

**Pioneering Shipping Waste Management at Carleton College: How Individual And
Institutional Behaviors Contribute to the Textbook Shipping Waste Stream**

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Introduction

Higher education institutions are contributing to the plastic packaging waste stream, a growing global concern. Plastic packaging is a single-use item that is difficult to recycle due to its multi-polymer construction, consequently, most U.S. packaging plastic is destined for landfills [Luijsterburgab , et al., 2013; Achilias , et al., 2009]. Plastics of this nature-- eg. plastic mailers-- that do not end up in landfills have made global news for their negative impacts on the environment and human health. Plastic clutters beaches, strangles sea turtles, chokes fish, and has entered the human body through the consumption of seafood [A.C. Vegter , et al., 2014; J. S. Silva-Cavalcanti , et al., 2017]. Plastic's contribution to cost efficient methods of production, its breath of application, and unknowingly long life-span ensures that companies will continue to use it in their production processes[Kathleen Pilfold, 2013]. The negative effects of plastic package usage are only expected to increase.

Plastic packaging is a contributor to a larger plastic issue in the United States, as the majority of the ~15 million tons of plastic that the United States generated in 2017 ended up in landfills [EPA, 2019]. The US has been able to deal with much of its recycling waste by exporting it to China and developing countries. The United States' lack of advanced waste treatment centers was not a significant issue until 2018, when foriegn powers began to accept significantly less plastic waste [McCarthy , et al., 1991; Christopher Joyce, 2019]. These new policies have increased the United States' risk of inadequate plastic packaging disposal [Ritchie , et al., 2018; National Overview, 2018].

Despite the risks of exporting large volumes of plastic waste generated in the U.S., much of the existing research on plastic waste management focuses on strengthening the efficacy of recycling programs. Studies that research methods for reducing the generation of plastic packaging waste have been very limited. This study contributes to this gap by investigating how the purchasing habits of college students interact with an integrated waste management system. Understanding this will help develop ways to manage plastic waste that are less reliant on recycling, this study focuses on plastic waste reduction. Higher Education Institutions (HEIs) an ideal location to research patterns of consumption, recycling, and reuse of plastics as they mimic

city characteristics and generate similar environmental impacts. The large quantity of plastic waste generated at HEIs forces them to develop creative methods to deal with waste streams on campus, and as such have important implications for surrounding municipalities [Alshuwaikhat, 2007]. Successful HEIs have Environmental Management Systems (EMSs) that deal with recycling, energy efficiency, etc.-- and the steps needed to get there. EMSs are often found in an institutions' Climate Action Plan (CAP) (e.g. Carleton College's 2011)["Climate Action Plan(CAP)-May 2011"].

Our study takes place at Carleton College, a liberal arts HEI located in Northfield, Minnesota. Northfield is a rural city with a population of ~20,000, and is home to two private Liberal Arts institutions of higher learning. The college is known for its 880-acre arboretum, where it facilitates the restoration of prairie fields, two wind turbines, which produce ~60% of the school's energy usage, and geothermal energy plants. Carleton College received an A- in 2011 from the College Sustainability Report Card, earning the rank of "Overall College Sustainability Leaders" ["Carleton College - Green Report Card 2011 "]. Carleton has recently made efforts to manage campus waste more sustainably by implementing a reuse, reduction, and recycling framework for varying forms of waste. Carleton is an ideal study location as it is restructuring its CAP, and aims to generate zero waste by 2030. However, Carleton's current CAP does not include the management of plastic shipping waste ["Zero Waste Task Force"].

Literature Review

Previous research highlights the importance of identifying the sources of waste and assessing how students interact with the institution's recycling program for successful waste management [Smyth , et al., 2010; Webb , et al., 2019]. Studies on successful HEI waste programs (e.g. Smyth , et al., 2010; Farmer , et al., 1997; Baldwin , et al., 2012; Armijo de Vega , et al., 2008; State University of New York, 2010; and "College Solid Waste Reduction...") rarely investigate the shipping waste generated by packages shipped to these institutions. Nor do these studies assess students' willingness to change the consumption habits that generate this waste. However, research into students' consumption habits is of increasing importance as college mailrooms flood with plastic mailers from companies like Amazon [Udland, 2015;

Stoltzfus, 2015; Young, 2019]. This project seeks to extend the literature on the subject by analyzing the plastic waste generated by selected Carleton students through their textbook purchasing habits.

Textbooks are an under-studied, yet consistent factor of waste creation on campuses, as students are required to purchase them. Students tend to prefer print textbooks versus electronic books, so they are faced with the choice to buy coursebooks online or from a bookstore [Woody , et al., 2010]. Carleton's rural location offers students few alternatives for buying books other than from the Carleton Bookstore or online, suggesting that the potential for generating high volume of plastic waste is substantial. Accordingly, our study aims to answer the following specific questions: 1) Where do Carleton students purchase their textbooks? 2) Why do Carleton students prefer to buy their textbooks from one source, not another? and 3) What is the volume of plastic shipping waste generated by Carleton students?

Understanding the significance of plastic shipping waste generated by student textbook purchasing habits at Carleton required an integrated analysis using multiple sources. This section reviews literature that discusses the increased usage of plastic shipping waste, the failings of current plastic waste mitigation methods, and urges future research on plastic to include reduction strategies. Then, we discuss the role of students' personal values, sense of community, and engagement in HEI waste management systems as indicators of successful waste management on college campuses. We will conclude this section by discussing factors that make student textbook purchasing habits a consistent and growing contributor to Carleton's plastic shipping waste stream.

Student Package Recieval At HEI's

HEIs are experiencing an increase in packages ordered and shipped to their institutions each year, and an increasing number of these packages contain unrecyclable plastics [Constable, 2015; Willie, 2015]. College students order online for many reasons, including convenience, brand loyalty, and necessity [Lauren Bailey, 2007]. These packages are of all shapes and sizes arriving via several well known mail services, including FedEx, UPS, DHL, and the United States Postal Service (USPS). Many of these mail services offer colleges discount shipping rates

due to the amount of packages shipped to and from HEI's, further enticing students to use their mailing system [Perkins, 2020].

Constable [2015] denoted an overwhelming quantity of packages arriving to HEI's across the country from companies like Amazon [Amazon, 2019]. Amazon is a particularly notable contributor to the composition of HEI shipping waste because of its heavy reliance on plastic envelopes as packaging material and appeal to college students with the slogan, "*College is hard, but an Amazon Student membership makes it easier*" [Knowledge@Wharton, 2018; Amazon, 2014]. Amazon also offers student discounts on "Amazon Prime," a two-day shipping service with targeted advertising toward college students looking for discounted textbooks online [Amazon, 2014]. Smaller essentials like textbooks are likely to arrive in plastic mailing envelopes (*Figure 1*), and contribute to the growing plastic packaging waste stream generated by colleges nationally.



Figure 1: Typical examples of poly-mailers, or plastic shipping envelopes. Both envelopes include a sealing adhesive and the envelope on the right is padded with bubble wrap.

Several other companies have replaced bulky cardboard packaging with plastic envelopes due to their compact nature [Kristen Young, 2019]. More envelopes can fit into company transport vehicles at a given time compared to cardboard boxes, making them a more fuel efficient alternative [Willie, 2015; Kathleen Pilfold, 2013]. However, where companies experience short term gains of increased mileage, the rest of the world pays in the long term as

improper disposal of plastic shipping waste often leads to the pollution of terrestrial and aquatic environments [A.C. Vegter , et al., 2014; J. S. Silva-Cavalcanti , et al., 2017; Swift , et al., 2015].

Plastic Shipping Waste

Plastic shipping waste [PSW] poses an immense ecological threat as it is primarily designed for single use and is non-recyclable with extended life-cycles [Hopewell , et al., 2009]. When improperly disposed of, plastics deposit harmful chemicals into the environment and may have negative impacts on marine wildlife and human health [Swift, 2015; A.C. Vegter , et al., 2014; J. S. Silva-Cavalcanti , et al., 2017].

