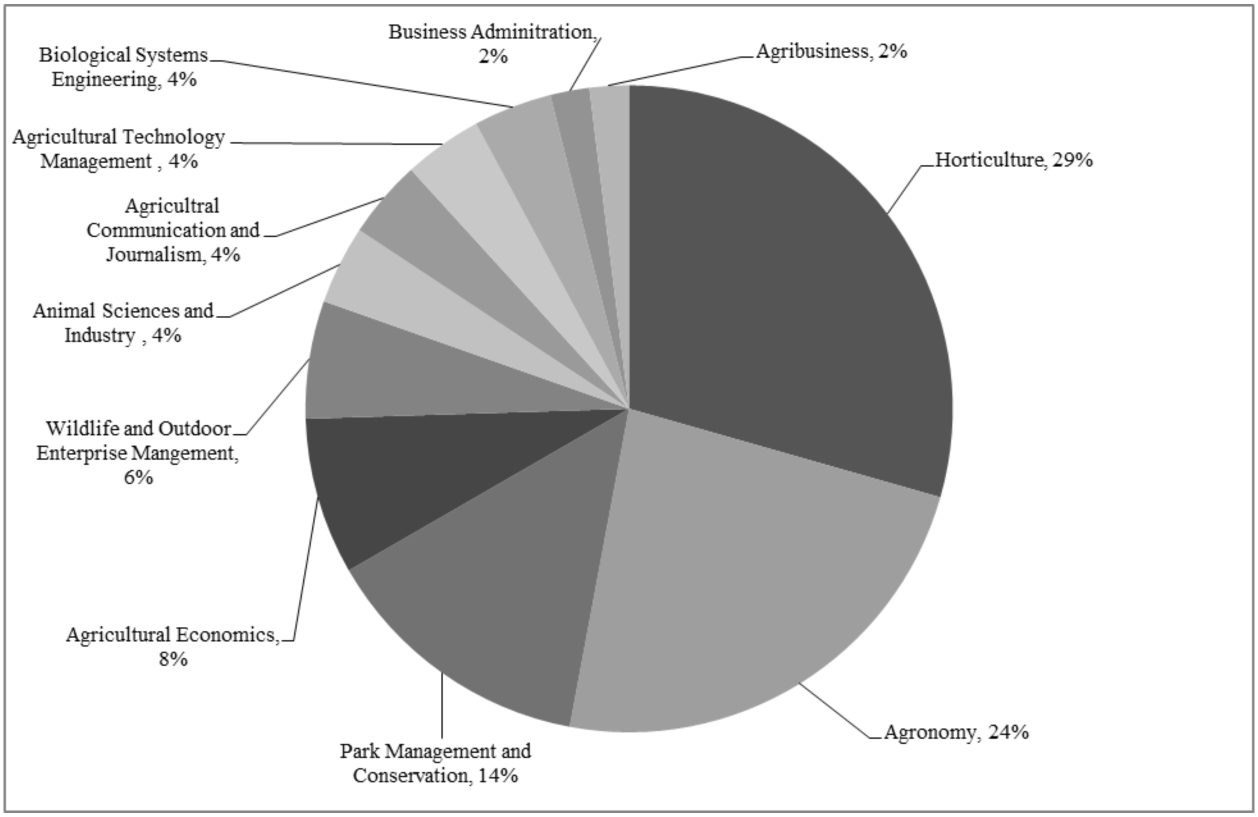


Figure 2.5 Majors of students enrolled in Agronomy 305: Urban Soils laboratory in the fall of 2011.

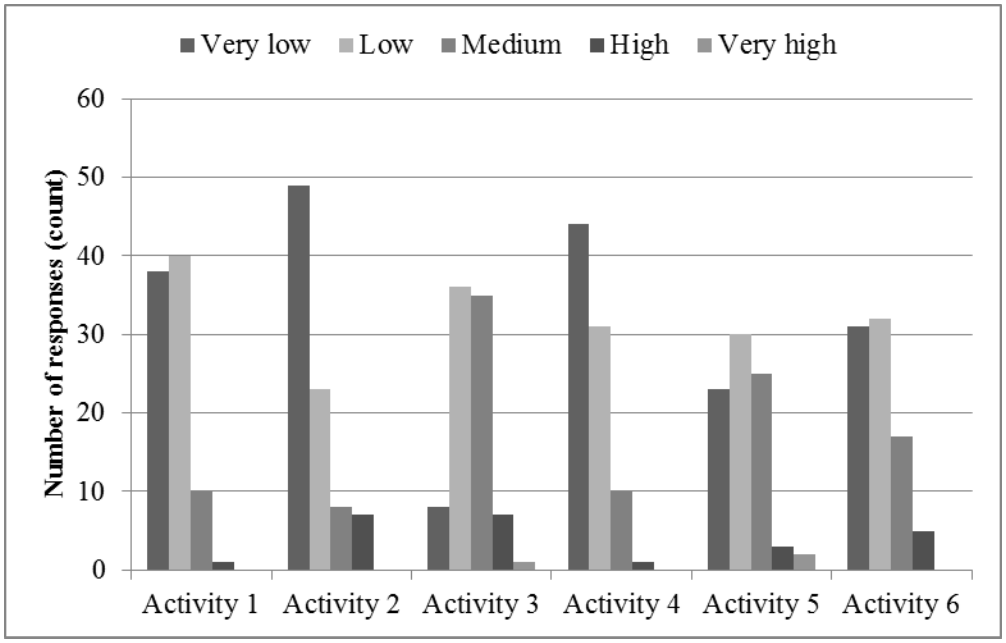


Figure 2.6 Students' reported level of prior knowledge of the learning outcomes concepts taught in the new/modified AGRON: 305 Urban Soils laboratory activities (spring and fall 2011).

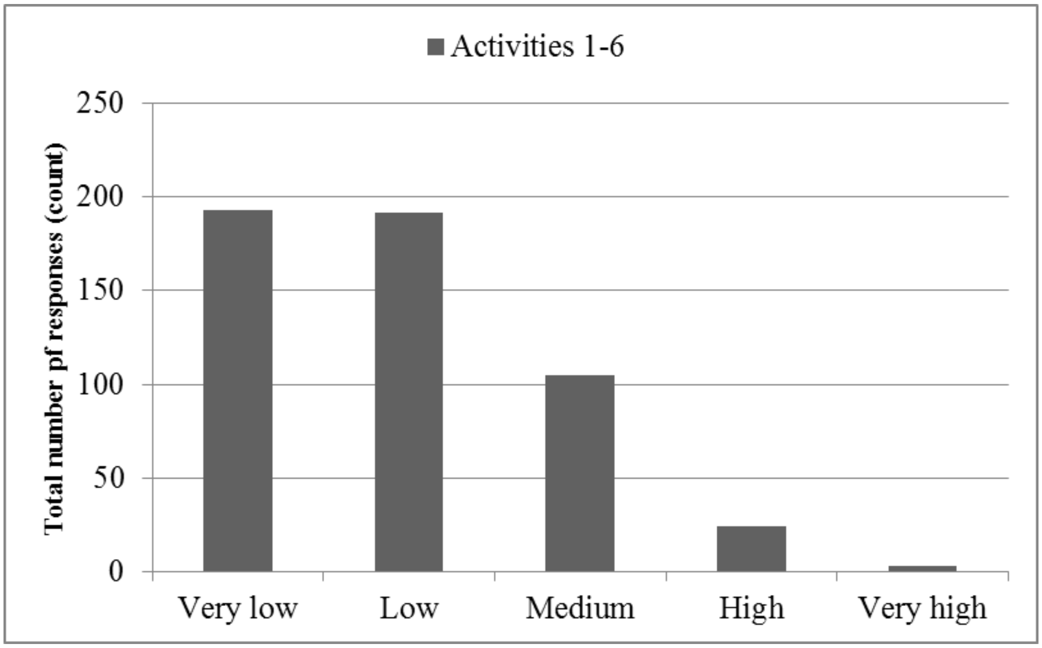


Figure 2.7 Student's reported level of prior knowledge of the learning outcome concepts taught in the new/modified AGRON: 305 Urban Soils laboratory activities (spring and fall 2011).

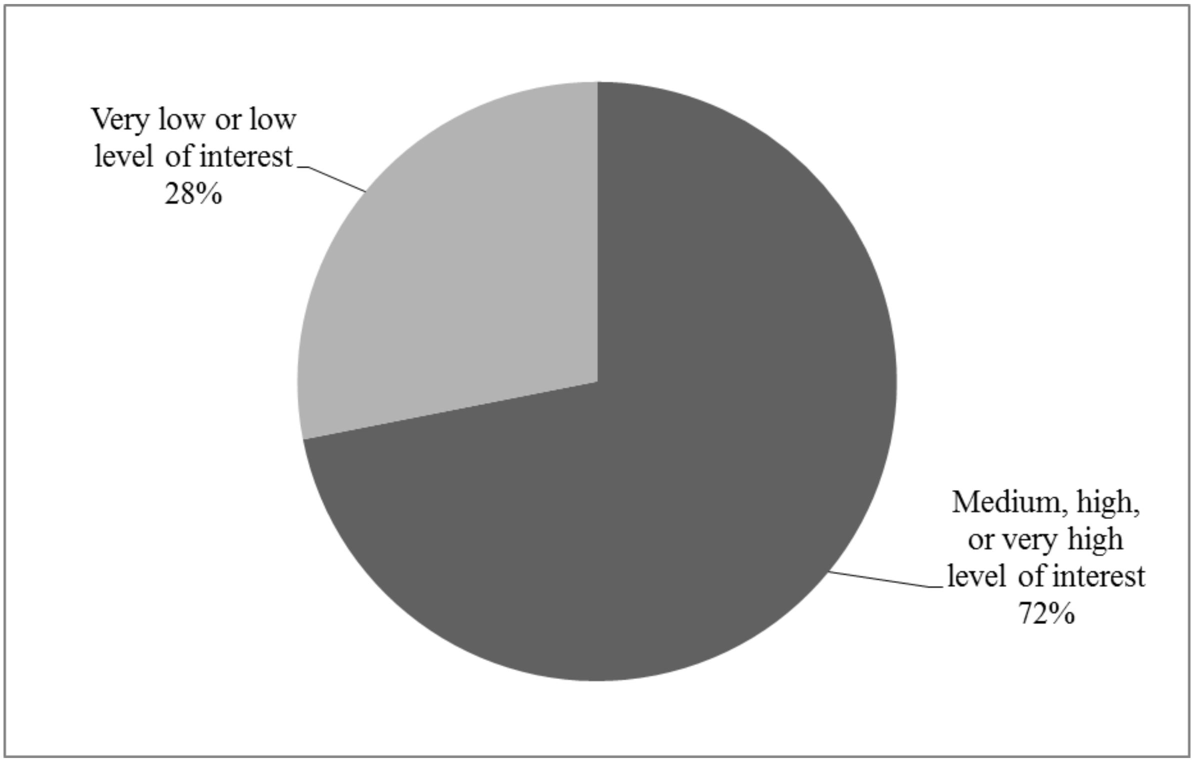


Figure 2.8 Students' reported level of interest in learning about urban soils (spring and fall 2011).

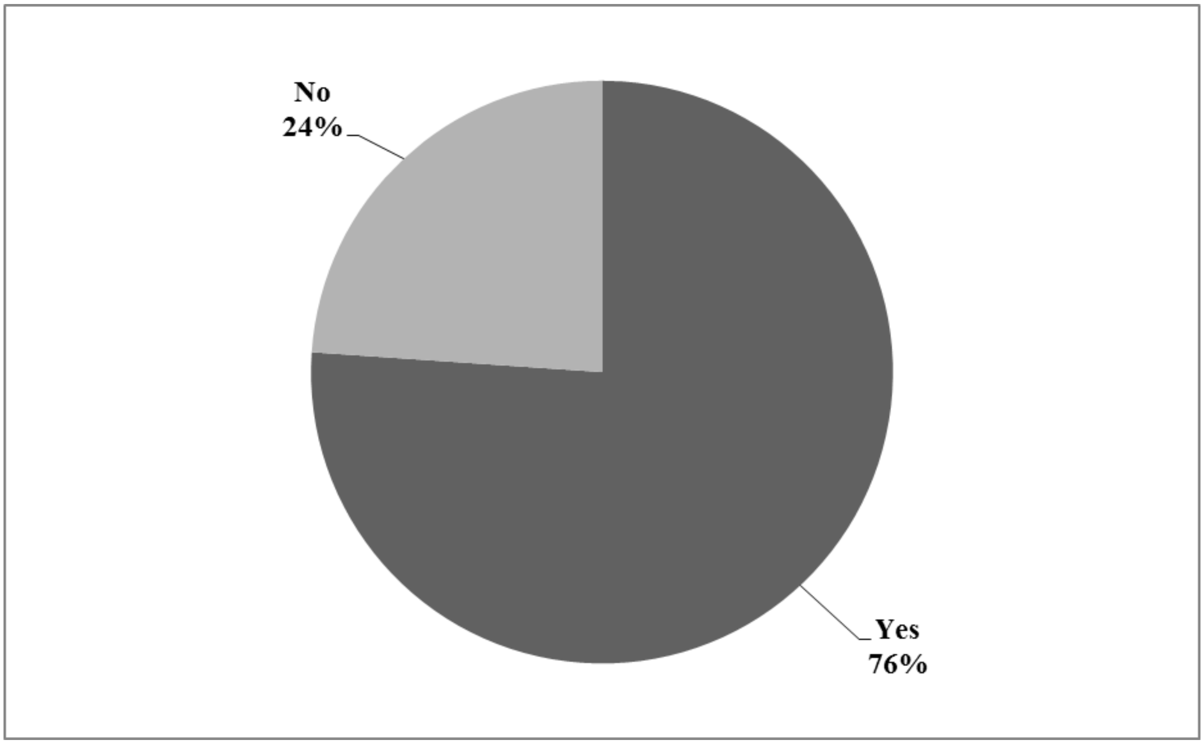


Figure 2.9 Students' perceived need/use for urban soils knowledge in their personal/professional futures (spring and fall 2011).

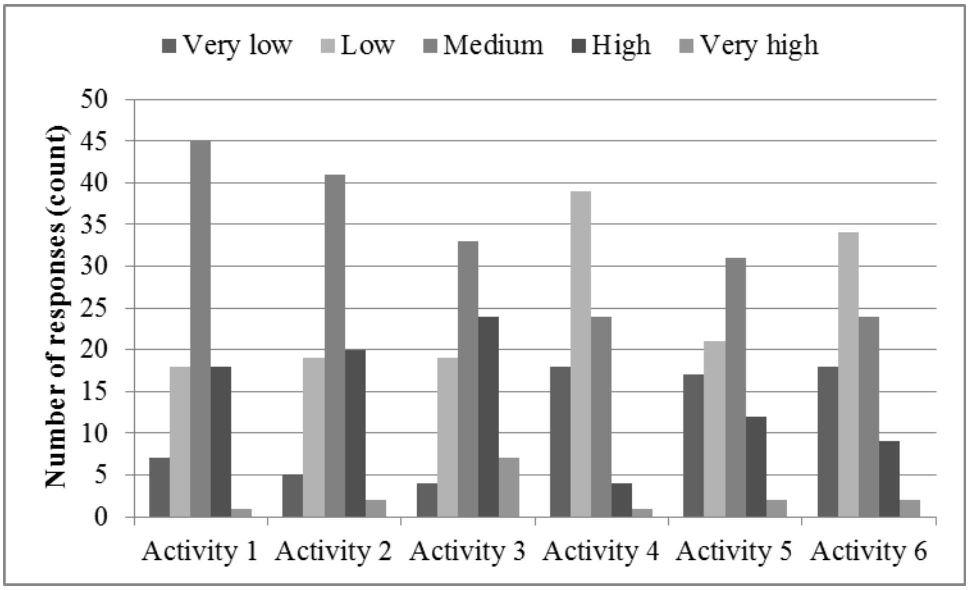


Figure 2.10 Students' reported level of interest in learning about learning outcomes/concepts taught in the new/modified AGRON: 305 Urban Soils laboratory activities (spring and fall 2011).

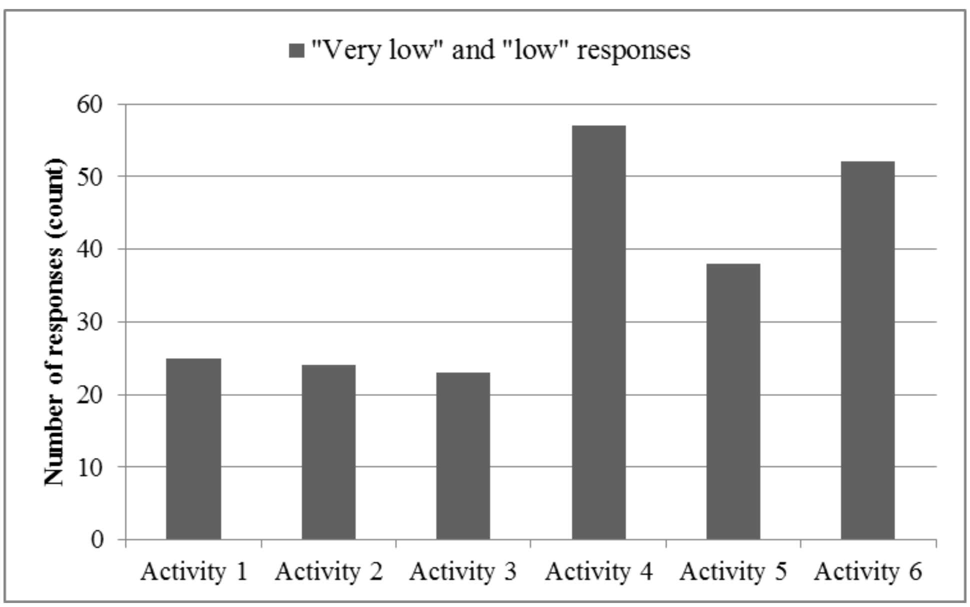


Figure 2.11 The number of students that reported "very low" or "low" levels of interest varied from activity to activity (spring and fall 2011).