Municipal and collegiate recycling programs designed to divert plastic from landfills and alleviate the effects of plastic pollution have been prevalent in the U.S. since the 1970s [Plastic Expert, 2014]. Most of this waste was disposed of by exporting it to countries like China to be transformed into new goods [CNBC, 2019]. However, in 2018, China was one of the first countries to halt the import of plastic waste. As a result, the ~700,000 tons of plastic the United States shipped to China every year must find new channels of export if it is not to exacerbate the already taxed landfills in the country [Ritchie , et al., 2018; National Overview, 2018].

Plastic is a synthetic polymer-- a long chain of carbon atoms-- that has a wide range of uses, but not all plastics are made equally. Single-sourced polymers-- or items made out of one type of plastic-- have relatively simple bonds and are easy to melt down for recycling purposes. In contrast, items made with multi-polymer plastics, such as plastic mailers, contain several complex polymeric bonds-- for example propylene, polyester, and ethylene homopolymer-- that are relatively difficult to melt down [Google Patents, 2019]. Although it is possible to break these bonds, these plastics are considered “non-recyclable” because they can not be easily melted and separated into pure components for reuse. Conventional municipal recycling services in the United States do not accept multi-polymer plastics for this reason, leaving them to fill up landfills across the country [Achilias , et al., 2009; Swift, 2015; “Polymer Science and Engineering...”; NPR, 2019].

Less well-known methods used to mitigate the effects of plastic packaging waste include reuse, upcycling and the use of biodegradable plastics. Recent research has focused on the reuse

and recycling of shipping plastics as well as substituting synthetic polymers with more eco-friendly materials. One study discusses upcycling plastic shipping waste using pyrolysis, where plastic waste is placed in a furnace in the absence of oxygen and superheated to approximately 400-500 °F and allowed to decompose. Through this process, natural oils and gases can be retrieved from the plastic for reuse [Demirbas, 2004]. Pyrolysis would be an excellent mitigation strategy to reduce the impact of plastic shipping waste that parallels how single use plastics are broken down for reuse. However, such methods are often costly, generate toxic emissions, and lack sufficient testing [Demirbas, 2004]. Even biodegradable shipping plastics, presumably eco-friendly substitutes for conventional plastic packaging, can potentially lead to ecological degradation. Research shows the adhesives used in their construction can persist in water columns and lead to a multitude of ecological problems like the toxification of marine based ecology [Swift , et al., 2015]. Recent changes in global, ecological and political climates have spurred an urgent and unexpected need for research on alternative ways to mitigate the effects of recyclable plastics as well.

Now that traditional recycling methods are no longer viable, and other methods for upcycling plastics are costly and not feasible, research into how to reduce the use of plastic packaging waste may be the most effective way for the United States to mitigate the growing risk of improper plastic disposal. Reduction of plastic consumption would decrease the amount of shipping waste destined for landfills, and allow innovators time to develop cost-effective ways to upcycle packaging waste. This study is designed to investigate factors that contribute to the production of plastic shipping waste at HEIs and will inform future studies on how to gain support for plastic waste reduction programs. Studies like this one will be crucial to Carleton's efforts to be waste free by 2030, as the college's unmanaged plastic shipping waste stream continues to grow.

Waste Mitigation Through Pro-Environmental Behaviors

The mitigation of large scale environmental issues like the growing plastic waste problem requires support from a like-minded community, yet hinges on an individual's willingness to participate in pro-environmental behaviors. According to the extant literature,

“Pro-environmental behaviors are intentional efforts made to reduce an individual's impact on the environment” [Sugandini , et al., 2019]. Pro-environmental behaviors include support for pro-environmental policy, participation in waste management initiatives, sustainable consumption practices, and participation in local environmental clubs and NGOs; they are also known as sustainable behaviors [McKenzie-Mohr , et al., 1999].

Research shows most people want to protect the environment; however, their likelihood of participating in pro-environmental behaviors is associated with factors beyond simply wanting to protect the environment. Participating in pro-environmental behaviors is often driven by an individual’s personal values and general knowledge about the environment [Sugandini , et al., 2019]. Studies that test for factors associated with pro-environmental behaviors typically use surveys and questionnaires to get self-reported values. Sugandini , et al., found that individuals are more likely to engage in pro-environmental behaviors if they are aware of the consequences of their actions on the environment, and if environmental action is convenient and feasible. Other scholars in this field suggest that demographics, aspirations, and community surrounds all play a role in an individual's propensity to engage in pro-environmental behavior.

Demographics

Studies indicate that income, age, and gender play a role in people's likelihood to participate in pro-environmental behavior [Ku and Zaroff, 2014; Tabenero, et al., 2015]. In their paper “How far is your money from your mouth?”, Ku and Zaroff [2014] build upon studies that found women to have a greater desire to support environmental policy while men tend to have greater participation. Beyond gender, Tabenero, et al. [2015], identified internal (eg. age and educational level), and external (e.g., social and cultural) variables, to affect a person’s environmentally responsible behavior. Individuals with greater educational levels typically demonstrate more environmental responsibility, no matter their discipline [Osbaldiston and Schott, 2012]. Research also discovered that economically deprived individuals typically display lower participation in sustainable activities [Groot, 2005].

Research on the Relationship Between Individual Psychological Factors and Pro-Environmental Behaviors: Construal Level Theory

Construal Level Theory (CLT), developed by Trope and Liberman is cited often as a reliable predictor of an individual's propensity toward pro-environmental habits and behaviors. Construal Level Theory suggests a relationship between psychological distance (PD) and the extent to which people think about their experiences as abstract or concrete [Trope and Liberman, 2010]. Psychological distance is a concept from social psychology that refers to how people relate themselves to the world around them. Things with psychological closeness are things that people perceive to be a part of their immediate experience of reality. Those with psychological distance are not a part of one's current experience of reality [Trope and Liberman, 2010; Liberman , et al., 2006]. PD is divided into spatial, temporal, social, and hypothetical dimensions that operate independently from one another [Trope and Liberman, 2008; Trope and Liberman, 2010]. One may experience psychological closeness to a person beside them along the social dimension, and psychological distance to a future conversation with them along the hypothetical dimension simultaneously. They found that people typically express psychologically close experiences with concrete construals and suggest that mental construals can be used to predict individual behaviors [Trope and Liberman, 2008].

Scholars that build on Trope and Liberman's work reveal that CLT is associated with an individual's likelihood to participate in self-regulatory and consumption behaviors. The relationships they prescribe do not always persist in the context of pro-environmental behaviors. It is said that people engage in more self-regulatory behaviors when the effects of their action or inaction are psychologically far and abstract [Fujita, et al., 2006]. Trope and Liberman, et al.'s [2007] research on CLT indicates that the consumption of goods increases when companies inspire abstract and concrete construals about their products based on the amount of detail that is included in their advertisement. They found that high level, abstract construals were associated with higher incidence of positive, self-regulatory recycling behaviors; this is in-line with previous research on CLT and behaviors [Fujita, et al., 2013; Katherine White, et al., 2011].

However findings by Wang , et al., challenged the conceptual validity of CLT and its relationship to pro-environmental behaviors, and sustainable consumption habits.

In their study, Wang , et al., adopted two Psychological Distance tests [Spence, et al., 2012; McDonald, et al., 2013] and two Construal Level Theory Tests called the Behavioral Identification Form (BIF) and Response Category Width (RCW). BIF is an established method for measuring an individual's construal level. RCW is a new test adapted by Krüger, et al.[2014] to determine an individual's PD to an object based on the associated construal of the object. They compared the results of the original BIF and RCW to their adapted versions, named BIF-E and RCW-E, to measure construal levels of objects and actions that impact the environment, such as carpooling [Wang, et al., 2019]. The four tests were conducted on the same sample of respondents and their following findings have significant implications on the validity of CLT as a predictor for environmental behaviors: 1.) PD was not measured consistently between the two PD tests, for the four dimensions(i.e a person could be deemed temporarily close to an event on one test but temporarily far to the same event, on the other test). This indicates flaws in the existing tools to measure PD variables. 2.) There was no consistent association between PD and construal level theory contrary to Trope and Liberman's claims. 3.) The results of the BIF and RCW construal tests had no ability to predict pro-environmental consumption or policy support, despite previous literature that claims an association between CLT and recycling.