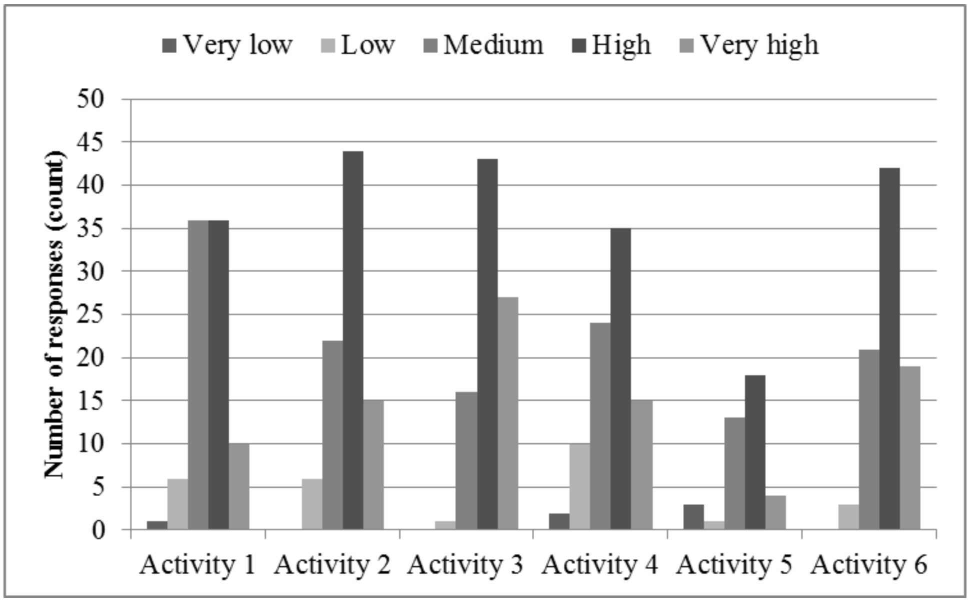


Figure 2.12 Level of impact each activity had on students' intellectual curiosity of the concepts taught (spring and fall 2011).

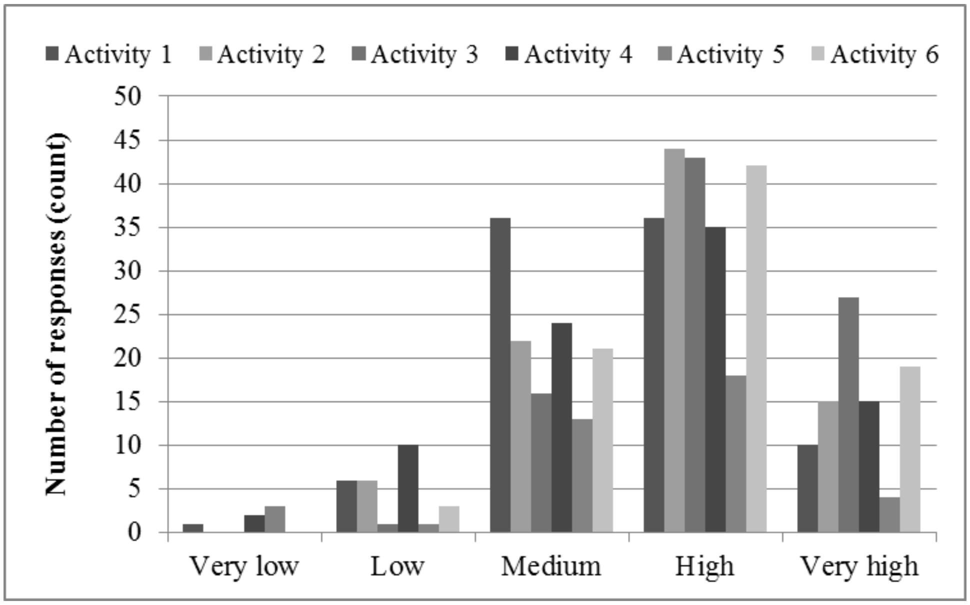


Figure 2.13 Reported level of impact of the new/modified activities on increasing students' intellectual curiosity of the learning outcome concepts (spring and fall 2011).

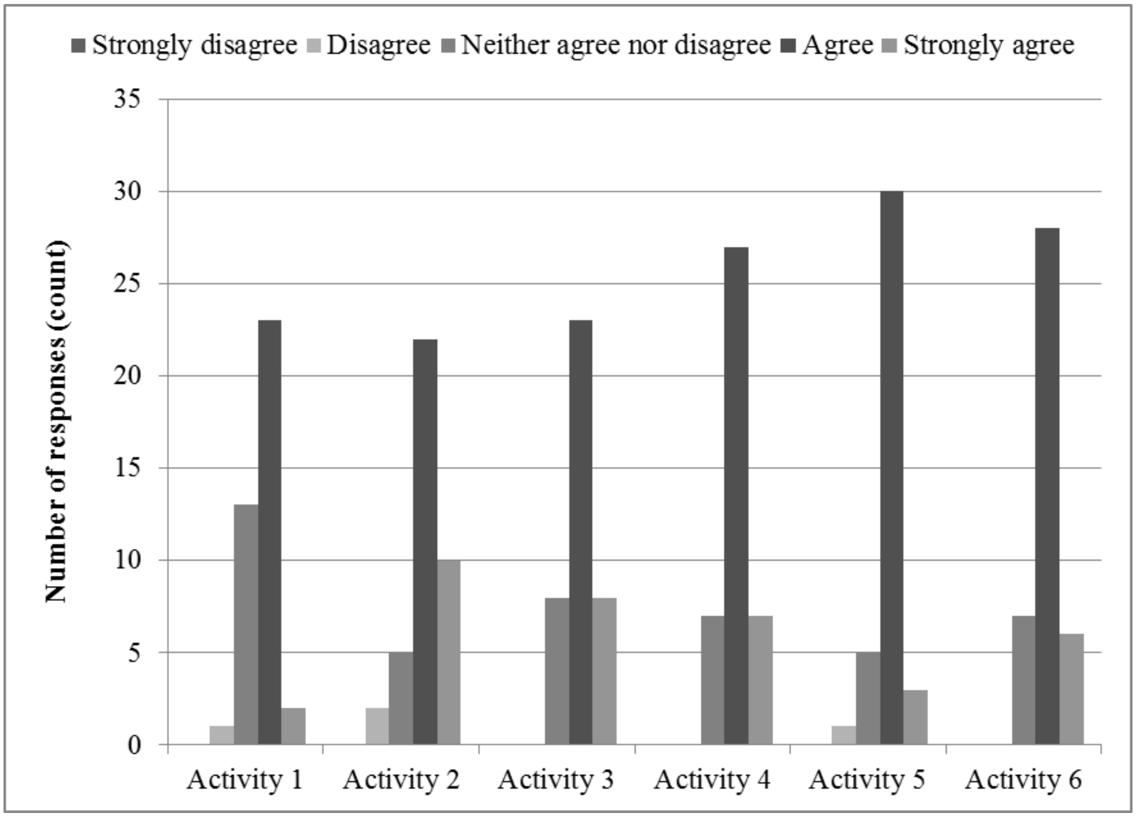


Figure 2.14 The number of responses of students in the spring of 2011 to the question/statement regarding each new/modified activity: "The activity improved my comprehension of the material. - Did the activity make sense to you?"

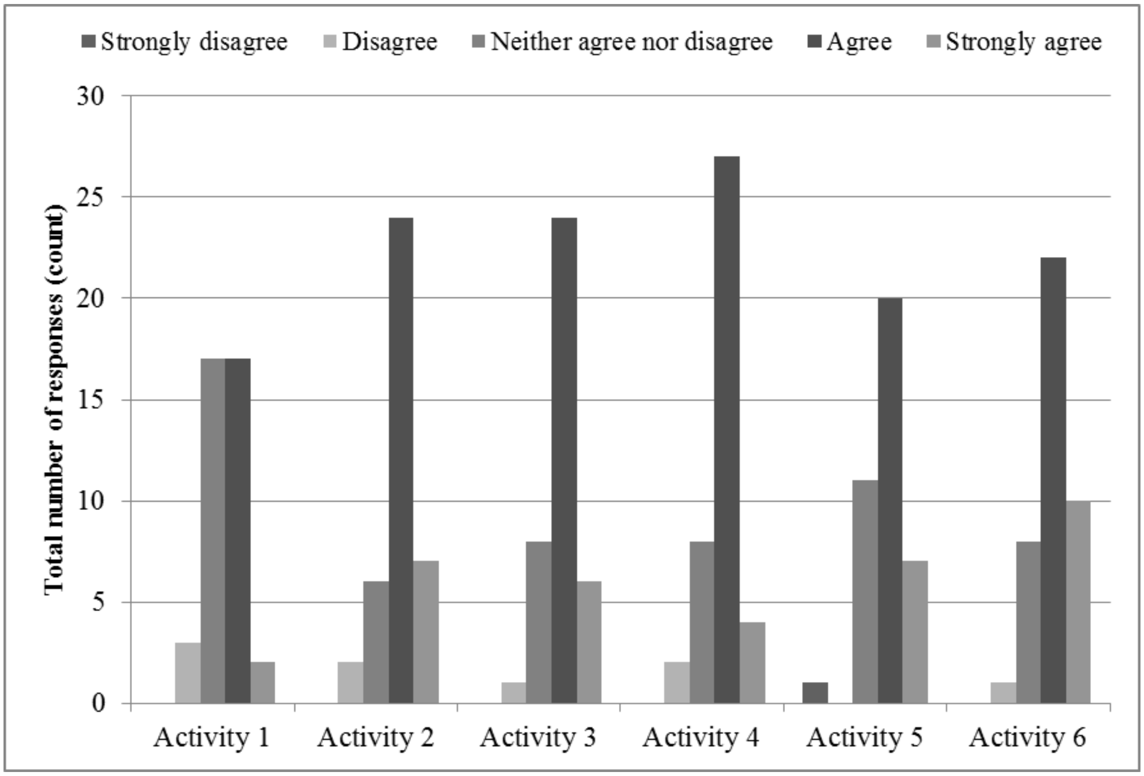


Figure 2.15 The number of responses from students in the spring of 2011 to the questions/statement regarding each new/modified activity: "The activity improved the relevance of the material for me. - Was the activity relevant to you?"

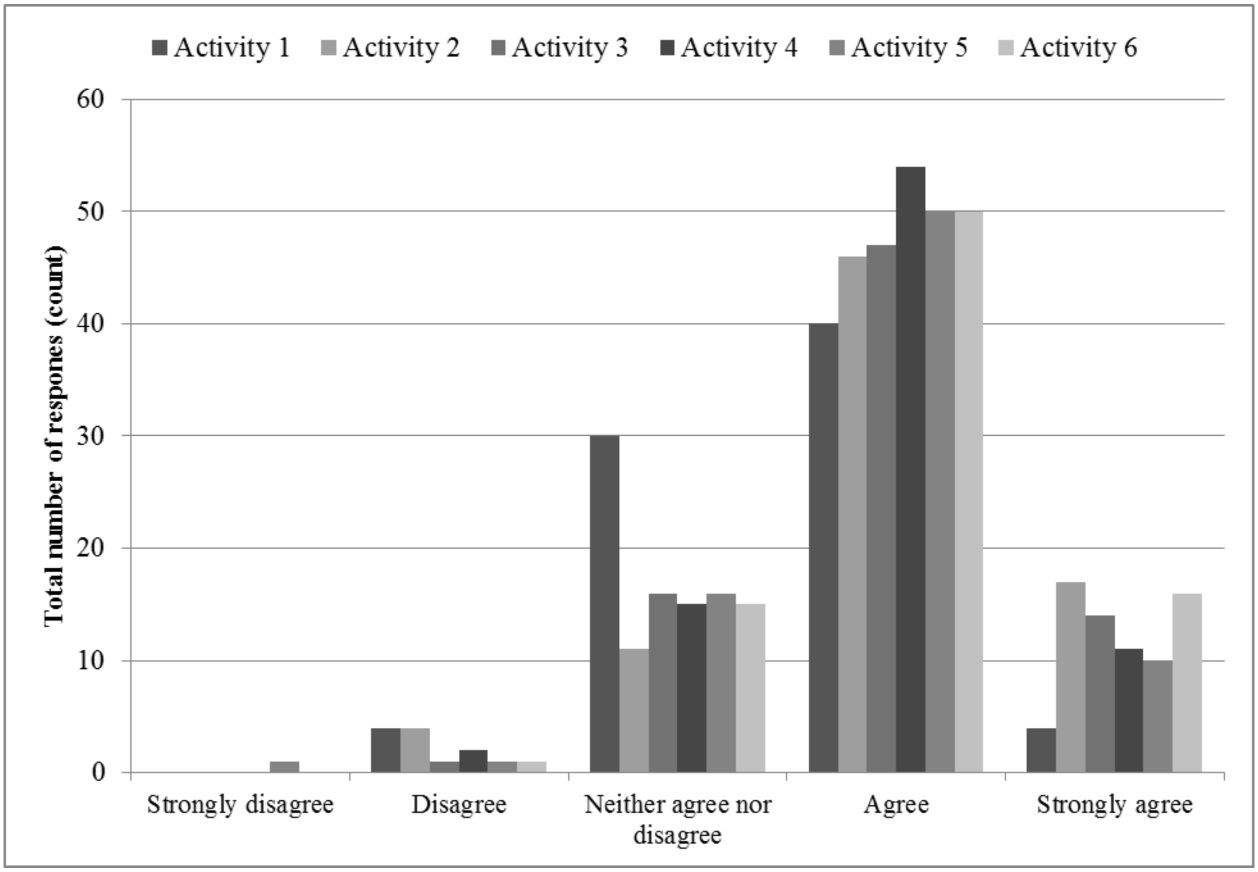


Figure 2.16 Overall total number of student responses to both the sense and meaning statements (spring 2011).

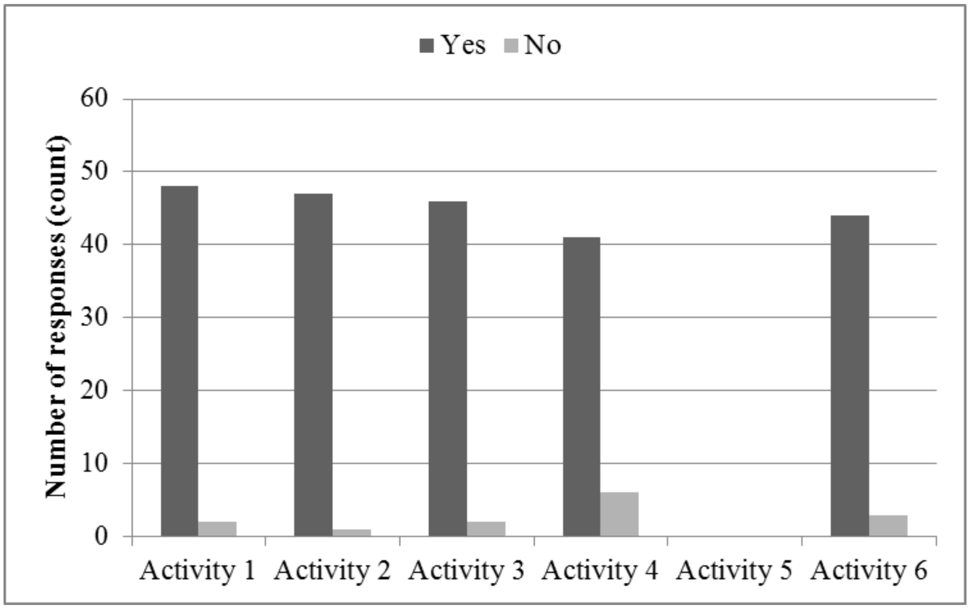


Figure 2.17 The total of student responses to the question, "Was sense present?" for each of the six new/modified urban soils activities (fall 2011).