Their finding poke holes in both the relationship between PD and CLT and the tools typically used to measure them. Their findings also suggest CLT may be a valid indicator of some, but not all pro-environmental behaviors; more research needs to be conducted on the validity of CLT in context of sustainable consumption habits. Literature on the relationship between Aspiration Index and pro-environmental behaviors propose a more reliable way of predicting a range of individuals' pro-environmental behaviors.

Self Determination Theory and The Aspiration Index

Aspiration Index (AI) is a well-established method for discerning an individual's central drive to action and is cited as an explanation in several studies within the past few decades. Aspiration Index draws on Self Determination Theory, a concept from psychological studies that

claims an individual's life goals or aspiration can be consistent indicators of one's psychological health and propensity for a range of behaviors. Current usage of the AI dates back to Kasser and Ryan's [1993] study on college students in which they received self reported answers to six questions adopted by the World Value Survey to classify a person as having primarily intrinsic or extrinsic aspirations. Intrinsic goals included values for self-development, community, and physical health, while extrinsic goals included aspiration regarding financial success and self image. The Aspiration Index has been measured extensively on college students in HEI's globally [Grouzet, et al., 2005; Deci, et al., 2009]. One study affirmed the dual dimensionality of the Aspiration Index framework on undergraduates across 15 cultures; their confirmation factor analysis showed that intrinsic goals included values for self-development, community, and physical health and extrinsic goals included value for financial success and self image [Grouzet , et al., 2005].

Other studies show that intrinsic values are associated with outcomes of positive well being and psychological health, whereas extrinsic values are associated with negative well-being, depression and anxiety [He, et al., 2016; Twenge, et al., 2016]. Further, they found that the effects of holding either value persists even after graduation, as those favoring Intrinsic values show higher rates of achieving their goals and better psychological well being [Deci, et al., 2009]. Intrinsically motivated individuals typically demonstrate pro-environmental behaviors when their community supports environmental stewardship [Ku and Zaroff, 2014]. Ku and Zaroff found that people who had high intrinsic scores were willing to pay more to protect the environment. They did this using the Willingness to Pay(WTP) framework, a parcel of the World Value Survey that analyzes a person's willingness to provide capital in order to protect the environment [Ku and Zaroff, 2014].

Institutional Role In Promoting Environmental Ethic

Individuals who feel a sense of belonging within a community or group of like-minded individuals with a pro-environmental ethic are more likely to engage in behaviors like waste reduction and environmental policy support [Tabernero , et al., 2015; Ku and Zaroff, 2014]. A

strong sense of community values is a typical trait of intrinsically minded individuals. The institutions can promote routine environmental behaviors by implementing visible pro-environmental initiatives and providing opportunities for student input on the creation and maintenance of the school's larger environmental goals [Taberner , et al., 2015]. Institutions that do this successfully have integrated management systems that mobilize institutional resources and students around pro-environmental goals that are reinforced through educational efforts. The successful implementation of pro-environmental goals on campus relies on support by three pillars : (1) Institutional/Administrative Efforts, (2) Student Engagement, and (3) Educational Reinforcement [Alshuwaikh and Ismaila, 2008].

Student body engagement is important as people were also willing to go out of their way to behave pro-environmentally if they perceived that their actions changed the community [Ku and Zaroff, 2014]. The importance of student voices is amplified by the fact that pro-environmental initiatives are more likely to be successful and sustainable when maintained by those most affected by their implementation [Weaver 2015; Zaroff & Ku 2014]. At Carleton College, the tri-bin compost, recycling, and landfill system is one such initiative where its efficacy depends on student participation. The tri-bin system was made to divert needless waste from the landfills, by offering co-located compost, recycling, and landfill bins at many locations around campus, with the goal of making it easy for students to dispose of waste in the most appropriate way without having to search out the right bin. A study conducted in Spring 2019 revealed that students who were aware of Carleton's Sustainability Office or participated in pro-environmental clubs on campus were most knowledgeable about how to correctly sort their waste [Hall , et al., 2019]. Their knowledge demonstrates the powerful effects of student engagement. Previous research shows that outreach to alumni and external partnerships are other ways the environmental administrative staff can foster community engagement by utilizing the institution's environmental management strategies (EMS) [Abukar 2007]. Carleton's Sustainability Office communicates with the College's numerous environmental clubs and alumni to improve its engagement with the student body to benefit EMS goals. *Figure 2* illustrates how the Carleton's Sustainability Office is organized and staffed to accomplish the institution's core environmental management goals.

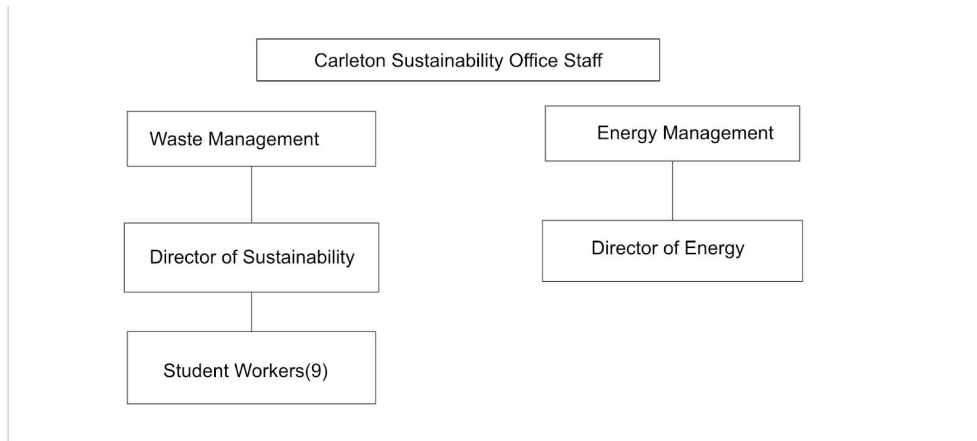


Figure 2: Carleton’s Sustainability Office staffing. The office manages the college's waste and energy concerns with cooperative leadership. The waste management team consists of one director and nine student workers. The energy management team has one director. Both team collaborate when assistance

Environmental efforts can be reinforced by institutional efforts to educate the community about the College’s sustainability goals. Stakeholder education can include integrating topics of sustainability into the curriculum or holding seminars or workshops that educate the campus community about the College’s environmental efforts. The Carleton Trash Talkers are an excellent example of an educational opportunity. Trash Talkers is an active workshop, administered by the Sustainability Office, where student volunteers teach others how to sort their waste into the tri-bins at sports games and other campus events.

It is also important to mention that a community’s pro-environmental ethic influences an individual’s sense of moral obligation to behave in an environmentally conscious manner [Gatersleben, 2014]. Research shows that one’s social status in a community can influence one’s self-regulatory behavior and policy support: people will act in a pro-environmental way if it improves their social status in the community [Rim, 2013]. In contrast, people are less likely to demonstrate pro-environmental behaviors or support pro-environmental policy if it threatens their social status in their community [Wang, 2019; Trope and Liberman, 2010; Ledgerwood, 2008]. When considering that social status is an extrinsic value, and the negative relationship between extrinsic values and WTP described in the previously discussed literature, it makes sense that those who value social status will adhere to, or abstain from pro-environmental behaviors on a situational basis. However, the relationship between social status and the

environmental ethic of a community highlights the fact that even extrinsically motivated people will participate in pro-environmental behaviors in an institution that makes active efforts to foster a high pro-environmental ethic on campus.

Textbook Purchasing Stream on College Campuses

Textbook purchasing practices are an under-studied, consistent source of waste generation on college campuses. The necessary relationship between students and textbooks is the impetus behind how and why waste is generated when students order textbooks. Professors choose which books to use for their classes and students are expected to purchase them regardless of price or personal convenience [“Fixing the Broken Textbook Market...”]. Book publishers recognize their power and charge as much for books as they feel they can. They are also infamous for employing tactics to keep book prices high. Such tactics include frequent textbook revisions, and the promotion of instructional manuals to professors for courses that require students to purchase multiple bundled texts without disclosing the costs students will incur [Zomer, 2007]. The price of required texts has become a major factor in student book purchasing practice as the monopolistic qualities of the textbook market have led prices to increase dramatically in the 21st century. The average price for college textbooks rose 84% between 2002 and 2012 alone [“Fixing the Broken Textbook Market...”]. Research conducted by the College Board indicates that college students in the U.S. tend to pay \$1200 for textbooks and material every school year [“Fixing the Broken Textbook Market...”; “A Single College Textbook...”].

Paying for textbooks can be a significant challenge for students. A challenge so significant that it can influence the academic path students take, where they buy their books, and how much waste is generated from their purchases. Humanities courses tend to use general reading books; these are books that are easily accessible to the general public and are not subject to frequent revisions like instructional textbooks. Science and language classes tend to use instructional textbooks that get updated every year by the publishers, to lower the market saturation of their books and keep the price high [Kock 2020]. If students want to follow along well in their courses, they often have to buy the newest edition of instructional textbooks.

Research shows that the price differential between general reading books and instructional textbooks may influence students' decisions to register for one course over another; these students are less likely to take a course that requires an expensive text["Fixing the Broken Textbook Market..."].

E-books are marketed as a cheaper, zero-waste option to alleviate the price burden of required course materials. However, research reveals that students prefer print books, forcing them to decide where to buy them [Woody, et al., 2010]. Student's book purchasing location ultimately decides how much waste will be generated from their purchase. Recognizing the bearing book prices have on student academic success, some colleges have implemented programs that help students get their books through borrow programs or at discount prices. Programs like the Carleton Student Association's Library and the Gould Library reserves, allow students to check-out and return copies of their required textbooks-- these alternative book access options produce no waste [Paul, 2020]. Carleton also supports a program that subsidizes student textbook purchases and allows students to buy books from their retailer of choice; be it online or in a bookstore ["Emergency Funding | Dean Of Students | Carleton College"]. Recent studies reveal that the increase in in-store book prices has led many students to online retailers in search of discount price books [Kristof, 2018; Zook, 2019; Udland, 2015]. The lack of research on the waste generated from textbook purchases makes it difficult to provide the types of waste generated from online textbook purchases compared to in store purchases. However, online purchases can be associated with higher rates of plastic waste generation because online purchases are typically individually packaged and shipped in cardboard boxes or non-recyclable plastics. Bookstores are able to buy their books in bulk to provide for a large portion of the school, allowing for many books to be shipped in one cardboard box.

The United States has no viable method for mitigating the growth of plastic shipping waste in landfills. Pyrolysis, biodegradable packaging, and export of waste are not enough to redress the issue. As such, reduction of plastic waste is an important method that needs to be explored. A study that focuses on waste reduction methods on college campuses is important as HEIs mimic the waste generation patterns of municipalities, and have the ability to construct and enact novel mitigation methods. It is important to investigate students' personal values,

aspirations, sense of community, and knowledge of the HEIs waste management system as they are drivers of a student's pro-environmental behavior such as sustainable consumption. Studying students' AI and WTP allows researchers to focus on the exact reasoning behind plastic packaging waste generation and possible methods for reducing its volume on campus. Student engagement with HEI management systems is also important, as previous studies note the need for collaboration between staff and students to achieve EMS goals. Carleton aims to be waste free by 2030. Studying the plastic packaging waste generated by student textbook purchasing is an important first step to the College's future management of campus shipping waste.

Methodology

Study Area

This study was conducted at Carleton College, a small private Liberal Arts institution located in Northfield, Minnesota. Northfield is a rural city with a population of ~20,000, which is home to two private Liberal Arts institutions of higher learning. Carleton's location means that there is limited public transportation beyond the city limits. Carleton College has a population of 2,046 students from 50 states and 35 countries and it offers over 1,000 courses of study, 69% of which require textbook purchases [“Carleton at a Glance...”; Fossum 2019]. As such, the region offers students few alternatives for buying books other than from Carleton or online textbook retailers.

Participants and Procedures

This is a mixed methods study that consists of a student survey, analysis of data from the Carleton Post Office, and conversations with staff at the Carleton Sustainability Office, Bookstore, and Post Office. Surveys are a validated method used to identify influences on pro-environmental behaviors [Stolberg, et al., 2007; Grob, 1995; Homburg and Stolberg, 2006; Lai, et al., 2003]. This study used a survey to obtain self-reported information on demographics, personal values, textbook purchasing habits, and knowledge about Carleton's environmental initiatives. We chose to survey students over conducting an observational study, as we

anticipated greater confidence from findings derived through a survey than those based on our assumptions of student habits.

Participants in the survey were all current Carleton students, enrolled in at least one of five different classes: Biology 240, Chemistry 233, History 138, Philosophy 226, and Spanish 102. According to the Carleton Hub, each of these courses required students to purchase at least one textbook. These classes were also selected to diversify the class years of our survey respondents, in addition to the prices and types of book required for each class based on the course subjects (i.e. humanities, language, or science) as shown in *Tables 1 and 2*. For the purposes of this study, we use the terms “books” and “textbooks” interchangeably, to refer to all required course books.

In order to get the survey to the students, we requested permission from professors via email to pitch the study to their respective courses. Five of the eight professors we contacted agreed. Amenable professors signed a form that stated that they consented to refrain from speaking to students about the survey contents, their participant status, and not to request de-identified survey results until after the study’s completion. Previous studies demonstrated greater recruitment when researchers met with proposed respondents in person [Ku and Zaroff, et al., 2014]. We personally pitched the project to each of the sample courses during the first week of classes, in Carleton’s Winter Term 2020. This pitch included an explanation of why their class was chosen and an overview of the survey purpose and contents. Students were also informed of their eligibility to win a prize-- a t-shirt from the Carleton Bookstore -- upon completing the survey. Professors were asked to leave the room during the voluntary sign up process to keep the students' participation confidential. Students formally agreed to the voluntary nature of their participation by reading a statement of consent at the beginning of the survey. The survey was created and disseminated using Google Forms; survey responses were recorded in a spreadsheet generated by Google Forms and stored in our Carleton Google Drive folder. The survey was sent out via email on Monday, Jan. 13 and ended Monday, Jan 27. Participants received reminders to complete the survey within this 2 week period.

Table 1: Sample courses including how many students enrolled in the course during Winter Term 2020, their required books and their average price ranges for used and new books this term, and number of books sold from each course by the Carleton Bookstore .

Class	Number of Required Books	Bookstore Price	Units of Each Book Ordered by the Bookstore	Units Sold by Bookstore
SPAN 102 (3 sections)	1	\$213.30	43	20
BIOL 240	1	(\$60.99 - \$240.50)	32	6
CHEM 233	2 (+1 optional text and a model kit)	(\$59.99 - \$265.20)	28 12 15 (optional texts) 2 (model kit) 12 (model kit)	16 6 9 2 7
HIST 138	4	(\$37.79 - \$81.60)	22 27 22 28	19 21 19 21
PHIL 226	2	(\$13.15 - \$28.00)	22 (of each)	17 18

Table 2: The number of students enrolled in each course during Winter Term 2020, the number of students from each course that responded to our survey and response rate.

Class	Number of Students Enrolled	Students That Responded to the Survey	Response Rate
SPAN 102 (3) sections)	47	26	55%
BIOL 240	24	20	83%
CHEM 233	22	18	82%
HIST 138	30	11	37%
PHIL 226	25	11	44%

Survey Elements

The survey had six parts to identify students' demographics, Aspiration Indices, course-book purchasing habits, and WTP in order to consume pro-environmentally. The survey also inquired about student awareness and morality of their waste generation on Carleton's campus. Information about our reasoning for including each of these sections follows. Section letter codes are given for easy cross-referencing with the complete survey, which can be found in *Appendix A*.

Participant Demographics (Section A): We wanted to understand the demographics of our survey respondents because studies suggest that women are more likely to exhibit pro-environmental behavior. We also expect upperclassmen to have more awareness and knowledge of their waste generation. Further, we hypothesized participants enrolled in STEM courses to purchase more books and the number of required texts to influence textbook purchasing behaviors and willingness to pay for a more sustainable option. We expected economic strains to lower students' participation in pro-environmental behaviors and to be a significant factor in students' decisions to buy online rather than locally, as online lenders tend to have cheaper purchasing options [Dean & Forray, 2018]. This hypothesis was tested by inquiring about students' reasoning for buying textbooks.

Aspiration Index (Section B): In this section, we adopted Ku and Zaroff's (2014) use of the Aspiration Index. AI is determined by a set of three intrinsic questions (e.g. *How important is sharing your life and experiences with another?*) and three extrinsic questions (e.g. *How important is a well paying job?*).