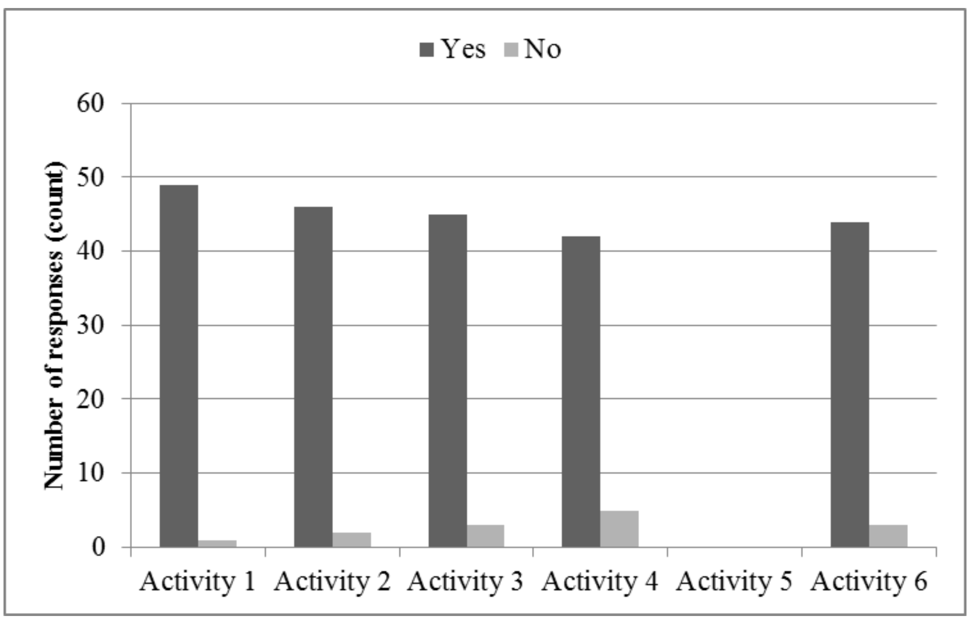


Figure 2.18 The total number of student responses to the question, "Was meaning present?" for each of the six new/modified urban soils activities (fall 2011).

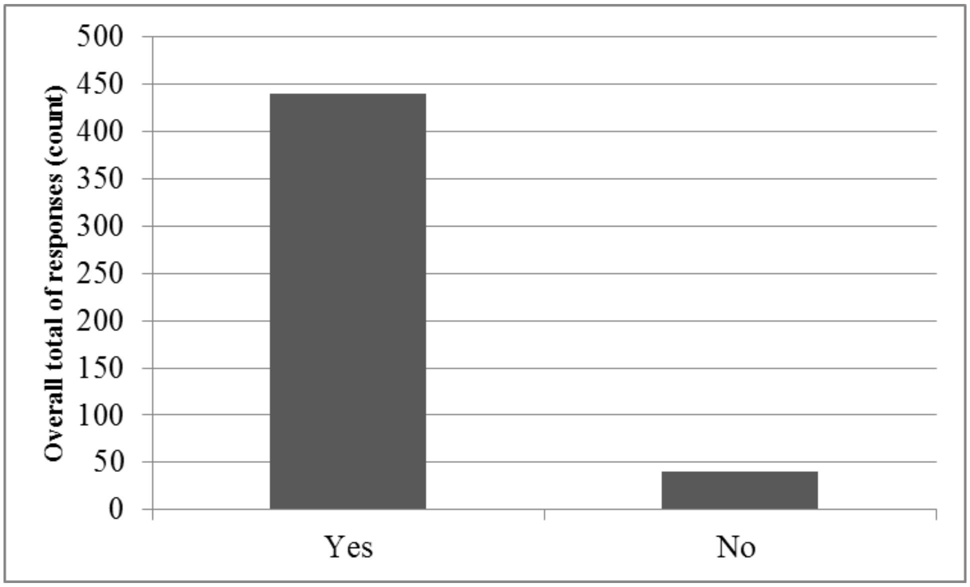


Figure 2.19 Overall total number of student responses indicating whether both sense and meaning were present in all of the activities (fall 2011).

Figure 2.20 Word cloud of student comments on their favorite AGRON 305: Urban Soils laboratory activities (fall 2011).

Appendix A

Learning outcomes handout for Lab 1: Urban Soil Development

AGRON 305 – Urban Soils Lab
August 23, 2011

Lab 1: Urban Soil Development
"Be it deep or shallow, red or black, sand or clay, the soil is the link between the rock core of the earth and the living things on its surface. It is the foothold for the plants we grow. Therein lies the main reason for our interest in soils."
- Roy W. Simonson, USDA Yearbook of Agriculture, 1957

Learning Outcomes:
What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 1: Soil Development, you should be able to do the following:

1. Define soil, anthropogenic soil, and urban soil.
2. List and describe the *six* soil forming factors.
3. Describe the *observable* differences between soils in urban and agricultural environments.
4. Recognize the heterogeneity of urban soils.
5. List several ways in which humans influence soils.

Lab Activities:
What will I do in lab this week?

1. Observe and describe soils.
   Create an observations list titled, *How Soils Differ*.
   Observe and discuss the variability and human impacts of urban soil profiles (Slide images).
   Investigate the different properties of Kansas soils using the Natural Resource.
   Conservation Service's (NRCS) soil survey reports, maps, and monoliths.
   Practice seeing the differences (even the slightest) among soils.

2. Model an urban soil
   Interpret a recorded history of an urban site and model the physical changes to the urban soil profile over time.
   Using a glass cylinder and materials in the lab, visualize and create the soil profile you would expect to see given the detailed site history.
   Sketch a drawing of the urban soil profile you created in lab.
   Compare and contrast your soil profile model to your peers' profile models

Appendix B

Lab 1: Urban Soil Development Handouts

Site # 1: Residential Neighborhood

The Natural Soil :

The natural soil of Site # 1 is a Smolan silt loam. See profile at the front of the room for an example of this soil series.

The Anthropogenic Soil :

In 1910, grading of areas throughout site # 1 leveled the landscape for houses. Basements were dug, and there was a mixing of soil horizons (layers) and removal of the dark topsoil. Grass was established for lawns around the houses built on Site # 1.

In 2002, the houses were dilapidated and each of the houses were razed and toppled into their foundations. Debris from the houses can be found in the top 10 feet of soil. Fill materials were brought onto Site # 1 to cover and fill in the areas where houses previously stood. Much of the debris from the homes, including concrete, glass, ceramic tiles, and wood, were simply covered up with subsoil (light colored, low organic matter) fill material that was brought in from another construction project site.

In 2011, the site was converted into a park and gravel was incorporated into the surface soil and spread on top of the soil surface at Site # 1.

Site # 2: City Lot

The Natural Soil :

The natural soil of Site # 2 is a Smolan silt loam. See profile at the front of the room for an example of this soil series.

The Anthropogenic Soil :

In 1940, grading of areas throughout site # 2 leveled the landscape to construct a grocery store. There was a mixing of soil horizons and removal of the topsoil (dark colored, high organic matter soil). An open lot beside the store was left bare and exposed.
In 1969, a fuel filling station was built. Underground storage tanks were constructed. The majority of the dark, fertile topsoil from the site was scraped from the surface during the construction of the fueling station, pump islands, and parking lot. Soils on Site # 2 were severely compacted throughout the construction process.

In 1990, the dilapidated site was razed, the concrete parking lot torn out, and the underground storage tanks were left intact underground. Although the majority of the building and parking lot materials were removed from Site # 2, debris was still strewn throughout the surface soil.
In 2011, the local government plant grass as a beautification project. The goal of this municipal project was goal to convert to the site into a playground area for local children.

Activity:

Model an example of a soil profile that you might find on Site #1 and Site #2 today. You may use the glass cylinders and materials provided in lab, including but not limited to:

Dark topsoil with high organic matter and crumbly structure
Lighter subsoil with low organic matter
Rubble : Concrete, glass, wood, metal, etc.
Other materials: rock, trash, wood chips, etc

Appendix C

Learning outcomes handout for Lab 2

AGRON 305 – Urban Soils Lab
August 30, 2011

Lab 2: Site Analysis – Urban Site Risk Assessment and Management
"Land use according to its capability conforms with natural law… Productive land is neither limitless nor inexhaustible."
Hugh Hammond Bennett. The Hugh Bennett Lectures. Raleigh, North Carolina: The Agricultural Foundation, Inc., North Carolina State College, June 1959.

Learning Outcomes:
What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 2: Site Analysis – Urban Site Risk Assessment and Management, you should be able to do the following:

1. Describe how soil properties relate to soil quality, use and management
2. Describe some of the unique soil properties of urban soils and explain how these properties impact soil quality for urban uses
3. Utilize the tools of the Web Soil Survey with ease
4. Interpret soil properties of an urban site using the Web Soil Survey and evaluate the potential risk and potential suitability of the urban soils present for a particular urban use or function
5. Propose a simple risk management option to address potential risks associated with urban land use

Lab Activities:
What will I do in lab this week?

1. Discuss soil quality/health, use, function, and indicators, and the use of these concepts to assess urban sites risk and potential management strategies
2. Practice using the tools and interpreting the resources of the Web Soil Survey
3. Assemble information from the Web Soil Survey and other resources on the Manhattan Community Garden site.
4. Compose a site analysis report detailing soils information of the Manhattan Community Garden from the Web Soil Survey
    - Assess soil quality and site risks as it pertains to the site use
    - Propose a risk management plan for site

See the report guidelines/rubric handout for guidance on writing this report.

Appendix D

Lab 2: Site Analysis – Urban Site Risk Assessment and Management Handouts

Urban Soils Lab – Risk Assessment and Risk Management

What is risk?

The United States Environmental Protection Agency (US EPA) defines risk to be: "the chance of harmful effects to human or ecological health resulting from exposure to an environmental stressor."

What is a stressor?

A stressor is any physical, chemical, or biological thing that can induce an adverse response. Stressors negatively affect plants and animals, impact natural resources, interrupt environmental cycles or degrade ecosystems.

Risk, in terms of human health and ecological systems, is the probability of a hazard causing harm to humans or the environment.

How do we determine risk?

The EPA uses *risk assessment* as a method of characterizing the risks present in the environment. Often times our perception of risk is different from reality, therefore, risk assessment and risk management objectively quantify the probability of a hazard and its impact on human or ecological health.

What is risk assessment?

A risk assessment characterizes the *nature and magnitude* of risks to humans (residents, workers, visitors, etc.) or the ecosystem (plants, animals, soil, water, etc.) that may be present on the site or within a direct proximity to the site. In other words, what is the risk and how great is it? Assessment should include risks/stressors relating to the historic, current, and projected land uses. In addition, it is often advisable to conduct a *field inspection* of the site to seek visible evidence of risks/stressors and collect samples. A good assessment considers many potential risks/stressors, including those which are off-site.

The assessment phase should identify:

- each risk/stressor
- the likelihood of exposure
- a rank the severity with regard to human and ecological health.

If no sign of risk is discovered during the site assessment, then the site can be deemed to be low risk and utilized according to its basic environmental limitations.

Once risk is determined, how do we minimize risk?

If risk to human and/or ecological health is identified, then *precautions and limitations* to use must be determined, and, if warranted, *a site cleanup* strategy proposed. This phase is called risk management.

What is risk management?

Risk management requires identifying the *best management practices* (BMPs) for reducing or eliminating risks/stressors at this specific site. In other words, what can we do to reduce the risk?

Risk management addresses:

- the extent of the problem (historic, ongoing, future)
- strategies for eliminating the cause
- remediation techniques
- specific cleanup goals
- timeline for cleanup
- follow-ups to determine the efficacy of the management methods

Application of the EPA's risk assessment and risk management guidelines demonstrate an example of scientific problem solving. Include at least one risk assessment and management strategy on your site analysis report in lab.

Useful references:

Environmental Protection Agency : http://epa.gov/riskassessment/basicinformation.htm#arisk
Ecological Risk Assessment : http://www.epa.gov/risk/ecological-risk.htm
Human Health Risk Assessment : http://www.epa.gov/risk/health-risk.htm
Waste considerations : http://www.epa.gov/oswer/riskassessment/index.htm

Appendix E

Lab 2: Site Analysis – Urban Site Risk Assessment and Management Report Rubric

AGRON 305 – Urban Soils Lab

Site Analysis Report - Laboratory Report Guidelines

DUE: September 6, 2011 **40 points total**

Scenario

Site : Manhattan Community Garden, the corner of 8th and Riley Lane.

Client : Urban growers at the Manhattan Community Garden and Manhattan community leaders.

Problem : This site is zoned as unspecified green space. Is this site is currently being utilized as community garden space. Is this site best suited as a community garden or is it better suited for another use?

Are there any human or ecological health risks on this site? If so, how can we mitigate these risks?

Your goal : Research the MCG site using the tools available on the Web Soil Survey, and prepare a typed report for your client (the gardeners at the MCG) explaining why this site is <u>or</u> is not suitable for use as a community garden and address an risks associated with the site.

Report Guidelines – Your client would like you to please include the following:

1. *Introduction (5 pts)*
   - Describe the site and its intended use
   - Describe the client to which you're writing this report

2. *Consulting information (5 pts)*
   - Describe the intended use
   - Include a soil map of the Area of Interest and a map legend

3. *Interpretation and recommendation (30 pts)*

- List and describe for your client the physical, chemical, biological, and water properties of the soils on the site. You may also want to incorporate relevant, individually created tables, graphs & graphics.
- Interpret these soil properties and explain how they impact the intended use of the site.
- Include an assessment of at least one ecological or human risk on the site, and suggest management strategies to mitigate this risk.
- Develop a recommendation giving the gardeners and community leaders a summary statement they could use when making a decision about the site and its future use. (Address the question associated with the problem above)

Appendix F

Learning outcomes handout for Lab 3: Principles of Composting

AGRON 305 – Urban Soils Lab

September 6, 2011

Lab 3: Principles of Composting

In 2009 alone, the Environmental Protection Agency reports, municipal solid waste produced by American households, businesses and hospitals amounted to ***243 million tons*** *of trash, or roughly 4.3 lbs. per person per day. In addition to common daily waste such as food scraps and paper, many other items contribute to the municipal solid waste stream, including yard waste and clothing.*

Although 82 million tons of this waste was recycled or composted in 2009, more than half ended up in landfills. The EPA estimates that 55 to 65 percent of total municipal solid waste in the U.S. comes from households.

Organic materials *continue to be the largest component of MSW. Paper and paperboard products account for 34 percent, with yard trimmings and food scraps accounting for 25 percent.*

Source: Environmental Protection Agency. 2009. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures. Available at: http://www.epa.gov/epawaste

Learning Outcomes:

What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 3: Composting, you should be able to do the following:

1. Define compost/composting
2. List the seven keys to composting
3. Explain how each of the seven keys to composting impact compost production
4. Practice the seven keys to composting - manage a compost bin in lab over the next several weeks
5. Debate the unique challenges of producing compost in urban and rural environments (Autrey et al., 2006)

Lab Activities:

What will I do in lab this week?

1. Discuss of the principles of composting
2. Implement the keys to composting – Assemble your compost bin
3. Judge the problem outlined in the Municipal Solid Waste case study (Autrey et al., 2006) and select a side to the issue. – Justify your stance in a one paragraph statement.

Appendix G

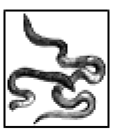
Lab 3: Principles of Composting Handouts

1. Materials:

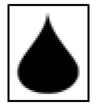
Organic materials such as leaves, grass clippings, food scraps, paper and cardboard, wood, etc. can be used in the composting process. Carbon and nitrogen compounds in these materials fuel microorganisms as they decompose these materials. The microorganisms use the carbon as an energy source. Nitrogen is used by microorganisms as a key element in proteins within their bodies. All organic materials have a ratio of carbon to nitrogen (C:N) in its tissues, ranging from 500:1 for sawdust, to 15:1 for food waste. A C:N ratio of 8:1 is ideal for the activity of compost microbes. This C:N balance can be achieved by thoroughly mixing together high C:N materials and low C:N materials within the same compost pile/bin. See the table below for the C:N ratios of common waste materials.

Material	C:N
Food waste	10-15
Grass	20-40
Leaves	40-100
Wood/Sawdust	200-800
Pine needles	200
Straw	50-150
Newspaper	400-800
Cardboard	500

2. Biology



The incorporation of soil into a compost pile encourages beneficial microbial communities of bacteria, fungi, actinomycetes, protozoa, worms, and insects which aid in the decomposition of the organic materials. These organisms benefit from the composting process by gaining energy and nutrients from the materials. The composting process continues quickly as these organisms work to decompose the materials. The smaller the pieces of organic materials (the greater the surface area exposed to microbes for decomposition) the faster the composting process will progress.

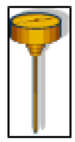


3. Moisture:

Microbes, like all organisms, require water to live. They function best when the compost materials are about as moist as a wrung-out sponge, allowing also for good aeration. Keeping your compost pile at a steady moisture level is essential, and the compost may need to be watered if it begins to dry out.

4. Aeration:

Most microbes in the compost pile require oxygen to complete decomposition. Turning the compost pile opens up pores and allows air to enter the middle of the pile.

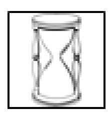


5. Temperature:

The decomposition process within a composting pile can increase the temperature of the material considerably. A compost pile can even be so hot at times that it may burn your skin. Compost piles should not become too hot that it might kill the beneficial organisms. Turning compost to lower any extremely high temperatures may be necessary.

6. Volume:

A large compost pile will easily hold its own heat from microbial activity. Its center will be warmer. Piles smaller than 3 feet cubed will have trouble holding this heat, while piles larger than 5 feet don't allow enough air to reach the microbes at the center.