Book Purchasing Habits (Section C): This section was designed to ask students when and where they accessed their required textbooks, for this term and previous terms. Here we also investigate what packaging the books arrived in, and what students typically do with their books after the term ends. We used these responses to generate an estimate of the magnitude of packaging waste at Carleton College and to determine which habits generate the most-- and least-- waste. Estimations were calculated by discerning the percentage of respondents who

generated *at least one* plastic envelope, then scaling to the size of the student body. We also asked if respondents were aware of the packaging reuse bin outside of the Carleton Post Office and what happens to their shipping packaging, post disposal, in order to gauge the possible utility of future educational opportunities regarding waste recycling.

Willingness to Pay (Section D): We adapted Ku and Zaroff's, (2011) Willingness to Pay study asking if participants care about the environment and *How much money they would be willing to sacrifice in order to protect the environment?* We expanded upon the WTP idea by using a price range estimation, as seen in Kannel , et al., (2019) surveys of people's willingness to pay for a bike-sharing program. Their survey first asked if the idea of a bike-sharing was appealing and, if so, what a person's willingness to pay was for their reported preference [Kannel , et al., 2019; Ku and Zaroff, 2014].

Awareness and Morality (Sections E and F): In these sections, we determined respondents' awareness of and moral responsibility for waste produced from their book purchasing habits in comparison to their consumption of all goods. A communal morality response would reveal the existence and type of community at Carleton college. We expected these answers to guide our understanding of students' willingness to change their habits to benefit the environment. Responses also provided participants' views on sustainable book purchasing habits as well as habits related to purchasing other goods. We tested Sugandini's hypothesis in our study by introducing participants to issues regarding plastic envelopes, then offering a reasonable increase of book prices in order to consume sustainably. They also discovered that people from a community that has high environmental ethics and a strong sense of community demonstrate pro-environmental behavior. Therefore, we also crafted questions to test the homogeneity of Carleton's responses with regard to the environment.

Waste Reduction (Section F) : This section includes a series of questions probing what respondents think attempts to minimize their book purchasing habits would be (expensive, difficult, etc). This helps us understand what drives students' willingness to, or predictions if they will, change their book purchasing habits to reduce their waste.

Data Analysis

Students' raw responses were collected into a google sheets document containing all 81 respondents of the survey and 79 survey questions. Questions were recorded as binary, e.g. yes or no, Likert scale, or written response. The number of responses for each question was calculated and considered when analyzing data. Responses were averaged to discern general information of the student body inside of google sheets. To conduct stronger statistical analyses, data was translated into R-Studios, an assisted data analysis program software.

Aspiration Index

In this study we calculated Aspiration Index and cronbach's alpha as described by [Zaroff & Ku 2011 and Duriez, et al., 2007] in R-studios. See *Appendix B* for code. Respondents were then separated into levels of "High" and "Low" intrinsic indices-- $\alpha = 0.53$; $HI > .614$; $LI > 0$; $N = 0$; $E < 0$.¹

K-Means Clustering

We conducted a K-means² test to cluster the data set with 81 rows (individual responses) and 79 columns (answers to specific questions) to sort our survey results into groups consisting of individuals with the most similar responses. In order to assure reproducibility of our results we set our seed value to 30. To prepare for the test we prepped the data by removing non responses values (e.g. N/A) and normalizing the data by scaling each variable. We used the "Elbow Method", to determine the optimal number of clusters specific to our data set ["Determining The Optimal..."]. The K-means test was run in R-studios on the scaled data using an optimal cluster value of 4. See *Appendix C & D* for code.

¹ α represents cronbach alpha score. HI demonstrates the threshold of highly intrinsic, while LI correlates to low intrinsic indices. N represents individuals neither who are not intrinsic or extrinsic and E stand for extrinsic.

² For more information on K-means clustering please see, "Clustering Analysis In R Using K-Means."

Post Office Data

We received data from the Carleton Post Office that recorded all students, and some faculty, and staff packages received between Fall Term 2013 and February of Winter Term 2020. We stored de-identified data on our Carleton Google drive in Google Sheets, and used Excel to remove all entries for faculty and staff packages. We then combined the data from all years into one sheet to calculate the trends of student package receipt to the Carleton Post Office from Winter Term of 2014-2020, compute a linear regression of this trend in R-studio, and compare the amount of packages received in the first five weeks of classes of 2019 and 2020. See *Appendix E* for code.

Results

Sustainability and Waste Management at Carleton

Carleton College developed an Environmental management system [EMS] in 2011 that is primarily governed by the Sustainability Office. Carleton's sustainability goals center around "improving the energy efficiency of its campus and reducing its environmental impact" ["Climate Action Plan | Sustainability | Carleton College"]. Carleton works to improve campus energy efficiency by increasing its use of sustainable energy sources like wind turbines and geothermal and monitoring the energy use of 103 campus buildings on the Lucid dashboard [Miller 2020; "Carleton College Expands..."]. Carleton also aims to reduce its environmental impact by diverting unnecessary waste from landfills. Carleton aims to be waste free by 2030; the school diverts 90% of its unnecessary waste from the landfill. Initiatives like Lighten Up- a program that allows students to donate unwanted items at the end of the school year for resale, and the tri-bins and terracycle bins that are distributed around campus for disposal of a variety of waste, assist Carleton's efforts of Zero-Waste ["Zero Waste Task Force"]. Reading the EMS and speaking to staff from the office reveals that Carleton puts the most resources toward becoming more energy efficient and reducing its greenhouse gas emissions, ahead of waste diversion. Our

investigation of waste related to textbooks provides a case study that could be of use to the Sustainability Office as they increase their attention to this lesser-studied area.

Though the Sustainability Office estimates that Carleton currently diverts 55% of its waste from landfills, they are unsure if Carleton is on track to be waste free by 2030. This is because they do not actively monitor how much waste is transported from the school's grounds. Of the three types of trash bins exported from the campus--curbside bins, dumpsters, and compactors-- the compactors are the only bin type that is weighed when removed from campus. They approximate the dumpsters weigh ~100lbs each and do not have weight estimates for the curbside bins [Miller, 2020]. It is important to note that the compactors only contain landfilled waste; while the other two bin types may contain compost and recycling. Thus, without measuring waste in the other two bins types, the Sustainability Office has no idea how much waste is actually being diverted from the landfill. The Sustainability Office also installed two waste bins for shipping waste disposal outside of the campus' Post Office. However, packaging in the disposal bin outside of the Post Office that is not reused by another student goes directly to the landfill [Miller 2020]. The Sustainability Office currently has no recourse for the oversight of the under examined waste streams.

The Life-cycle of Required Textbooks on Carleton's Campus

The process by which students get their textbooks is complicated-- illustrated in *Figure 3* and described here. Professors order books for the term near the end of the previous term. The Carleton Barnes and Noble acquires book requests from the professors and searches for the titles inside of the Barnes and Noble bookstore network at other colleges. They stated that it is common to receive two books apiece from four to five stores. Books unavailable from alternative stores are then sourced from an online service called Textnet. Schools send their unwanted books to warehouse adoption centers like Textnet to be adopted by other schools. These books arrive in fifty-pound recycled boxes using recycled paper as stuffing-- generating only easily recyclable shipping waste. Carleton typically receives twenty-five of these fifty-pound boxes per term. The exact number of books ordered per term for a class is up to the Bookstore staff's discretion. These decisions are guided by the staff's relationship with the professor, the price of the book, as

well as the type of class the book is for. Sometimes teachers make a specific order for hard to find foreign books. The staff makes sure to get the exact number of such requested books. The bookstore manager also procures books for Carleton’s TRIO program-- a Carleton service which works through the Bookstore to help provide low income students with textbooks. Books ordered online, before the start of school, are collected from the twenty-five boxes of books ordered from Textnet. They are packed by a library assistant into clear, non-reusable plastic bags and either put into students’ mailboxes or held by the Bookstore until they are picked up. Textbooks for students who purchase books online through the Carleton Bookstore after the term starts are also placed into plastic bags, but their books do not all come from the boxes ordered before the term. Books requested after the start of term may no longer be in stock in Carleton’s bookstore. The bookstore would then need to source the book from fellow schools or, if unavailable, from the publisher. These orders are fulfilled by shipping one to three books in plastic envelopes to the post office [Fossum, 2020].