7. Time:

Composting requires time. The entire compositing process could take as little as six weeks and as long at 6 months depending on the all of the previously mentioned conditions.

Appendix H

Lab 3: Principles of Composting Procedure

Composting Activity
September 6, 2011

Constructing a Compost Bin

Each lab bench group will construct one compost bin. The group will be responsible for also maintaining the compost bin for the remainder of the semester.

Materials

- 3 gallon bucket or large coffee can
- Compostable materials with varying C:N ratios such as food waste, leaves, egg shells, coffee grounds, newspaper, compostable food containers, crop residues, grass clippings, etc.
- Soil
- Plastic beakers
- Balance
- Thermometer
- Water

Part 1. Evaluating the compostable materials

1. Determine the weight of a plastic beaker, then place materials in this beaker to determine the weight of the different compostable materials. Record each material and its weight on your provided record sheet.

2. Utilizing the C:N ratio table provided, determine the C:N ratio for each of the compostable materials. Record each C:N ratio.

3. Combine all compostable materials into the provided compost bin (3 gallon plastic bucket or plastic coffee can). Fill the bin only 2/3 full to allow room for mixing your compost.

4. Fill your plastic beaker once or twice with soil. Determine the weight of the soil before adding it to the compost bin mixture. Record the mass of soil added.

5. Cap the bin and roll across the bench top to thoroughly mix.

6. Uncap the bin and carefully insert a thermometer into the center of the bin to determine the temperature of the compost. Record the temperature.

7. Use a graduated cylinder to measure a volume of tap water. Add enough water your bin to slightly moisten the compost. Remember the Squeeze Test rule! If you’ve added a large quantity of moist food waste, then no additional water is needed. Record the volume of water added.

8. Cap the bin and roll to thoroughly mix the compost.

9. Label the lid on your bin with colored tape. Indicate your lab section and group name.

10. Repeat steps 6-9 each week until the end of the semester to track the progress of the compost.

Composting Activity Record Log

AGRON 305 - Fall 2011

Lab Section ____

Lab Group ____

Date:		
Mass of soil added (g)	Volume of water added (mL)	Temperature (°C)

Description of material	Mass (g)	C:N

Appendix I

Lab 3: Principles of Composting Activity Questions

AGRON 305 – Urban Soils Lab
Lab # 3 – Composting
Due: September 13, 2011

NAME:____

1. Read the article "A Blessing or a Curse: An Environmental Decision Case for Secondary and Higher Education" by Autry et al. (2006).
2. Answer each of the following short answer questions (Autrey et al., 2006).

Q1. What issues do you think are more important in this case?

Q2. What was the dilemma/problem from Tom Walker's point of view?

Q3. Who, besides Keller, could be affected by Walker's decision?

Q4. What should Tom Walker do and why?

Appendix J

Learning outcomes handout for Lab 4: Detection of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer

AGRON 305 – Urban Soils Lab
September 27, 2011

Lab 4: Detection of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer

Learning Outcomes:
What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 4: Detection of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer, you should be able to do the following:

1. Define FP XRF
2. Illustrate how a FP XRF instrument measures the presence and concentration of trace elements in a soil sample
3. Explain how a FP XRF instrument can be utilized during an urban site analysis
4. Differentiate between the common trace element contaminants of urban soils (Pb, Cd, As), their sources, exposure pathways, and risks to human health.

Lab Activities:
What will I do in lab this week?

1. Sketch how the XRF measures the presence and concentration of elements in soil. Sketch how you might sample using the XRF on a small urban site such as the Manhattan Community Garden
2. Measure the presence and concentration of trace elements in agricultural, suburban, and urban soil samples
3. Compile and compare information on common urban contaminants, their sources, exposure pathways, and any potential risks.

   Read the document,
   EPA. 2011. Reusing Potentially Contaminated Landscapes: Growing Gardens in Urban Soils. available at www.epa.gov/brownfields/urbanag/

   Visit the website,
   EPA. 2011. Tools for Ecological Land Reuse. Available at: http://www.clu-in.org/ecotools/urbangardens.cfm

Appendix K

Lab 4: Detection of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer Handouts

AGRON 305: URBAN SOILS LAB

Field Portable X-Ray Fluorescence Spectrophotometer (FP-XRF)

What is a FP-XRF?

FP-XRF is a handheld instrument used for routine, non-destructive chemical analysis of soils, rocks, minerals, etc. The XRF instrument is often used for preliminary analysis of soils to determine presence and/or general concentrations of common elements.

How can FP-XRF be effectively utilized for site analysis in urban environments?

XRF can easily be utilized in the field to easily determine of the presence and concentration of common trace element contaminants in urban environments such as lead, cadmium, arsenic, and many others. The XRF cannot detect organic contaminants. A simple map can be constructed using GPS coordinates of sample locations, Geographic Information Systems (GIS) software, and the soil analysis data. Preliminary sampling maps allow rapid site analysis and may indicate areas of higher contaminant concentrations.

How does the XRF work?

The instrument releases x-rays to the sample's surface few millimeters. When this x-ray strikes the sample, it can either be absorbed by the atoms present or can scattered throughout the material. When the x-ray is absorbed by the atom, it transfers all of its energy to an inner electron. If the x-ray has enough energy, then electrons are ejected from the inner shell which creates available gaps in the inner shell. This creates unstable conditions, and the electrons from the outer shells are transferred into the inner shells. This transfer gives off a unique x-ray and the energy of this unique x-ray is used to determine the presence and concentration of the particular elements present.

Demonstrate your interpretation of the process described above - Please sketch below how the x-ray emitted by the XRF interacts with trace elements present in a sample.

Appendix L

Lab 4: Detection of Soil Trace Element Concentrations using an X-Ray Fluorescence Spectrophotometer Procedure

AGRON 305: Urban Soils Lab

Measuring the presence & concentration of common urban trace elements using a Field Portable X-Ray Fluorescence

Experimental Procedure

Materials

- Ground, homogenized soil (> 20 g per sample)
- Brown packing paper to place samples on
- Small plastic soil scoop
- Field portable X-Ray Fluorescence (XRF) instrument
- National Institute of Standards soil standard

Measurement

1. Grind the soil through a 2mm mesh sieve**,** homogenize each soil sample
2. Weigh 20 grams of soil onto a piece of clean, brown packing paper
3. Using a plastic soil scoop, push the soil into a mound, flatten the top of the mound forming a plateau
4. Calibrate the XRF instrument using a known NIS soil standard
5. Carefully place the emission screen parallel to the surface of the soil sample, and gently lower the XRF onto the surface of the soil sample being careful not to use too much pressure as to disperse the soil sample into a thin layer.
   CAUTION – The XRF emits small amounts of x-rays. Please remain behind the XRF device at all times. NEVER point the XRF emission screen at another person. If you have questions about these words of caution, please ask before we begin our readings.
6. Pull the trigger of the XRF instrument to begin a measurement. Measurements should take between 2 and 4 minutes. When a measurement is complete, the instrument will beep.
7. Remove the trigger and carefully lift the XRF device away from the soil sample.
8. The concentrations in ppm may be read from the small screen on the XRF instrument.
9. Record the concentrations for our samples below.

Element	Eudora soil concentration (ppm or mg/kg)	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Agricultural soil concentration (ppm or mg/kg)	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Suburban soil concentration (ppm or mg/kg)	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Sample:	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Sample:	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Sample:	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Sample:	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		
Element	Sample:	Is this of concern?
Lead (Pb)		
Cadmium (Cd)		
Arsenic (As)		

Appendix M

Learning outcomes handout for Lab 5: Impact of Soil Contamination on Soil Microbes

AGRON 305 – Urban Soils Lab
October 18-November 15, 2011

Lab 5: Impact of Contamination on Microbial Decomposition of Organic Materials in Soil
"*The soil is the great connector of our lives, the source and destination of all.*"
Wendell Berry, The Unsettling of America, 1977

Learning Outcomes:
What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 5: Impact of Contamination on Microbial Decomposition of Organic Materials in Soil, you should be able to do the following:

1. Diagram the relationship between the terms decomposition, mineralization, immobilization, nitrate depression, and C:N ratio.
2. State our two research hypotheses for the Microbial Decomposition experiment.
3. Evaluate the validity of information sources.
4. Assemble and interpret research results on the impact of gasoline contamination on soil microbial activity.
5. Demonstrate mastery of acid-bas titrations, soil extraction, and colorimetric analysis procedures.
6. Collect and prepare experimental data.
7. Construct graphs in Microsoft Excel of experimental data.
8. Analyze experimental data and propose conclusions to our experimental hypotheses.
9. Apply results/conclusion from our experiment to a real-life situation in an agricultural and urban situation.

Lab Activities:
What will I do in lab this week?

1. Recall and discuss experimental procedure, acid-base chemistry, and quantitative techniques.
2. Measure, collect, and discuss data on carbon dioxide evolved and soil nitrate concentrations in our Microbial Decomposition of Organic Materials in Soil experiment. Please also see the amendment to Exercise 14.
3. Practice acid-base titration, soil extraction, colorimetric analysis.

4. Compose a research report on the benefits of soil microbes and the impacts of gasoline contamination on soil microbial biomass and community structure. (See handout)
5. Prepare an experiment report in which you detail and interpret your findings from our Microbial Decomposition of Organic Materials in Soil experiment. (See handout/rubric)

Appendix N

Lab 5: Impact of Soil Contamination on Soil Microbes – Literature Review Handout

Impact of Gasoline Contamination on Soil Microbes

AGRON 305 – Urban Soils Lab
Due: November 1, 2011

Learning outcome:
Upon completion of this activity you should be able to:

1. Investigate a new topic utilizing the resources available at the Hale Library
2. Assess the validity of scientific references.
3. Conclude on the functions of soil microbes in the soil ecosystem.
4. Categorize the impacts of gasoline contamination on soil microbial communities.

Activity:

1. *Research the benefit of microbes in the soil.*
   Questions you may want to explore:
   What functions do soil microbes serve in the soil ecosystem?
   How do soil microbes impact soil quality:
   for plant growth?
   for water movement?
   for water storage?
   for carbon and nutrient storage?

2. *Research how gasoline contamination may impact soil microbial biomass and community structure.*
   Questions you may want to explore:

   Do soil microbial populations increase or decrease in the presence of the pollutant?
   Does the composition of the soil microbial community change?
   Is there more fungi, bacteria, actinomycetes, or macrofuana, etc?

Compose 1 page literature review summarizing your research findings on the two topics listed above. Please cite all references, and include at least two scientific journal articles in your research.

Appendix O

Lab 5: Impact of Soil Contamination on Soil Microbes Procedure Handout

AGRON 305: Urban Soils Lab

Amendment to Exercise 14: Microbial Decomposition of Organic Materials in Soil

Treatment Comparisons

Use the following treatment comparison to aid in the interpretation of this experiment.

1. Decomposition of low C:N ratio residue : Alfalfa and untreated
   Alfalfa contains more readily decomposable carbon materials than wheat. Also, the higher nitrogen content of this residue reduces soil nitrate immobilization. The carbon dioxide evolution peak and nitrate depression should both happen rather quickly.

2. Decomposition of wide C:N ratio residue: Wheat and untreated
   Adding wheat residue (wide C:N) to soil illustrates the nitrate depression effect. The magnitude of this effect is observed by comparing it with the untreated sample to see how much soil nitrate is immobilized. Adding residue with a C:N ration greater than 26:1 typically causes periods of net immobilization. The wider C:N of the residue, the greater will be the extent of the nitrate depression period.

3. Comparison of decomposition of two organic materials : Wheat and Alfalfa
   Comparing residues with different C:N ratios demonstrates the effect of this characteristic on rate of decomposition of organic materials, carbon dioxide evolution (microbial activity), and soil nitrate levels (nitrate immobilization).

4. Decomposition of low C:N ratio residue in gasoline contaminated soil : Alfalfa in gasoline contaminated soil and Alfalfa in uncontaminated soil
   Comparing contaminant concentrations in the soil (natural soil and gasoline spill) demonstrates the effect of this contamination on the rate of decomposition of organic materials, carbon dioxide evolution (microbial activity), and soil nitrate levels (nitrate immobilization).

5. Comparison of microbial activity of two soils: Contaminated soil and untreated soil
   Comparing an uncontaminated soil with a soil contaminated by gasoline demonstrates the effect of contamination on carbon dioxide evolution (microbial activity) and soil nitrate levels (nitrate immobilization).

Appendix P

Lab 5: Impact of Soil Contamination on Soil Microbes Report Rubric Handout

Microbial Decomposition of Organic Materials in Soil

Laboratory Report Guidelines

Each of you will prepare a written laboratory report for Exercise 14: Microbial Decomposition of Organic Materials in Soil, based on the averaged class data and using the format described here.

DUE : April 15, 2011 by 5:00pm

80 points are possible (85 with bonus points)

Include the following headings to indicate each of the sections within your report.
Include all of the information outlined below to receive maximum points for each section.

Page 1. Introduction (10 pts)

Your introduction should consist of 3 parts:

A. Title and your name
B. A description of the audience you're writing to and their expected application of this information
   (Please direct your report to the gardeners of the Manhattan Community Garden)
C. A clear statement of the objective (or purpose) of this laboratory experiment

Page 2. Results 1 (20 pts)

A detailed comparison of the results of the wheat and alfalfa treatments (uncontaminated soil)

Your results section should consist of 3 parts:

A. A computer-generated graph that compares the wheat and alfalfa treatments. (Please include a title and axis labels on your graph)
B. Detailed explanation of how and why the CO_2 and NO_3^- levels change over time in a way that illustrates your knowledge of the following terms:
   - Immobilization
   - Mineralization
   - Microbial decomposition

(Please include each of these terms in your explanation)

C. A description of the significance of your results to your audience's informational needs and interests. (Explain how this information affects their soil management)

Page 3. Results 2 (20 pts)

A detailed comparison of the results of the alfalfa in contaminated soil and alfalfa in uncontaminated soil treatments

Your results section should consist of 3 parts:

A. A computer-generated graph that compares the alfalfa in contaminated soil and in uncontaminated soil treatments. (Please include a title and axis labels on your graph)

B. Detailed explanation of how and why the CO_2 and NO_3^- levels change over time in a way that illustrates your knowledge of the following terms:

   Immobilization
   Mineralization
   Microbial decomposition

   (Please include each of these terms in your explanation)

C. A description of the significance of your results to your audience's informational needs and interests. (Explain how this information affects their soil management)

Page 4. Results 3 (20 pts)

A detailed comparison of the results of your choice

Your results section should consist of 3 parts:

A. A computer-generated graph that compares the results of your choice. (Please include a title and axis labels on your graph)

B. Detailed explanation of how and why the CO_2 and NO_3^- levels change over time in a way that illustrates your knowledge of the following terms:

   Immobilization
   Mineralization
   Microbial decomposition

   (Please include each of these terms in your explanation)

C. A description of the significance of your results to your audience's informational needs and interests. (Explain how this information affects their soil management)

Page 5. Conclusions (10 pts)

Briefly answer the following questions for your audience in no less than 2 paragraphs. Please explain these topics in relation to your audience, their interests, and our laboratory experiment.

A. What does previous research report about the effects of gasoline on microbial activity and growth? (You may use the information you gathered for the microbe research activity)
B. What do your experimental results indicate about the effects of gasoline on microbial activity and growth?
C. Do your experimental results from Exercise 14 support what the previous scientific research has found?

Bonus (5 pts)

Include at least 3 references (other than the text, lab manual, and articles handed out in lab) in support of your evaluations and correctly cite them in text and at the end of your report. If you are unsure of how to correctly cite references, look it up.

Appendix Q

Learning outcomes handout for Lab 6: Assessment of Urban Soil Quality and Gardening in Urban Environments

AGRON 305 – Urban Soils Lab
October 4, 2011

Lab 6: Assessment of Urban Soil Quality and Gardening in Urban Environments

Is it safe to grow food in urban areas? How can we assess the health of urban soils?

Learning Outcomes:
What should I be able to do after this week's lab activities?
What should I learn from this week's activities?

After completing Lab 6: Assessment of Urban Soil Quality and Gardening in Urban Environments, you should be able to do the following:

1. Demonstrate mastery of soil sampling and field soil testing techniques.
   Sample soils in urban environments and measure the following key soil properties using the soil testing kits: bulk density, soil temperature, texture, infiltration rate, pH, vegetative cover, microbial activity, macrofauna community structure, taxonomic order, presence of heavy metal contaminants, and extent of human disturbance.
2. Propose a best management practice (BMP) based on your soil testing for the urban gardeners of the Manhattan Community Garden to mitigate their risks associated with gardening in urban soils.

Lab Activities:
What will I do in lab this week?

1. Interact with gardeners and leaders of the Manhattan Community Garden
2. Practice soil sampling and testing techniques – Record data on handouts
   Cornell Soil Health Assessment Training Manual available at:
   http://soilhealth.cals.cornell.edu/extension/manual.htm
3. Inspect the urban site – Using all senses create a list of observations
4. Interpret the soil quality and potential risks for gardening on the soils of the Manhattan Community Garden – Act as a consultant and propose a BMP to the gardeners present.