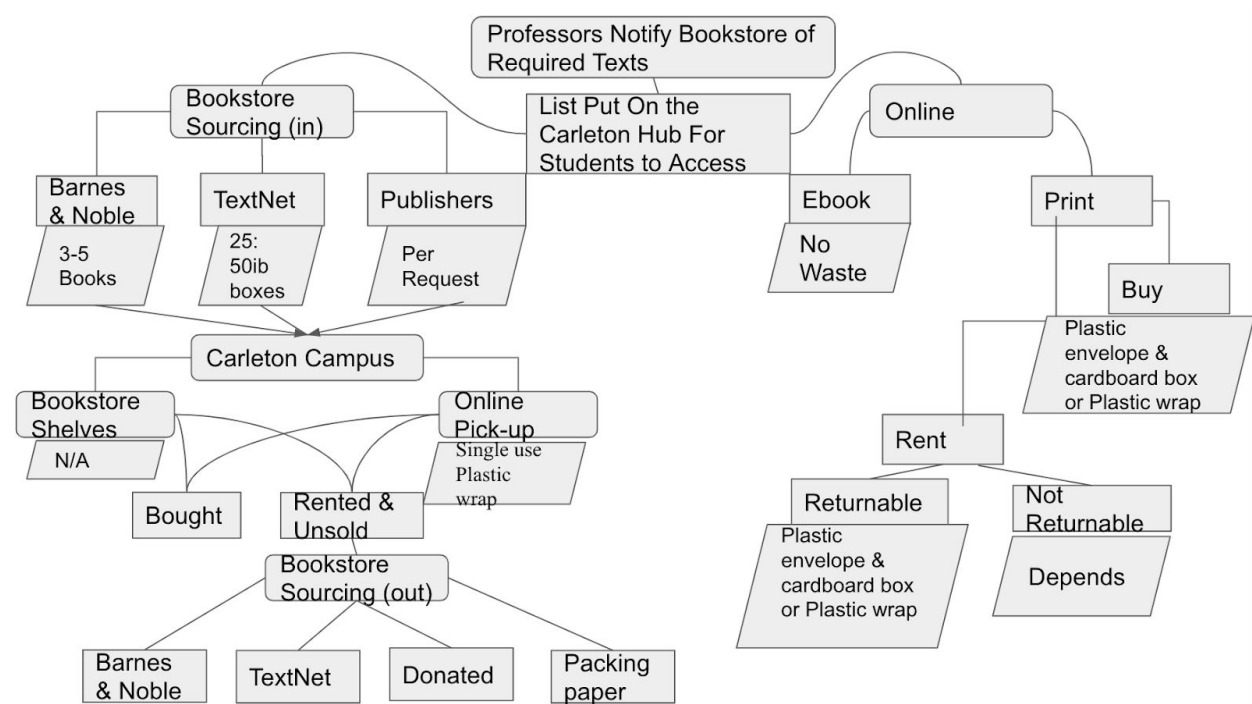


Figure 3: Details the life-cycle of a book on campus. Associated waste generated from the process is detailed below the methods. Repeated methods generate identical waste in this cycle.

Survey Results

Students' Descriptive Qualities

Of the 219 students enrolled in the eight classes surveyed, 139 students signed up to participate, of which 81 students completed the survey, a response rate of 36%. The distribution of students was skewed young, but included students from all four class years, with ~66.7% of respondents being first and second year students. The majority of respondents (66.7%) identified with gender pronouns she/her. See *Appendix F* for graphic depictions of these demographics.

Willingness to Behave Environmentally

Respondents had an average Aspiration Index score of 0.53 ($\alpha = 0.50$, $sd = 0.38$).³ We are 97.5% confident that Aspiration Index scores below 0.45 and above 0.614 are statistically significant; these scores are three standard deviations away from the mean ($sd = 0.042$). ~88% of students scored above 0, ~63% scored .614 and higher. Almost all survey respondents (98.8%) say that they care about the environment, 97.5% would be willing to change their consumption habits to protect the environment, 64.2% predicted that they actually would change regardless of price or convenience, and 76.5% intended to change their consumption habits ($n = 81$).

Book Purchasing Habits and Willingness to Pay

Students on average purchase 3.3 books a term. Students reported an average response of 2.2 regarding their perceived obligation to purchase textbooks each term, using a Likert scale where 1= Very Obligated; 5= Very Unobligated; $n = 81$. Half of the students buy books for every class that has required textbooks. Students were asked to select how much more they would be willing to pay to participate in a more sustainable method of purchasing textbooks. On average, students are willing to pay ~\$13.17 more to participate in sustainable textbook consumerism

³ $n = 81$ for all Aspiration Index questions except "Achieving the 'look' you've been after where $n = 80$

(n=80), as is shown in *Figure 4*.

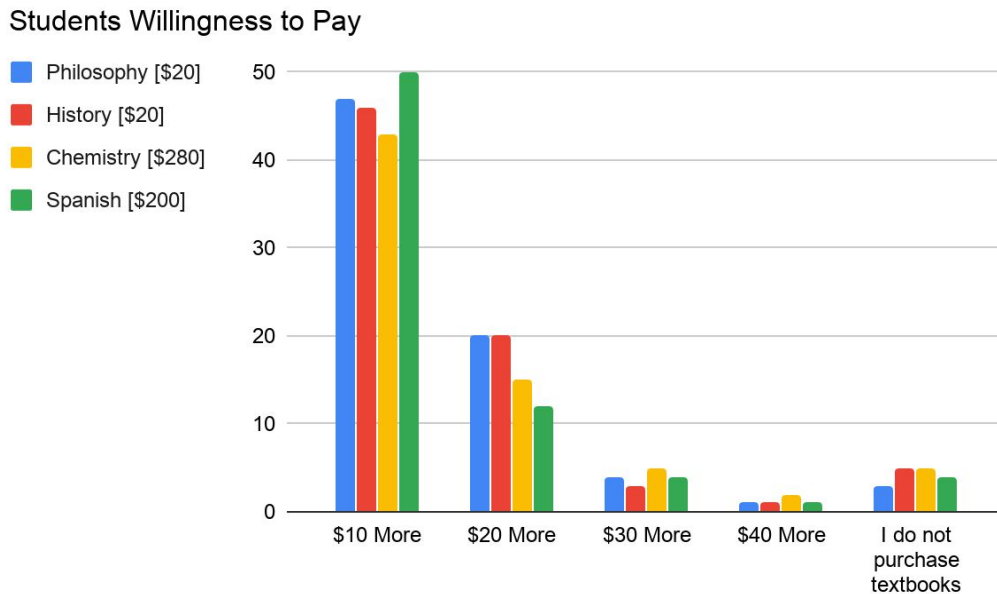
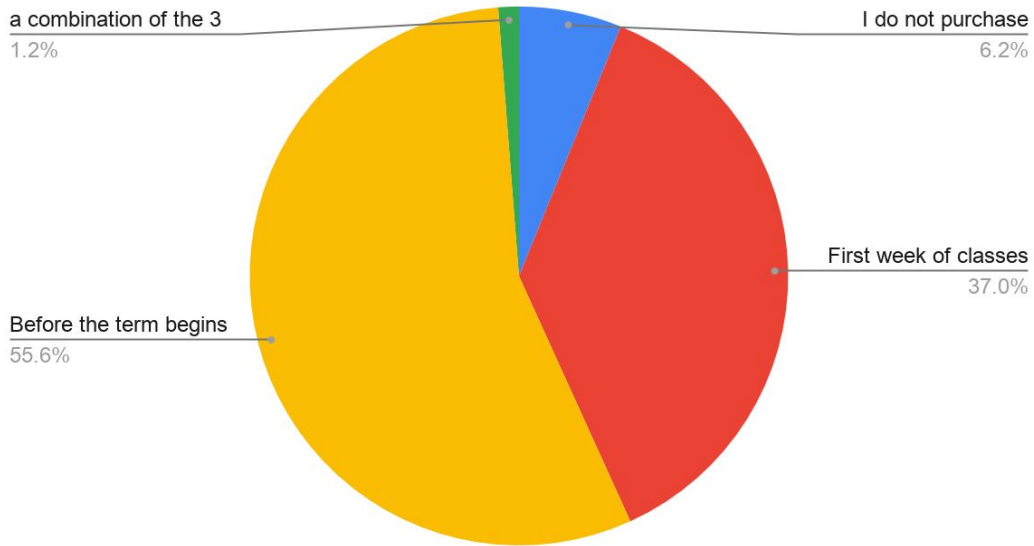


Figure 4: Students reported WTP per course. The average price of books for these courses are recorded next to the course title. Students were asked how much more they were willing to pay (Philosophy n = 75 , History n = 75, Chemistry n = 70, Spanish n = 71).

We discovered that 92.6% of students typically purchase their textbooks either before the term begins or during the first week of classes (*Figure 5*). When questioned on important factors, 93.8% reported the price of textbooks and 66.7% cited convenience as the most important factor for when they purchased books (n = 81). Most, (60.5%), of students purchase course materials from Carleton’s Barnes and Noble bookstore, and 35.8% of students purchase their books from online retailers. Students, who purchase their books online, purchase from 6 websites including AbeBooks, Amazon, and Chegg; see *Table 3* for the services these retailers provide and the types of waste their shipments generate. Aproximately 95% of those who purchase books from online retailers use Amazon (n=33). Aproximately 52% of online retail shopper students generated plastic envelopes. 12% of students ordered their books during the first week of classes and generated a plastic envelope.

When do you typically purchase textbooks needed each term?



Count of Which retailer(s) are you most likely to purchase textbooks from?

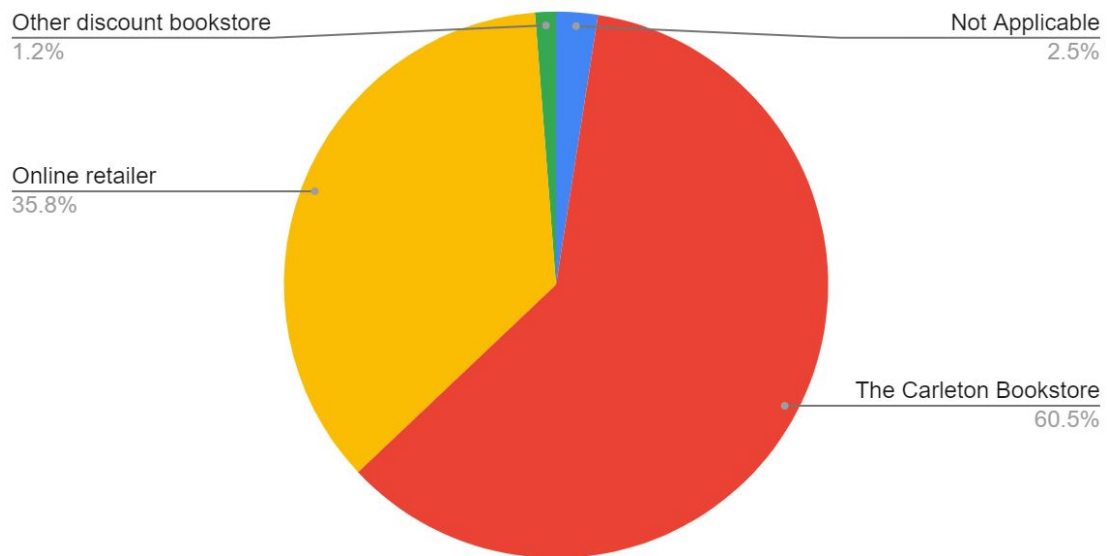


Figure 5: Participants reported typical timing, above, and methods for purchasing textbooks for courses, below. (n= 81)

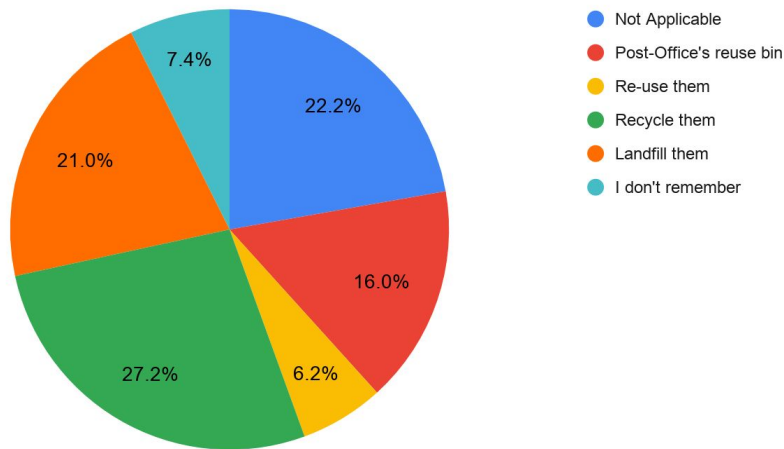
Table 3: Reported online retailers and the services they provide. Asterisk denotes a limited supply. Sources: Amazon.com, eBay.com, Barnes&Noble.com, AbeBooks.com, Chegg.com, Thriftbooks.com

	New	Used	Rent	Out-of-print	International	Book Warehouse	Shipping Material
AbeBooks	X	X	X	X	X	X	Cardboard Box
Amazon	X	X	X	X*	X*	X*	Plastic Envelope
Barnes & Noble	X	X	X	X	X	X	Plastic Envelope / Cardboard Box
Chegg	X	X	X			X	Cardboard Box / Plastic Envelope
eBay	X*	X*		X*	X*		Plastic Envelope
Thriftbooks	X	X				X*	Cardboard Box/ Plastic Wrap

Knowledge and Disposal of Plastic Envelopes

Nearly 80.2% of student respondents do not know what happens to plastic envelopes following disposal. 6.2% of Carleton students try to reuse packaging material (n= 81). 40.7% of students knew they could dispose of P.E.s in the Post Office reuse bin; 16% reported using them. 6.2% reuse the packaging and 5% of Carleton students know what happens to packaging after disposal, *Figure 6*.

What do you normally do with the packaging materials your books arrive in?



Do you know what happens to plastic shipping envelopes after you throw them away?

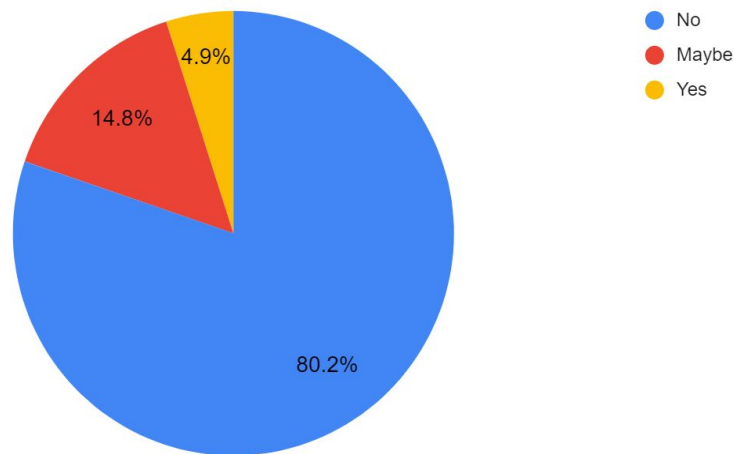


Figure 6: Where students typically dispose of packaging material, top, students' self-reported knowledge of what happens to shipping waste after disposal, bottom, (n=81).

K-Means Cluster Results

To view our respondents in groups of similar responses, we conducted k-means clustering. As seen in, the sum of squares is relative to the number of groupings-- k. With a seed of 30, our optimal number of clusters tests indicated four clusters to be appropriate as shown in *Figure 6*. In Clusters 1-4, $n = 27$, $n = 23$, $n = 17$, and $n = 14$. The k-means test gave individual cluster sums of 1700, 1232, 801, and 1646 for Clusters 1- 4, and a within-cluster sum of squares of 5379. Although some questions received similar responses from all students, the members of each cluster differ in a notable way. We describe their responses below by comparing average answers to questions by cluster.