Appendix R

Lab 6: Assessment of Urban Soil Quality and Gardening in Urban Environments Reading Questions

AGRON 305: Urban Soils Laboratory

Activity 6: Assessment of Urban Soil Quality and Gardening in Urban Environments

Please read the Environmental Protection Agency document, Reusing Potentially Contaminated Landscapes: Growing Gardens in Urban Soil, available at:

http://clu-in.org/download/techdrct/urban_gardening_fact_sheet.pdf

Then read the following statement from Kim and answer the questions below prior to the Manhattan Community Garden field trip next week.

"My name is Kim, and I am 37 year old teacher in Joplin, Missouri. My husband and I live in a house built in the 1940's with our two children, Henry aged 3 ½and Jill aged 4 months. During a routine health check-up for Henry, our pediatrician determined that Henry had elevated blood lead levels (20µg/dl). I am worried about the health of my child. Please help me understand how he might have been exposed to lead and what I can do to lower his blood lead levels."

What are some potential sources of lead (Pb) in this child's environment?

What are the potential exposure pathways for this child?

What would you suggest that Kim do to reduce her child's exposure to Pb?

Appendix S

Lab 6: Assessment of Urban Soil Quality and Gardening in Urban Environments Sampling and Testing Techniques

Laboratory Activity 4: Assessment of Urban Soil Quality

Soil Kit Equipment

- 3 gallon bucket

Soil Sampling:

- Soil knife
- Auger probe
- Plastic zip-top bags for soil samples
- Sharpie marker
- Balance

Soil Texture:

- Squeeze water bottle

Bulk Density and Soil Water Content:

- 3 inch diameter stainless steel bulk density ring
- 8 inch length of 2x4 wood board
- Rubber mallet
- Tin can, large enough for bulk density sample

Soil Temperature:

- Soil thermometer

Infiltration:

- Minidisc infiltrometer
- Small container of fine sand
- Extra volume of water

Soil Strength:

- Pocket penetrometer and adapter foot for weak soils

Microbial Activity:

- Small 10mL glass vials with lids
- Bulb planter
- 1.5 N NaOH (sodium hydroxide) – 6mL per vial
- 2.5 inch diameter PVC pipe-end dome

Soil pH:

- Portable pH meter
- 250 mL plastic beakers

Presence and concentration of trace element contaminants:

- Field-portable X-Ray Fluorescence Spectrophotometer (FP-XRF)
- National Institute of Standards soil standard

Part I. Soil Physical Properties

SOIL TEXTURE:

Follow Exercise 2: Soil Texture procedure (Thien and Graveel, 2003)

BULK DENSITY:

Follow Exercise 4: Part I – Tin Can Sampling Method (Thien and Graveel, 2003)

SOIL TEMPERATURE:

Place a soil thermometer at least 15cm into soil. Wait until temperature reading stabilizes. Record soil temperatures under different vegetation, cover, management systems, etc.

Part II. Soil Water Properties

INFILTRATION RATE:

Infiltration is the movement of water into soil. How soil and water interact has the potential to impact many facets of soil management in urban and rural environments. Drainage, ponding, erosion, irrigation, septic systems, nutrient management/fertility, urban runoff to storm water systems, water quality, and many other issues are influenced directly or indirectly by infiltration of water into the soil profile.

Minidisc Infiltrometer Procedure:

1. Fill the bubble chamber with tap water by placing the suction control tube under the water stream.
2. Move the suction control tube all the way down in the chamber.
3. Turn the infiltrometer upside down, remove the rubber base, and fill the large chamber with tap water.
4. Place the rubber base firmly back onto the infiltrometer and return to the upright position.
5. Adjust the suction rate by moving the small, metal suction tube up or down in the rubber, upper stopper. The water level in the small, upper chamber should be even with the marking that indicates the desired suction rate on the metal suction tube. We will use a **2 cm suction** for our soil samples.
6. Carefully secure the measuring tape along the large, lower chamber. Take care to level the measurement marks perpendicular to the water level for ease of reading.

Infiltration Measurement

1. On the data sheet record the starting water level in the large, lower chamber (water reservoir) of the minidisc infiltrometer at time zero.
2. Carefully place the infiltrometer on the soil surface.
   Keep the infiltrometer upright at all times
   Ensure good contact between the porous disc and the soil surface
3. One member of your group should be a timer, a second a data recorder, and a third a monitor.
4. At the designated times, record the water volume in the infiltrometer and the depth of water infiltrated into the soil profile.

Data Analysis

1. Plot, on a piece of graph paper, the cumulative infilitration (cm) over cumulative time (sec) for your samples. The slope of the data line will be your rate of water infiltration (cm/sec).

SOIL WATER CONTENT:

The soil sample collected for bulk density analysis may also be used for water content analysis. A representative sample should be weighed in the field or wrapped/sealed in a container to minimize moisture loss. Mass of the soil at field moisture condition should be recorded. The sample is then dried at 105°C until the soil has reached oven dry weight, or until the soil weight remains constant. Percent water by weight or percent water by volume can then be calculated.

% soil water content by weight =

((moist soil mass – oven dry soil mass)/(oven dry soil mass)) x 100

% soil water content by volume =

(% soil water content by weight x soil bulk density)

Part III. Soil Biological Properties

MICROBIAL BIOMASS AND STRUCTURE:

Observe the number and types of macrofauna in the soil. Record your observations.

MICROBIAL ACTIVITY:

Using the bulb planter, remove a column of soil and discard. Place one glass vial of 6 mL of 1.5 N NaOH (sodium hydroxide) into the cavity with the soil surface. Take care to not spill the solution or to allow any soil to enter the vial. Place a plastic cap over the cavity. Retrieve and cap the vial after 30 minutes. Then follow Exercise 14: Part III. Carbon dioxide analysis (Thien and Graveel, 2003), and calculate carbon dioxide evolved (mg).

Part IV. Soil Chemical Properties

pH:

Follow Exercise 9: Part I Determination of soil pH (active hydrogen ion content) (Thien and Graveel, 2003).

XRF:

Experimental Procedure:

1. Calibrate the XRF instrument using a known NIS soil standard
2. Carefully place the emission screen parallel to the surface of the soil sample, and gently lower the XRF onto the surface of the soil sample being careful not to use too much pressure.

    CAUTION – The XRF emits small amounts of x-rays. Please remain behind the XRF device at all times. NEVER point the XRF emission screen at another person. If you have questions about these words of caution, please ask before we begin our readings.

3. Pull the trigger of the XRF instrument to begin a measurement. Measurements should take between 2 and 4 minutes. When a measurement is complete, the instrument will beep.
4. Remove the trigger and carefully lift the XRF device away from the soil sample.
5. The concentrations in ppm may be read from the small screen on the XRF instrument.
6. Record the concentrations for our samples below.

DATA SHEET

Sampling Location:______________________

Please indicate the six soil forming factors below:

1.
2.
3.
4.
5.
6.

Physical Properties

Bulk Density

Tin mass (g) ____________________

Moist soil weight + tin (g) ___________

Dry soil weight + tin (g) ____________

Soil Texture___________________________

Soil Temperature (°C) ____________

____

____

Chemical Properties

pH ________________________________

Total soil contaminant concentrations (mg/kg)

Pb _________

As _________

Cd _________

Hg _________

Ni _________

Biological Properties

Vegetative Cover ____________________

Macrofauna present ________________

Quantity ______________

Carbon Dioxide evolved (mg) __________

Water Properties

Soil Moisture Content (cm^3/ cm^3)__________

Infiltration Rate – slope (cm/30min) ________

SHOW YOUR CACLULATIONS TO THE RIGHT & ATTACH GRAPH

Appendix T

Survey assessments administered to Agronomy 305: Urban Soils laboratory students in the spring of 2011.

AGRON 305 – Urban Soils Lab
Spring Course Evaluation # 1

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about urban soils

_____ your prior knowledge of the properties of urban soils

_____ your interest in learning about urban soil development

_____ your prior knowledge of urban soil development

_____ your interest in learning about urban site analysis and risk assessment and management

_____ your prior knowledge of urban site analysis and risk assessment and management

_____ your interest in learning about composting

_____ your prior knowledge of composting

_____ the amount you learned from the Urban Soil Development Model activity

_____ the amount you learned from the Urban Site Assessment activity

_____ the amount you learned from the Composting activity

Rate the following statements using the rating scale below:
(1= strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree)

______ The Urban Soil Development Model activity enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The Urban Soil Development Model activity stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The Urban Soil Development Model activity increased my intellectual curiosity of the topics covered.

______ The Urban Site Assessment activity enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The Urban Site Assessment activity stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The Urban Site Assessment activity increased my intellectual curiosity of the topics covered.

______ The Composting activity enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The Composting activity stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The Composting activity increased my intellectual curiosity of the topics covered.

AGRON 305 – Urban Soils Lab
Spring Course Evaluation # 2

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about using X-Ray Fluoresence Spectrophotometer (XRF) technology to determine concentrations of trace elements in soil and other materials

_____ your prior knowledge of X-Ray Fluoresence (XRF) technology to determine concentrations of trace elements in soil and other materials

_____ your interest in learning about urban soil quality

_____ your prior knowledge of urban soil quality

_____ the amount you learned from the X-Ray Fluoresence Spectrophotometer (XRF) demonstration

_____ the amount you learned from the Manhattan Community Garden Field Trip activity

Rate the following statements using the rating scale below:
(1= strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree)

______ The X-Ray Fluoresence Spectrophotometer (XRF) activity enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The X-Ray Fluoresence Spectrophotometer (XRF) activity stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The X-Ray Fluoresence Spectrophotometer (XRF) activity increased my intellectual curiosity of the topics covered.

______ The Manhattan Community Garden Field Trip enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The Manhattan Community Garden Field Trip stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The Manhattan Community Garden Field Trip increased my intellectual curiosity of the topics covered

AGRON 305 – Urban Soils Lab
Spring Course Evaluation # 3

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about the impact of contamination on soil microbes

_____ your prior knowledge of the impact of contamination on soil microbes

_____ the amount you learned from the “impact of contamination on soil microbes activity”

Rate the following statements using the rating scale below:
(1= strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree)

______ The Impact of Contamination on Soil Microbes activity enhanced my comprehension of the learning outcomes of the lab. (The learning outcomes made more sense to me after completing the activity.)

______ The Impact of Contamination on Soil Microbes activity stimulated you to think more deeply about the subject matter. (The learning outcomes were more relevant to you personally after completing the activity.)

______ The Impact of Contamination on Soil Microbes activity increased my intellectual curiosity of the topics covered.

State one piece of information you learned about urban soils this semester, and apply it to your academic major, future career, or a personal interest.

Of the lab activities we completed this semester in AGRON 305, which was your favorite and why?

Appendix U

Survey assessments administered to Agronomy 305: Urban Soils laboratory students in the fall of 2011.

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 1

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about urban soils

_____ your prior knowledge of the properties of urban soils

_____ your interest in learning about urban soil development

_____ your prior knowledge of urban soil development

Use the rating system above to answer the following question:

_____ What level of impact did "Urban Soil Development Model" activity have on your intellectual curiosity?

Please respond the following questions by circling either "yes" or "no":

Yes / No Did the "Urban Soil Development Model" activity make sense to you?

Yes / No Did the "Urban Soil Development Model" activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the "Urban Soil Development Model" activity to other styles of learning such as lecture.

Yes / No The "Urban Soil Development Model" activity increased my intellectual curiosity of the topics covered.

Yes / No I will need/use knowledge of urban soils in my future (personally or professionally).

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 2

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about urban site assessment and risk assessment and management.

_____ your prior knowledge of urban site assessment, and risk assessment and management.

Use the rating system above to answer the following question:

_____ What level of impact did "Risk assessment and management of an urban site" activity have on your intellectual curiosity?

Please respond the following questions by circling either "yes" or "no":

Yes / No Did the "Risk assessment and management of an urban site" activity make sense to you?

Yes / No Did the "Risk assessment and management of an urban site" activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the "Risk assessment and management of an urban site" activity to other styles of learning such as lecture.

Yes / No The "Risk assessment and management of an urban site" activity increased my intellectual curiosity of the topics covered.

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 3

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about composting.

_____ your prior knowledge of composting.

Use the rating system above to answer the following question:

_____ What level of impact did "Composting" activity have on your intellectual curiosity?

Please respond the following questions by circling either "yes" or "no":

Yes / No Did the "Composting" activity make sense to you?

Yes / No Did the "Composting" activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the "Composting" activity to other styles of learning such as lecture.

Yes / No The "Composting" activity increased my intellectual curiosity of the topics covered.

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 4

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about determining heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF).

_____ your prior knowledge of determining heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF).

Use the rating system above to answer the following question:

_____ What level of impact did "Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)" activity have on your intellectual curiosity?

Please respond the following questions by circling either "yes" or "no":

Yes / No Did the "Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)" activity make sense to you?

Yes / No Did the "Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)" activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the "Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)" activity to other styles of learning such as lecture.

Yes / No The "Determination of heavy metal contamination using an X-Ray Fluorescence Spectrophotometer (XRF)" activity increased my intellectual curiosity of the topics covered.

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 5

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about urban soil quality.

_____ your prior knowledge of the urban soil quality.

Use the rating system above to answer the following question:

_____ What level of impact did "Assessment of Urban Soil Quality (Manhattan Community Garden Field Trip)" activity have on your intellectual curiosity?

Please respond the following questions by circling either "yes" or "no":

Yes / No Did the "Assessment of Urban Soil Quality (Manhattan Community Garden Field Trip)" activity make sense to you?

Yes / No Did the "Assessment of Urban Soil Quality (Manhattan Community Garden Field Trip)" activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the "Assessment of Urban Soil Quality (Manhattan Community Garden Field Trip)" activity to other styles of learning such as lecture.

Yes / No The "Assessment of Urban Soil Quality (Manhattan Community Garden Field Trip)" activity increased my intellectual curiosity of the topics covered.

AGRON 305 – Urban Soils Lab
Fall Course Evaluation # 6

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about the impact of soil contamination on soil microbes.

_____ your prior knowledge of the impact of soil contamination on soil microbes.

Use the rating system above to answer the following question:

_____ What level of impact did "“Impact of Soil Contamination on Soil Microbes” activity have on your intellectual curiosity?

Please respond the following questions by circling either “yes” or “no”:

Yes / No Did the “Impact of Soil Contamination on Soil Microbes” activity make sense to you?

Yes / No Did the “Impact of Soil Contamination on Soil Microbes” activity have meaning for you? (Was the activity relevant to you?)

Yes / No I prefer the “Impact of Soil Contamination on Soil Microbes” activity to other styles of learning such as lecture.

Yes / No The “Impact of Soil Contamination on Soil Microbes” activity increased my intellectual curiosity of the topics covered.

Chapter 3 - Washington Wheatley: A Decision Case on Gardening on a Brownfields Site

Abstract

In March of 2009, Mr. Hammons and his neighbors in the Washington Wheatley neighborhood of Kansas City, Missouri were excited to begin gardening on a vacant city lot in their neighborhood. The underutilized lot, a brownfield, had sat for years, overgrown with weeds and an eyesore to the neighborhood. Mr. Hammons, a leader in his community, hoped that a community garden would not only improve the aesthetics of his neighborhood, but also provide a local, inexpensive source of fresh fruits and vegetables for his neighborhood that is located in a food desert. When concerns arose about soil contaminants on the site, Mr. Hammons grew panicked that a community garden on a brownfield site would do more harm than good in his neighborhood. This case focuses on Mr. Hammons decision of whether to continue gardening on the brownfield site in Washington Wheatley. The decision requires that students evaluate environmental, agronomic, human health, social, and economic issues related to the problem Mr. Hammons faces. Objectives of this case are for students to analyze and discuss data and concepts related to gardening on brownfield sites, urban soil contamination, urban food deserts, and human health.

Introduction

In 2010, 83.7 percent of the United States population was living in urban areas and that percentage is only estimated to increase in the future (US Census Bureau, 2011). However, this population growth is not uniform throughout the various neighborhoods of these cities. Many urban neighborhoods with higher poverty rates (30% or greater) have experienced rapid decline in population since the 1980s. Nearly 15% of urban land in U.S. cities, or approximately 4,500 acres per city, is vacant or abandoned (Pagano and Bowman, 2000). As urban populations transitioned to suburbs surrounding cities, inner-city businesses, houses, parking lots, etc. were abandoned or razed leaving open, vacant lots. Publically and privately owned vacant lands and brownfields in many U.S. cities are quickly being converted to urban gardens and farms by individuals, families, neighborhoods, schools, nonprofit organizations, and many others. Brownfields, as defined by the United States Environmental Protection Agency (USEPA), are vacant or abandoned properties, the reuse of which may be complicated by the presence or potential presence of a contaminant. The U.S. alone has an estimated 450,000 to 1 million brownfields, many of which are often considered as potential gardening sites due to their proximity to residential areas. This problem case is based on an actual situation faced by a neighborhood group that established a community garden on a brownfield site. A recommendation for best management practices must be made to reduce any potential risk from gardening on the contaminated soil.

20 February 2008

Mr. Hammons grew up in Washington Wheatley, and he built his life and career in this area of Kansas City. He saw first-hand when more and more of the neighborhood's houses were left empty, unkempt, and eventually boarded-up or razed. Mr. Hammons knew that he had to do something to remedy this, to improve his neighborhood, his lifelong home. He was concerned that if nothing was done, his neighborhood would become nothing but endless vacant, unused lots and unsafe structures. Mr. Hammons envisioned a more prosperous and vibrant future for his neighborhood and fellow neighbors.

Neighborhood history

The Washington Wheatley neighborhood of Kansas City, Missouri, is located southeast of the historic 18th and Vine Jazz District, between 18th Street to 27th Street and Prospect Avenue to Interstate 70. A great deal of Kansas City's African-American history took place in this area of the city, and is also the area where many of the city's notable African-American leaders once resided. Over the last 50 years, the neighborhood experienced a population decline from 11,700 to 2,500. In 2008, nearly 95 acres or approximately 25% of the land area in the Washington Wheatley neighborhood was vacant lots. Since the decline in population, many historic buildings and residences fell into disrepair and vacant lots turned into weedy sites or were used for illegal trash dumping. Not uncommon is the sight of boarded-up homes and business, as well as the demolition of condemned structures. Decline in number of businesses throughout the Washington Wheatley neighborhood also forces current residents to travel farther from home for basic needs, such as groceries, fresh produce, medicines, clothing, etc.

A neighborhood within a food desert

The residents of the Washington Wheatley neighborhood live in a food desert. Low-income, minority neighborhoods in many cities throughout the United States are often disproportionately located in food deserts (Chung and Myers, 1999; Powell et al., 2007; Zenk et al., 2005). A food desert, as defined by Cummins and Macintyre (2002), is a "poor urban area, where residents cannot buy affordable, healthy foods." The lack of access to healthy, fresh, affordable foods threatens the livelihood of millions of Americans that live within food deserts, including the residents of Washington Wheatley.

For low income urban residents, such as the residents of the Washington Wheatley neighborhood, eating a healthy diet is difficult because of several factors. The Washington Wheatley neighborhood does not have a local grocery store or supermarket, and gas station convenient stores are the only locations in the neighborhood where residents can purchase food items. Jackson County, where Washington Wheatley is located, saw a 10-24.9% decrease in grocery stores from 2007 to 2008 (Breneman and Todd 2011). Poorer neighborhoods throughout the U.S. have fewer supermarkets, nearly 30% less, than the highest income neighborhoods, so access to food is more often limited to smaller convenience stores (Chung and Myers, 1999; Giang et al., 2008; Moreland et al., 2002a; Weinberg, 1995). Poor minority neighborhoods are even less likely to have access to a supermarket than poor white neighborhoods (Morland et al., 2002b; Powell et al., 2007; Zenk et al., 2005). The smaller convenience stores that offers foods in these food deserts often offer a lower selection of higher priced, lower quality food items (Chung and Myers, 1999; Hendrickson et al., 2006; Zenk et al., 2006). The access to food is further limited as well for many low-income residents due to a lack of reliable transportation and the greater distance from home to store (Walter et al., 2010).

The lack of affordable, healthy, and fresh foods decreases the ability of Washington Wheatley residents to maintain a healthy diet. Research has found that low-income populations, especially minorities, consume less fruits and vegetables than is currently recommended by the Food and Drug Administration (FDA) (Kratt et al., 2000; Resnicow et al., 2001). A healthful, balanced diet contributes to a healthy body and decreased instance of diet-related health issues (Ness and Powles, 1997; Van Duyn and Pivonka, 2000). Food desert neighborhoods are disproportionately affected by adverse diet-related health problems such as diabetes, cancer, obesity, heart disease, and premature death (Deaton and Lubotsky, 2006; Hendrickson et al., 2006).

Mr. Hammons and other community members, aware of these economic, social, and health problems in their neighborhood, set out to make changes for themselves and their friends and neighbors. Efforts began in 2008 to revitalize this historic neighborhood. The Washington Wheatley Neighborhood Improvement Association, in conjunction with University of Missouri-Kansas City and governmental groups, worked together to implement plans of historic preservation of many buildings in the neighborhood, as well as the transformation of many vacant lots into usable green spaces. The Washington Wheatley Neighborhood Action Plan (Appendix A) outlined the numerous efforts these groups planned to accomplish throughout the revitalization of this neighborhood. The overall goal of these efforts was to restore the neighborhood's social, economic, and environmental sustainability. The first recommendation outlined by the Washington Wheatley Neighborhood Action Plan was to "enhance self-sufficiency and economic growth through the development of urban agriculture on vacant lots."

The Case:

In early 2009, Mr. Hammons and his neighbors gathered to discuss what should be done with a vacant lot on Montgall Avenue. Mr. Hammons, president of the Washington Wheatley Neighborhood Improvement Association for 15 years and resident of the neighborhood, led the neighborhood gathering. As a prominent figure and friend throughout the neighborhood, Mr. Hammons is passionate about uplifting Washington Wheatley and reintroducing the neighborhood to the rest of the Kansas City metropolitan area as the historically and culturally rich community that it once was. His efforts can already be seen on many of the residential streets in Washington Wheatley. Houses that were once boarded up and abandoned are now hopeful reminders of the resilience of this neighborhood, standing strong with fresh paint and new windows, roofs, and residents. Although abundant strides have been made to revitalize the community, several vacant lots on each residential block are empty, weedy dumping grounds and remain as eyesores to residents. Mr. Hammons wanted to do something about the ninety-five acres of unused, vacant lots throughout Washington Wheatley.

The Montgall Avenue vacant lot

An example of these vacant lots is one of three vacant lots located in the middle of the 2400 block of Montgall Ave (Figure 3.1). The 42m x 37m vacant lot on the 2400 block of Montgall Ave. was situated within a residential area of the Washington Wheatley neighborhood. To the north and south edges of the lot sat two uninhabited, boarded-up houses. (Figure 3.2) The lot had a westerly ascending slope of 2-9% to an elementary school yard that was once the site of an auto-body shop. The east edge was bordered by Montgall Ave., across which were a row of inhabited houses. On the site, once stood four houses which fell to disrepair and in the 1990s and were razed and cleared away. Remnants of these former houses, broken glass, bricks, paint chips, wood, cement, etc. remained in the soil. The site's soils were subjected to many anthropogenic impacts, and were mapped by the United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS) as an Urban land-Harvester complex, a soil formed in less than 40 inches of disturbed material over a truncated loess. (Appendix B)

Mr. Hammons and neighbors wanted to craft something on the lot to improve the neighborhood. The group discussed many potential uses for the lot, including a park, a playground, a flower garden, an orchard, etc. Mr. Hammons and his fellow neighbors finally settled on the decision in March of 2009, to establish a community garden. They envisioned a community gardening space with numerous plots to grow vegetables, fruits, herbs, and flowers. Each 300 square-foot plot was to be assigned to an individual or family in the neighborhood, and each gardener could keep what would grow and give away extras to neighbors. The garden would provide a local source of fresh produce for the Washington Wheatley community that they wouldn't have to venture far from home to get, and that would improve the diets of these low-income individuals and families. Mr. Hammons thought a garden would be aesthetically pleasing as well, and a relaxing place for recreation and socializing.

By April of 2009, the vacant lot on Montgall Ave. was cleared of weeds and loose debris and the soil tilled in preparation for establishing a garden that spring and summer (Figure 3.3). Even before the plots were delineated, all available plot spaces were claimed by Washington Wheatley residents. Elderly women, young men, and families with children were all excited to enjoy the recreation of gardening and to devour the fresh produce from their plots. The neighborhood was anxious to move forward with their plans for the community garden, and many gardeners began to plant early spring crops such as swiss chard, lettuces, and spinach in anticipation of their first growing season on their new garden plots.

The problem

One morning, when Mr. Hammons was reading the paper and drinking his morning cup of coffee, he came across a newspaper article on President Obama's new garden (Burros, 2009). The article read, "When the Obamas decided to turn some of the South Lawn at the White House into a kitchen garden, they did what may smart urban gardeners do: they had the soil tested for its nutrients and potential contaminants, like lead." Mr. Hammons felt alarmed; he hadn't thought to have the soils tested for potential contaminants. He wondered what types of contaminants could possibly be in a soil in his neighborhood. Surely, we have nothing to worry about, he thought. Mr. Hammons visited the garden that evening to pick his newest batch of ripe tomatoes and okra and saw the grandchildren of his elderly neighbor, Norma, playing in the soil of her garden plot as she weeded and watered her crops. He began to worry, "if our soil is contaminated, then are Norma's grandchildren at risk from playing in the soil?" And what about the tomatoes and okra he had planned to bring home to family for dinner, could they be contaminated too? Although a garden was a beautiful addition to Montgall Ave. and their neighborhood, Mr. Hammond did not want to put any of his friends or family at risk. Mr. Hammons decided to add his new harvest of fresh veggies to the compost pile instead of taking them home for dinner. He needed more information before he could be safe eating anything grown on the site.

The next day Mr. Hammond called the extension service at the nearby land grant university to request help with his problem. Mr. Hammons knows he needs to somehow determine whether it was safe to garden on and eat food from their community garden lot. He especially wants help figuring out how to better manage the urban soils they are growing on in order to keep everyone healthy. What good is a beautiful community garden in a food desert if it is contaminating everyone he loves? The garden was supposed to improve his neighborhoods health and vitality, not threaten it.

Soil and plant tissue sampling and testing

Soil scientists from the university came to help Mr. Hammons assess the soil quality, potential presence of contaminants, and any potential human health risks of the Montgall Avenue community garden site. Screening of the site for trace elements (specifically Lead, Cadmium, and Arsenic) was done using a field portable X-Ray Fluorescence Spectrophotometer (XRF)

(Figure 3.4 and 3.5). Measurements were taken every 3 meters across the site in a rough grid pattern. The XRF measurements were georeferenced using a global positioning systems (GPS) unit. Total soil lead concentration maps were created using this spatial data to determine areas of high or low total soil lead concentrations (Figure 6). Eight soil samples were collected from the site for confirmation analysis, laboratory digestion followed by analysis using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (Table 3.1). Soil samples were collected from areas where compost was added to plots and from areas where compost was withheld from plots. Addition of compost to soil was also evaluated (Table 3.2)

The soil scientists told Mr. Hammons that the common sources of trace elements in urban environments included leaded paint and gasoline, historical pesticide use, industrial and commercial activities, etc. The potential sources of contamination of urban areas including the Montgall Avenue lot can be found in Table 3.3. Additional soil samples were collected to analyze for chlordane (C1-C3, Figure 6) and for dichlorodiphenyltrichloroethane (DDT) (C4-C9, Figure 6). Chlordane, a pesticide and common urban persistent organic contaminant, was used to treat house foundations for termites, and is commonly found in soils around house foundations or where previous structures stood. Because houses boarder the lot and rubble from formerly razed houses was found on the site, the soil scientists told Mr. Hammons, additional soil tests would need to be conducted to determine if chlordane was present in the soil. And DDT, the soil scientist explained, was a commonly used insecticide before it was banned in the U.S. in 1972, and is commonly found in soils where pesticide spray was common, so tests would be done to determine its presence. Nutrient analysis of the soil (Table 3.4) on the site were measured and reported. Plant tissue samples of carrot, tomato, and swiss chard were collected from garden plots on the site and analyzed for trace element concentrations using Graphite-Furnace Atomic Absorption Spectrophotometry (AAS) (Table 3.5).

Background on brownfields and urban soils

Natural and urban derived soils vary considerably. Urban soils are often highly disturbed and/or contaminated due to human activities (Bullock and Gregory, 1991; Craul, 1999; Reimann and De Caritat, 2000). Urban soils are often more physically, chemically, and biologically heterogeneous than naturally derived soils, posing unique management issues (Craul, 1984). Previous land use and human activities on and around an urban site (e.g. industries, automobile emissions, leaded paint, mining, and use of man-made products) can lead to increased accumulation of trace elements and organic compounds, or soil contamination (Boyd et al., 1999; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1979; Nriagu, 1996; USDA-NRCS, 2000). Lead (Pb), Cadmium (Cd), and Arsenic (As) are the most common contaminants in urban environments (USDA-NRCS, 2000). Trace elements are found naturally in many soils, however, urban soils often contain elevated concentrations of these elements and compounds due human activities (Finster et al., 2004). Soils are a sink for many trace element contaminants, and most of these urban soil contaminants are persistent, immobile, and non-biodegradable (Boyd et al., 1999; Finster et al., 2004; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1988; Watt et al., 1993).

Contaminated urban soils require unique management techniques due to their heterogeneity and potential contamination in order to reduce exposure pathways and any human health risks. Past and unseen sources of contamination, razing of aboveground materials, and mixing of urban soils can lead to sites with variably distributed contamination making understanding and minimizing human health risks difficult (Craul, 1984).

Urban soils are an important pathway for human exposure to trace elements and organic contaminants (Boyd et al., 1999; Gallacher et al., 1984; Mielke et al., 1999; Mielke and Reagan, 1998; Nriagu, 1988; Watt et al., 1993). This is troublesome because common urban contaminants (e.g. Pb, Cd, As) are toxic to humans, especially children (Boyd et al., 1999; Finster et al., 2004; Hettiarachchi et al., 2004; Mielke et al., 1999; Mielke and Reagan, 1998). Gallacher et al. (1984) found that residents living in areas with highly contaminated soils had higher blood Pb levels than residents of areas with minimally contaminated or uncontaminated soils. Humans may be exposed to soil contaminants through three main pathways: ingestion, inhalation, and dermal (Boyd et al., 1999; Mielke et al., 1999; Mielke and Reagan, 1998).

The two main exposure pathways affecting urban dwellers, especially gardeners and farmers, are ingestion of soil dust and ingestion of food grown in contaminated soil (Cambra et al., 1999; Hawley, 1985; Hettiarachchi et al., 2004). Direct ingestion of soil dust may be from pica behavior, which is common for children, or from soil dust adhered to produce, hands, and clothing. Root crops grown directly in the soil and crops that grow close to the soil such as spinach often have soil dust adhered to the tissue when harvested (Finster et al., 2004). Ingestion of food grown in contaminated soil also may pose a risk to human health if the bioavailability of the contaminant is high and if translocation of the contaminant from soil to the edible portion of the plant has occurred (Finster et al., 2004; Purves and Mackenzie, 1970). The bioavailability of an individual contaminant impacts the plant uptake and translocation of the contaminant from soil into the roots, from the roots to shoots, and shoots to fruiting bodies. Hettiarachchi et al. (2004) defined bioavailability is the proportion of a soil contaminant that is available for absorption into an organism. Some research have attempted to develop rules of thumb for managing soils based on the measured contaminant concentration (Table 3.6) Individuals whom are in direct contact with urban soil should be aware of urban soil quality and soil contamination issues to minimize environmental and human health risks associated with soil contamination.

The Decision

Mr. Hammons is frightened to make a decision about gardening on the Montgall Avenue site. He wants to improve his neighborhood with this beautiful garden, to give his neighbors the opportunity for recreation and socializing while gardening, and to provide everyone with fresh, healthy, and local produce, but what if their health is at risk? He is alarmed, but doesn’t want to also alarm his friends. “We’ve put so much effort into this garden and it has already become a bright spot in Washington Wheatley. What should I do?”

Teaching Notes

Uses of the case

This case could be effectively used by undergraduate students interested in urban soil quality, soil contamination, urban soil sampling, food deserts, and urban agriculture. The case should be used by students to investigate the complex environmental, human health, social, economic issues of urban agriculture on brownfields. Students with varied academic and personal backgrounds could make use of this case to practice the following skills: uncover and assess validity of scientific information, interpret research data, analyze social, economic, environmental, and human health issues associated with a complex real-world problem, and formulate a Best Management Practices protocol to mitigate human health risk for urban growers and consumers. It should be emphasized to students that additional information from scientific literature and reference guides will be necessary in making a sound decision on the case.

Students could be given the case several class periods before the scheduled discussion in class, as well as additional reading materials, and should be encouraged to research case topics on their own. Students should arrive to the discussion period prepared to discuss the case problem and topics with their peers and instructor.

Case objectives

Upon completion of this case, students should be able to:

1. Discuss issues related to brownfields, food deserts, urban soil quality and contamination, and growing food on mildly contaminated soils.
2. Discuss the common urban soil quality and contamination issues related to historical and current human impacts on urban lands.
3. Discuss how food deserts affect urban dwellers ability to access healthy, fresh foods.
4. Discuss the potential human health risks associated with exposure to contaminated soil.
5. Uncover relevant scientific information and evaluate its validity.

6. Analyze site specific data on the physical, chemical, and biological properties of a soil to determine: urban soil quality for gardening use and the potential risks associated with growing food crops on brownfields.
7. Formulate a Best Management Practices (BMP) recommendation for gardening on a brownfield given that the gardeners have already begun growing on the site.

Questions to stimulate discussion and to examine the issues of the case

Review the evidence of contamination on the site, as well as the social, economic, human health, and environmental issues of this case and answer the following questions:

1. What is the dilemma that Mr. Hammons faces?
   Should he and his fellow neighbors continue to garden on and eat produce grown on the brownfield site, the vacant lot on Montgall Avenue? Mr. Hammons also needs to decide, is it a good idea to convert the vacant city lots in their neighborhood into community garden spaces to grow fresh foods for neighborhood consumption?
2. Does Mr. Hammons have a legitimate reason to worry about the health of his neighbors, friends, and family who are gardening on the site?
   The total soil Pb concentrations are mildly elevated, indicating the past human impacts have raised Pb concentration above the natural soil levels. Mr. Hammons and the other gardeners should be aware that the soils they're growing in contain elevated levels of Pb, however, these concentrations should not provoke panic for these gardeners.
3. Who will Mr. Hammons' decision affect?
   Mr. Hammons is a leader in the community and many people are looking to him for guidance on whether or not they should continue to garden at the site. His family, neighbors, and any other consumers of produce from the site will be impacted by his decision to continue or to stop gardening on the Montgall Avenue lot. If they continue gardening without taking the proper precautionary measures, then they may be endangering themselves. However, the soil total Pb concentrations are not elevated enough to warrant the immediate termination of gardening on the site.

4. Should Mr. Hammons tell the gardeners on the site about the contamination?
   Mr. Hammons, as a leader in his neighborhood, has a responsibility to his neighbors and to the consumers of the produce from the garden to notify all who are involved of the mildly elevated concentrations of Pb in the soil.
5. What are the benefits of locating the community garden on this brownfield site?
   The Washington Wheatley neighborhood is located in a food desert in which access to affordable, fresh, healthy foods is limited. The residents of Washington Wheatley could benefit from a local, free supply of healthy fruits and vegetables. Improved diets may help to improve the health of these community members. Also there are benefits for these residents from socializing at this community gathering spot, enjoying a beautiful piece of nature and green space in the middle of the city, and recreation and exercise while engaging in gardening activities. This brownfield site was an underutilized and convenient location in the neighborhood.
6. What are the disadvantages of locating the community garden on this brownfield site?
   The urban soils on the site are highly heterogeneous making management of the site more difficult. The total soil Pb concentrations are elevated, and low levels of DDT and Chlordane were also found in the soils of this brownfield site. These issues can make management decisions complex and difficult for gardeners to make. Expensive soil tests and potentially expensive risk mitigation techniques may be too expensive for a community gardening group to shoulder. Outside technical assistance is often required to determine the safety of and the best management practices of a specific brownfield site.
7. Do the benefits of growing fresh produce for the neighborhood outweigh the disadvantages associated with the urban soils of the lot
8. Based on the evidence, what Best Management Practices would you recommend that Mr. Hammons and the other gardeners implement on the site? What, if anything, could be done on the site to ensure the health of growers and consumers?
   Many answers are possible. Students should identify that the addition of compost to soils on the site decreased the total soil Pb concentration. Therefore, gardeners could add

compost to the entire site to reduce the total soil Pb concentration in the surface soil. Mr. Hammons and the gardeners added compost to the entire Montgall Avenue site and incorporated it into the top 6 inches of soil. Mulch was also added to all walkways to reduce the amount of exposed soil and to minimize soil dust in the garden. Gardeners should be advised to wear gloves while gardening or to wash hands after working in the soil. Children should be prohibited from putting soil in their mouths. All produce should be thoroughly washed with soapy water to remove adhered soil particles prior to eating.

Tables

Table 3.1 Average total soil lead concentrations of the Montgall Avenue vacant lot in the spring of 2009 (Attanayake et al., 2011).

Soil sample	Average sample total Pb
	mg kg^{-1}
1	288.5
2	254.8
3	335.8
4	173.1
5	252.9
6	141.8
7	183.0
8	185.7
Average	226.9

Table 3.2 Average total soil lead concentrations of the Montgall vacant lot before and after the addition of compost in the spring of 2009 (Attanayake et al., 2011).

Compost	Average total soil Pb
	mg/kg
Before adding	245.49 ± 21.54
After adding	145.92 ± 20.34

Table 3.3 Common urban soil contaminants and their sources (Angima and Sullivan, 2008).

General Source	Examples of Previous Site Uses	Specific Contaminants
Paint (before 1978)	Old residential buildings; mining; leather tanning; landfill operations; aircraft component manufacturing	Lead
High traffic areas or near roadways	Next to trafficked roadways or highways; near roadways built before leaded fuel was phased out	Lead, zinc, polycyclic aromatic hydrocarbons (PAHs)
Treated lumber	Lumber treatment facilities; structures built with treated lumber	Arsenic, chromium, copper
Burning wastes	Landfill operations	PAHs, dioxins
Contaminated manure	Copper, zinc salts added to animal feed	Copper, zinc
Coal ash	Coal-fired power plants; landfills; homes with coal furnaces	Molybdenum, sulfur
Sewage sludge	Sewage treatment plants; agriculture	Cadmium, copper, zinc, lead, persistent bioaccumulative toxins (PBTs)
Petroleum spills	Gas stations; residential/commercial/industrial uses (anyway an aboveground or underground storage tank is or has been located)	PAHs, benzene, toluene, xylene, ethyl, benzene
Pesticides	Widespread pesticide use, such as in orchards; pesticide formulation, packaging and shipping	Lead, arsenic, mercury, chlordane, and other chlorinated pesticides
Commercial or industrial site use		PAHs, petroleum products, solvents, lead, and other heavy metals (such as cadmium, arsenic, chromium, lead, mercury, and zinc)
Dry cleaners		Stoddard solvent and tetrachloroethene
Metal finishing operations		Metals and cyanides

Table 3.4 Average total soil nutrient concentrations of the Montgall Avenue vacant lot in the spring of 2009 (Attanayake et al., 2011).

	Soil Nutrient Concentrations				
	Mehlich3 P	Available K	NH4-N	NO3-N	OM
	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	%
Compost Added	409 ± 64	1813 ± 83	53.4 ± 10.8	191.2 ± 32.6	5.5 ± 0.4
	456 ± 44	2120 ± 232	54.6 ± 15.8	232.9 ± 54.5	5.9 ± 0.1
	450 ± 16	2003 ± 160	50.5 ± 14.8	255.0 ± 40.5	5.7 ± 0.3
No compost added	68 ± 12	362 ± 27	5.1 ± 0.6	14.0 ± 2.7	3.8 ± 0.1
	62 ± 10	295 ± 26	5.0 ± 0.4	12.8 ± 0.8	3.6 ± 0.2
	75 ± 9	327 ± 47	5.1 ± 0.6	12.5 ± 1.1	3.7 ± 0.2

Table 3.5 Average total plant tissue lead concentrations of produce grown on the Montgall Ave. vacant lot in the spring of 2011 (Hettiarachchi et al., 2011).

	Kitchen Cleaning	Lab Cleaning
	Average Total Pb	
	µg kg^{-1}	
	Carrot	
Compost added	1330.00 ± 152.02	1405.63 ± 233.70
No compost added	1833.83 ± 146.46	3025.45 ± 1661.03
	Swiss Chard	
Compost added	834.13 ± 133.58	289.18 ± 42.47
No compost added	2171.15 ± 450.46	704.73 ± 84.32
	Tomato	
Compost added	164.43 ± 39.03	164.43 ± 39.03
No compost added	406.23 ± 524.85	406.23 ± 524.85

Table 3.6 Recommended gardening practices based on results of soil test for lead (Angima and Sullivan, 2008).

Less than 50	Little or no lead contamination in soil. No special precautions needed.
50 to 400	Some lead present from human activities. Grow any vegetable crops. Choose gardening practices that limit dust or soil consumption by children.
400 to 1200	Do not grow leafy vegetables or root crops. Choose gardening practices that limit dust or soil consumption by children.
Greater than 1200	Not recommended for vegetable gardening. Mulch and plant perennial shrubs, groundcover, or grass. Use clean soil in raised beds or containers for vegetable gardening.

Figures

Figure 3.1 Montgall Avenue vacant lot prior to garden establishment.

Figure 3.2 Montgall Avenue vacant lot and two, boarded-up homes to the north and south of the lot.

Figure 3.3 Community garden site cleared of all debris, weeds, and woody vegetation.

Figure 3.4 Field-portable X-Ray Fluorescence Spectrophotometer sampling for preliminary total soil trace element concentrations.

Figure 3.5 Conducting preliminary soil tests for total soil trace element concentrations on the Montgall Avenue vacant lot using the Field-Portable X-Ray Fluorescence Spectrophotometer.

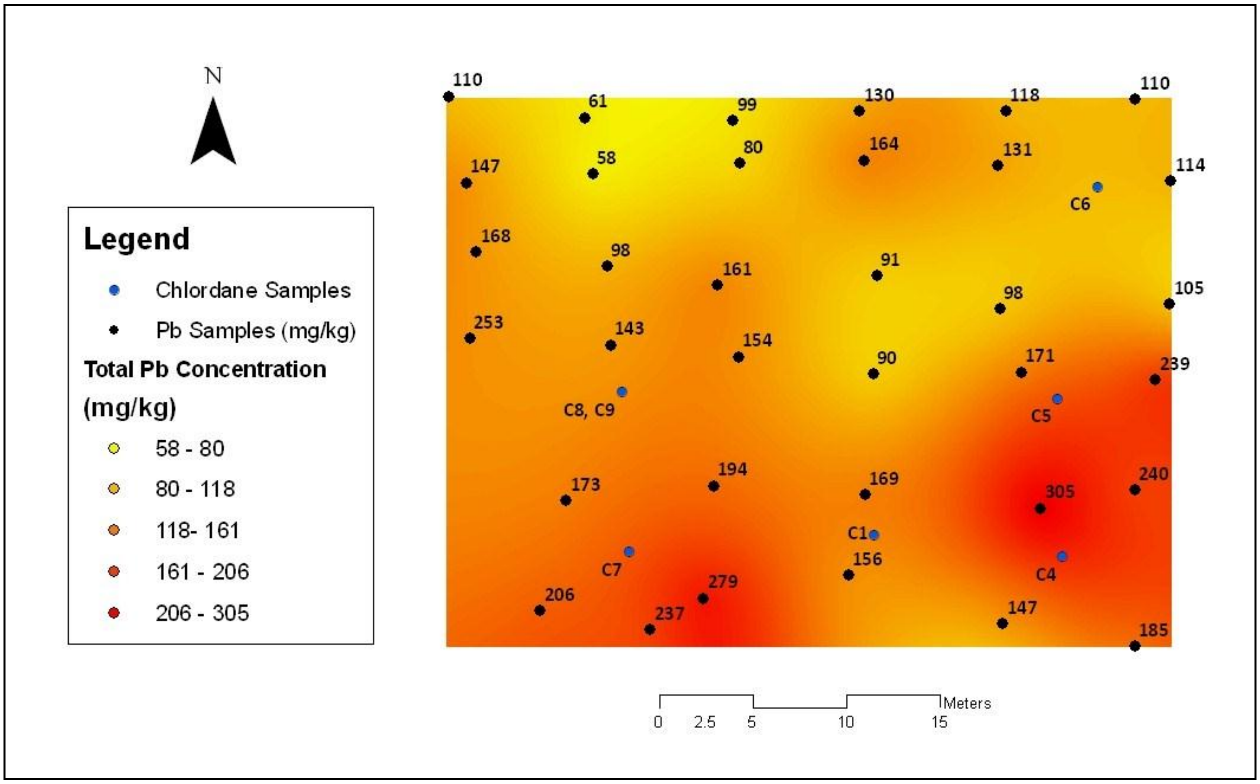


Figure 3.6 Chlordane sample locations and Field Portable X-Ray Fluorescence sampling locations with preliminary total surface soil lead concentrations across the Montgall Avenue community garden site (Attanayake et al., 2011).

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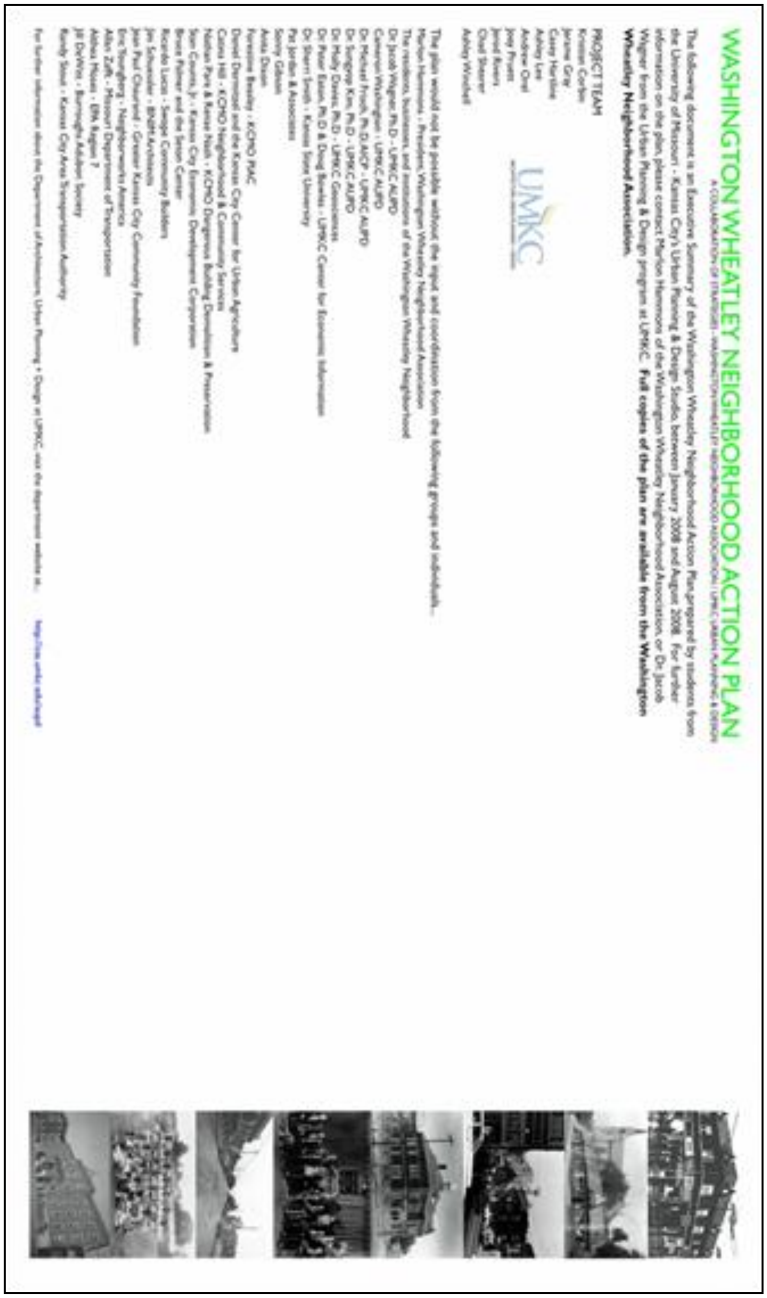
Appendix A - Washington Wheatley Neighborhood Association Action Plan


WASHINGTON WHEATLEY NEIGHBORHOOD ACTION PLAN

Holy Name Church, built in 1925. Significant site of KC Civil Rights Movement. Currently falling apart.

Dumping on Montgall Avenue.

Historic commercial building on Prospect Avenue.

Crumbling sidewalk adjacent to Blues Park.

Interstate 70 traffic, perpetuating air pollution up to 43 times higher than national standards.

WASHINGTON WHEATLEY NEIGHBORHOOD ACTION PLAN

PURPOSE STATEMENT

"The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to a close. In it's place we are entering a period of consequences..."
Winston Churchill

Washington Wheatley is in the heart of Kansas City, located only three miles east of downtown. There are many historic, physical, institutional, and social assets in the neighborhood, and the residents are committed to creating a healthy, safe, and *sustainable* community. We believe that there is an opportunity for the neighborhood to become an exemplary urban core neighborhood that will take Kansas City into the future in a smart, urban, and environmentally focused manner, that will help the city and region be at the forefront of sustainability. In too many instances, Kansas City has fallen behind other peer cities on matters of urban vitality and sustainability, and we look to put an end to the status-quo mentality that is so pervasive in Kansas City. It is time to be on the cutting edge of an issue that is of vital importance to the health and well being of the city and its residents.

What's next for the Washington Wheatley Neighborhood?

After 50 years of neglect and population decline, we need new strategies to turn urban neighborhoods around, and to create a truly sustainable urban community.

A sustainable city requires jobs and businesses to return to local corridors like Prospect Avenue, 27th Street, and Indiana Avenue. Kansas City must reverse the trend of abandonment, and stop the unnecessary demolition of historic structures east of Troost. The Washington Wheatley neighborhood needs smart infill housing, and innovative land use solutions that prevent vacant lots from becoming dumping sites full of trash. Residents want to see people come back to their neighborhood to raise families in a safe, walkable community they can be proud to call home.

Residents need a healthier environment, and the air quality in the neighborhood must be improved.
Neighborhoods want a safe and reliable public transportation system and bicycle network so residents don't have to depend on automobiles to get to work and other places. Residents want a strong and innovative school system so families know their children are being prepared for an emerging, sustainable economy. The neighborhood needs energy efficient homes and businesses that save money and are more sensitive to the environment.

Being "green" is not just about buildings - it's about the social, environmental, and economic fabric of a neighborhood. A sustainable Washington Wheatley will improve air and water quality, enhance the health and well-being of residents, minimize the strain on infrastructure, and help reduce the pressure to develop the exurban fringe.

It is time for Kansas City to become a true leader in urban core restoration and sustainable neighborhoods. Our future depends on it.

PLANNING PROCESS

In the Spring of 2007 the senior level Urban Planning & Design Studio from the University of Missouri - Kansas City's Department of Architecture, Urban Planning & Design, led by Dr. Jacob Wagner and Dr. Michael Frisch, created an award winning "A City at the Crossroads" project, which laid out a plan connecting the East Crossroads district to the 18th & Vine Jazz District. Following the success of this project, the UMKC AUPD program was urged to take their skills east along the 18th Street corridor, into the historic residential neighborhood, Washington Wheatley to help re-energize the neighborhood's development efforts. Beginning in the fall of 2007, the program's Community & Neighborhood Development class began surveying the neighborhood, and brainstorming ideas for growth of the community. This initial introduction to Washington Wheatley led to the senior level Urban Planning & Design Studio class in the Spring of 2007 to develop an action plan for the neighborhood, which would supply the necessary tools for a grassroots, community driven, neighborhood plan.

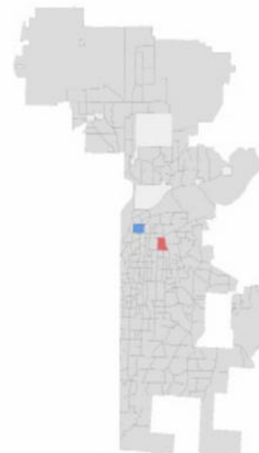
The Spring 2008 Urban Planning & Design Studio team, led by Dr. Jacob Wagner, and Cameron Washington (UMKC AUPD Graduate 2007), began the Washington Wheatley Neighborhood Action Plan project by attending the January 2008 Washington Wheatley Neighborhood Association meeting, to introduce themselves to the residents, and to lay out a process for developing a plan. The team then began an intense 8 week Neighborhood Analysis collecting data and information about the history, demographics, environmental and transportation conditions, housing stock, and the urban design characteristics of Washington Wheatley. This analysis included the team taking a survey of each parcel of the neighborhood, and inputing the data into a Geographic Information System (GIS) database, to provide an up-to-date snapshot of the conditions of the neighborhood.

Following the base analysis of the neighborhod, the students presented their data to the residents at their March 2008 neighborhood meeting, and to a group of planning & design professionals from the Kansas City area. The result of these presentations was a solid direction given to the students on how to apply their analysis into design and implementation strategies of the neighborhood planning process.

The students then began a design charrette process targeting areas identified by the base analysis and from concerns made by residents at the neighrborhood meetings. After initial ideas and drafts were made, the students presented their work to residents at the ensuing monthly meetings for feedback and revisions, as well as at numerous meetings with the President of the WWNA in the classroom at UMKC. These feedback sessions led to the students developing strategies for the neighborhood, focusing on specific goals and ideas. The class also found precedents of neighborhood and community development projects from around the United States, to learn new ideas, and see what's working and not working elsewhere.

After all of this work, the result was the Washington Wheatley Neighborhood Action Plan, which was presented at the Bruce R. Watkins Cultural Center in May of 2008 to an audience of professionals, developers, city leaders, educators, and residents from Washington Wheatley and Kansas City's urban core.

However, the work between UMKC and Washington Wheatley did not end in May of 2008. Dr. Wagner has committed to continuing the work in the neighborhood in the future, hoping to aid in the process of implementing the ideas and strategies laid forth in this plan. The UMKC program hopes that the future success of Washington Wheatley will be an example to leaders from the local, state, and federal levels to re-invest in urban neighborhoods.



Kansas City, Missouri City Limits
Downtown Loop in Blue
Washington Wheatley in Red

Washington Wheatley Neighborhood Association Meeting
March 2008

Washington Wheatley Neighborhood Association Meeting
April 2008

Final Presentation at Bruce R. Watkins Cultural Center
May 2008

STRATEGIES & SOLUTIONS

The general characteristics of the neighborhood analysis reveal that Washington Wheatley has been in a steady decline for the last 50 years. The residential population has declined from its peak of 11,697 residents in the 1940's, to approximately 2,500 residents present day. At the same time, the overall residential density of the neighborhood has drastically declined from 45 persons per acre, to 10 persons per acre presently. The decline of residential population has led to the massive decrease of physical structures in the neighborhood, resulting in nearly 95 acres of vacant land in 2008. Many structures of historical and architectural value have been demolished because of disrepair, abandonment, vandalism, and lack of tenancy.

Along with the residential decline, many businesses have left the neighborhood as well. There were five corridors (18th Street, Prospect Avenue, 23rd Street, Indiana Avenue, 27th Street) all bustling with commerce in the early and mid-20th century. What remains today, with the exception of a few remaining businesses, are vacant lots, empty storefronts, and unhappy residents travelling far outside of the neighborhood for their basic shopping needs.

Washington Wheatley has many environmental issues as well. The extremely poor air quality resulting from vehicles on Interstate 70 and local arterial roads such as 18th Street, Prospect Avenue, Benton Boulevard, Indiana Avenue, and 27th Street, as well as polluting industries and the rail freight traffic is a large concern. There is a reoccuring problem of illegal dumping happening in and around the neighborhood's vacant lots. In the warmer months, grass and weeds take over many of these vacant properties, concealing the dumping, and causing visual blight for residents.

After studying and analyzing the present conditions of the neighborhood, the goal was to conceive ideas for an action plan of strategies and solutions to help the neighborhood. These ideas consist of neighborhood conservation, air quality buffers, housing priorities, street design, community nodes, urban agriculture, a "green demonstration" block, economic drivers, and a business park. Each of these strategies and solutions have been devised for the sole purpose of bettering the neighborhood, and reversing the negative trends of the past 50 years.

Another driving factor in these strategies and solutions is the idea of the "green", or sustainable neighborhood. The reasoning behind these ideas is to ensure that Washington Wheatley meets a triple bottom line of social, environmental, and economic vitality for the years to come. These ideas push to encourage the neighborhood to be friendly to the environment, as a better environment improves the health and well being of residents, as well as improving market conditions for economic growth and development. A cleaner, safer environment also helps prevent crime, providing a safer neighborhood for residents to enjoy.

Through conserving the neighborhood's historic identity, and building upon it's unique location in the urban core, these strategies and solutions look to return Washington Wheatley to a vibrant, healthy neighborhood, which can be an example to other similar communities in Kansas City, and around the country. Although there are many obstacles for Washington Wheatley to overcome, there are signs of passion and energy in the neighborhood which will be important in implementing these strategies and solutions. These ideas provide the neighborhood with a means to stabilize and grow through the use of ideas to guide it's future development.

STRATEGIES & SOLUTIONS

Conservation

Interstate Buffer

Housing Priorities

23rd Street Connector

Community Nodes

Urban Agriculture

21st Century Green Block

Blues Park

Economic Development

Business Park

Appendix B - Harvester Official Series Description

HARVESTER SERIES

The Harvester series consists of very deep, moderately well drained soils formed in less than 40 inches of disturbed material over truncated loess soils. Permeability is moderately slow. These upland soils have slopes ranging from 2 to 30 percent. The average annual precipitation is 38 inches, and the mean annual temperature is about 55 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, nonacid, mesic Oxyaquic Udorthents

TYPICAL PEDON: Harvester silt loam - vacant lot under grass on a 3 percent slope in an area reshaped by heavy equipment at an elevation of 520 feet. (Colors are for moist soil unless otherwise stated.)

A--0 to 2 inches; brown (10YR 4/3) silt loam; common coarse distinct very dark grayish brown (10YR 3/2) mottles; few pockets of brown (7.5YR 4/4) silty clay loam; moderate very fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary. (0 to 6 inches thick)

C1--2 to 7 inches; dark yellowish brown (10YR 4/4) silt loam; common pockets of brown (7.5YR 4/4) silty clay loam; weak medium platy fragments; friable; many fine roots; neutral; clear smooth boundary.

C2--7 to 13 inches; brown (7.5YR 4/4) silty clay loam; few fine pockets and thin discontinuous lenses of brown (10YR 4/3) silt loam; strong medium platy fragments; firm; common fine roots; moderately acid; abrupt smooth boundary.

C3--13 to 15 inches; brown (10YR 4/3) silt loam; few blocky pockets of brown (7.5YR 4/4) silty clay loam; moderate medium platy fragments; firm; common fine roots; slightly acid; abrupt smooth boundary.

C4--15 to 21 inches; brown (7.5YR 4/4) silty clay loam; few thin discontinuous lenses of brown (10YR 4/3) silt loam; strong coarse blocky fragments; very firm; common fine roots flattened along faces of peds; common black (10YR 2/1) masses of iron and manganese accumulation; neutral; abrupt smooth boundary.

C5--21 to 31 inches; dark grayish brown (10YR 4/2) silt loam; common fine pockets of brown (7.5YR 4/4) silty clay loam; moderate medium platy fragments; firm; common reddish brown

(5YR 4/4) masses of iron accumulation along cleavage planes; common partially decomposed organic material; neutral; abrupt smooth boundary. (Combined thickness of the C horizon is 10 to 40 inches thick.)

Bb1--31 to 47 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium prismatic structure; very firm; few fine black (10YR 2/1) iron and manganese concretions throughout; slightly acid; gradual smooth boundary. (0 to 20 inches thick)

Bb2--47 to 67 inches; brown (7.5YR 4/4) silty clay loam; weak medium prismatic structure; firm; few fine black (10YR 2/1) iron and manganese concretions and stains throughout; slightly acid.

TYPE LOCATION: St. Charles County, Missouri; between I-70 and Mexico Road in Survey 979; 190 feet north and 360 feet east of the northwest corner of sec. 34, T. 47 N., R. 4 E; USGS Kampville quadrangle.

RANGE IN CHARACTERISTICS: Reaction ranges from neutral to strongly acid in all horizons.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2, 3 or 4. It is silt loam or silty clay loam.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 through 6. It is silt loam or silty clay loam with clay content ranging between 18 and 35 percent. Subhorizons are in random sequence, variable in thickness, textures are variable, and often the horizons are discontinuous. The blocky or platy structure fragments of the C horizon are not due to pedigenic factors but due to the way the soil material was put into place by mechanical means.

A buried A horizon is present in some pedons, but most of the time it has been removed and stockpiled for later use. When present, it has hues of 10YR or 7.5YR, value of 2 through 5, and chroma of 1 through 3. Texture is usually silt loam but ranges to include silty clay loam.

The Bb horizon has hue of 10YR or 7.5YR, value of 3, 4, or 5, and chroma of 3, 4, or 5. It is silty clay loam, but silt loam textures are within the range.

COMPETING SERIES: There are no other series in this family. Similar soils are the Dow, Fishpot, Ida, and Kanima series. The Dow and Ida series are calcareous throughout. The Fishpot series formed in disturbed fine-loamy materials greater than 40 inches in thickness. The Kanima series is loamy-skeletal and thermic and formed in dump remains from strip mining operations.

GEOGRAPHIC SETTING: Harvester soils are disturbed materials in areas where loess deposits that have been graded and reshaped for urban and suburban development have been placed over truncated loess soils. Slope gradients range from 2 to 30 percent. The average annual precipitation ranges from 35 to 42 inches and mean annual temperature from 52 to 57 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Menfro and Winfield soils. Menfro and Winfield soils formed in deep undisturbed loess deposits which have argillic horizons. Each of these series occur on similar landscapes.

DRAINAGE AND PERMEABILITY: Moderately well drained. Runoff is moderate. Permeability is moderately slow.

USE AND VEGETATION: Harvester soils are used for residential, commercial and industrial buildings, and adjacent grounds and roadways. Present vegetation is lawn grasses, ornamental shrubs, and shade trees. Native vegetation was forest consisting of oaks and hickory.

DISTRIBUTION AND EXTENT: Urban areas in MLRA 115 and 116B and possibly other urban areas in the midwest. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: St. Louis County, Missouri, l979.

REMARKS: Areas of Harvester soils were in deep loess deposits prior to disturbance by earth-moving equipment. The amount of filling, cutting, alteration of existing soil is variable from place to place.

National Cooperative Soil Survey

U.S.A.

Chapter 4 - General Conclusions

The preceding chapters of this master's thesis detail the specific informational and technical assistance needs of urban growers in Tacoma and Seattle, WA and Kansas City, KS and MO on soil contamination topics, as well as how the urban soils laboratory for the introductory soil science course at Kansas State University was designed, taught, and assessed. Upon completion of this research, many beneficial insights were gained.

The low response rate of the needs assessment survey and low completion rate of demographics questions facilitated new recognition of survey design and distribution challenges. The low response rate may confirm that the topic of urban soil contamination was a sensitive issue for many urban growers. Many urban growers indicated to me in casual conversation or in written comments in the survey that they were concerned that the determined presence of soil contamination on their site would terminate their garden or farm operation. When addressing soil contamination issues with the urban clientele it is necessary to ease their concerns as to not further invoke fear.

The survey we designed was too long. When distributing the survey at community meetings, growers commented on the long length of the survey. Urban growers found it too time consuming and daunting a task to complete it in full, therefore many respondents failed to even begin or complete the survey. I found that many respondents dedicated no more than 10-12 minutes to completing the survey; therefore efforts should be made to design surveys to be completed in less than 12 minutes.

Finally, this was our first attempt at contacting the new urban grower clientele in these communities. Often new clientele can be difficult to reach. Contacting urban agriculture leaders within the surveyed communities was beneficial. These leaders provided recommendations for best distribution methods within their communities. The P-Patch organization in Tacoma and Seattle, WA had a functioning urban agriculture listserv, and the Cultivate Kansas City organization in Kansas City, KS and MO had a listserv, newsletter, and annual community gathering each of which served as beneficial survey distribution catalysts in these communities.

Leaders also personally assisted with distribution of the survey, improving our credibility and trust with the new clientele in each community. I found that the assistance of urban agriculture leaders was vital to the successful distribution and completion of the survey in these communities.

The greatest proportion of urban gardeners and farmers in both these communities indicated that they use the internet as a source of information to answer their questions on urban agriculture issues. The internet is a convenient source of information for many urban growers and this clientele may be most comfortable with the anonymity of the internet. In the future, new informational resources (e.g. videos) should be available on the internet for this urban grower clientele to conveniently access on their own terms. We created a video for the internet detailing the basics of urban soil sampling and testing for common urban soil contaminants. This extension video was designed to address some of the educational and technical assistance needs of the urban grower clientele and was made available on the Kansas State University Research and Extension page available at: http://www.youtube.com/ksrevideos (Harms et al., 2011).

When working with the urban grower clientele in the future, we should keep these new insights in mind. We need to address urban growers concerns associated with soil contamination issues, work with urban agriculture community leaders, and utilize the internet for distributing educational and technical assistance resources for the urban growers in these communities.

New insights were also gained throughout the process of designing, teaching, and assessing the new urban soils laboratory. Overall, we learned that most students had sense and meaning of the material throughout all of the new activities. However, insights were also gained into how to improve upon student learning in two of the six new activities Activity 1 and Activity 5, of which a greater number of students reported a lack of meaning. In Activity 1, building a soil profile model did not interest students. Many students reported that the activity was boring. If students don’t find the activity engaging or interesting, then they may not gain sense or meaning from the material. Students may be more interested in viewing an urban soil profile in a pit. Perhaps future labs could visit a pit dug in an urban environment demonstrating the same concepts as the urban soil profile models but in a real-life context.

Improving students’ sense and meaning in Activity 5: Determining soil contamination using an X-Ray Fluorescence Spectrophotometer may be accomplished by better establishing relevance with the students. Many students indicated that they did not think they’d ever use an XRF again in their careers. Perhaps, allowing students to bring in their own potentially contaminated soil samples would help establish relevance with students. Also, establishing the unique capabilities, efficiency, and cost-effectiveness of the XRF may also improve students’ interest and meaning in the material.

When teaching these two activities in the future more effort should be placed on hands-on, real-world, and interesting examples or activities to better establish relevance and interest in material outlined in the learning outcomes. Effort and enthusiasm for the material is required on the part of the teacher throughout the implementation of each of the six urban soils activities. Students will pick up on this enthusiasm for each topic which will potentially create interest in the students. The greater the interest students have in each topic, perhaps the more ease the teacher will have in facilitating sense and especially meaning of the material.

The urban soils activities should be continued in the design and teaching of future introductory soil science courses. Each of the individual urban soils activities could easily be incorporated into a new or existing course to improve students’ sense and meaning of each particular urban soils topic detailed in the learning outcomes.

To summarize my point, urban growers and future agricultural and environmental professionals need and want information on urban soils and urban soil contamination. Information is needed and wanted on how to safely and efficiently utilize this vital resource within urban environments. My research has brushed the surface of these needs. Further research is needed to determine more on the urban clientele and their informational needs so that our extension professionals can better serve this ever growing audience. My research efforts have attempted to address some of these needs (e.g. undergraduate coursework, online extension video) however, much more needs to be done. Future extension and educational efforts should strive to reassure and inform urban clientele, extension professionals, policy makers, consumers, etc. that urban soils can be managed to improve urban soil quality and can be safely utilized for urban agriculture and other beneficial uses.