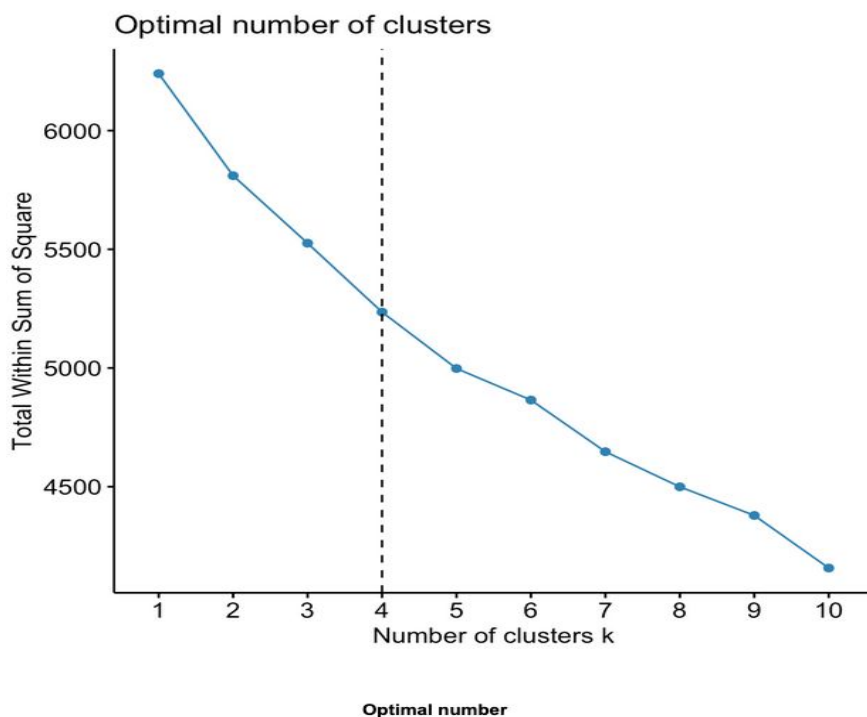


Figure 6: This method uses the Euclidean distance to determine the individuals that should be grouped together into "k" groups, where each individual is a survey respondent. The distance is calculated between their responses in n-dimensional space, where n is the number of individuals' responses that are being clustered. Based on the value of the within-cluster sum of squares, the number of clusters chosen for our analysis (k) was 4. The optimal number of clusters to analyze based upon a wss-optimal sums of an area test was conducted in R-Studios. The dashed line indicates the number of groupings, 4, closest to the calculated total withinnes, 5379.

Descriptive Qualities by Cluster

Clusters 1- 4 had average Aspiration Index scores of 0.58, 0.65, 0.55, and 0.21. Their total average willingness to pay for a Chemistry, Philosophy, Spanish, or History textbook for each Cluster was \$18, \$10.70, \$16, and \$8, as shown in *Figure 7*. Their average perceived obligation to purchase textbooks each term were 2.16, 1.91, 2.77, and 3.33 (1= Very Obligated 5= Very Unobligated).

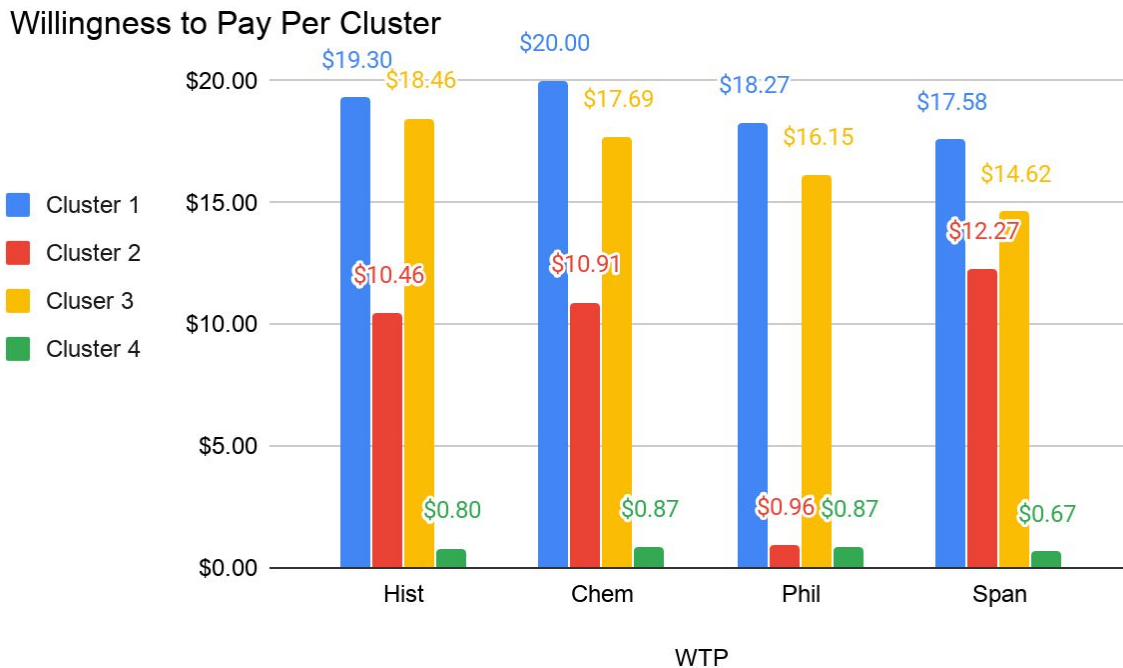


Figure 7: How much Clusters were willing to pay on average per subject in order to purchase textbooks from the Bookstore instead of from online retailers. Responses are in US dollar amounts. Exact values of WTP for each course are directly above the bar charts and correlate to Cluster colors in the legend.

Knowledge and Disposal of Plastic Envelopes by Cluster

Each Cluster only had one individual aware of the afterlife of packaging waste. Clusters 1- 4 had 17, 11, 0 and 4 people, respectively, who were aware of the packaging waste disposal bin outside of the Post Office. Cluster 2 contained the highest proportion of individuals who recycled their packaging, 26%.

Textbook Purchase Methods by Cluster

Clusters 1- 4 bought 125, 101, 70, and 74 books, respectively, this term. Each person bought 4.03, 4.59, 5.38, and 4.93 books, on average. Of students in Clusters 1- 4, ~40%, ~27%, ~38%, ~47% buy their books during the term, as shown in *Figure 8*.

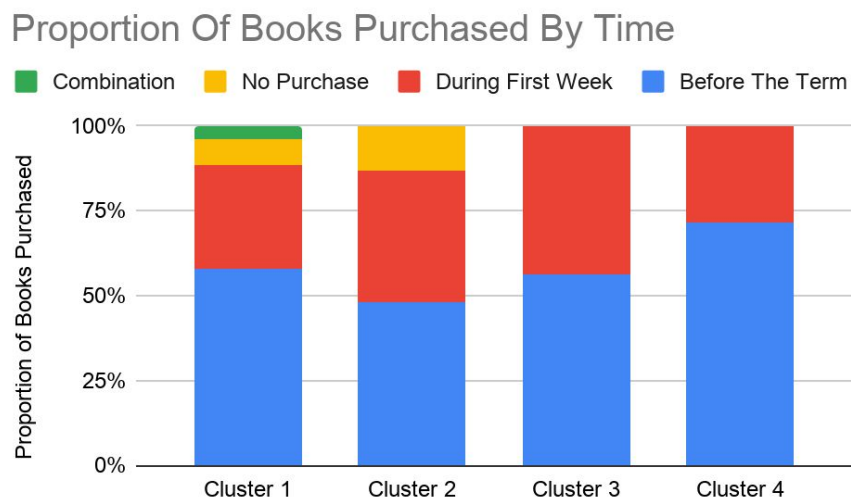


Figure 8 : This chart shows how respondents in each Cluster reported when they typically purchase their books each term, if they purchase them. This includes students who denoted that they do not purchase their textbooks.

The average number of books ordered by each student differed between the Clusters. The following lists the Clusters from the highest to lowest the average number of books ordered: Cluster 3,4,2, and 1. Students from Clusters 1-3 bought most of their books from the Bookstore 65%, 43%, and 74% respectively. Clusters 1 and 2 had the most similar purchase pattern, see *Figure 8*. While the second most popular book access locations for Cluster 1 were the library (10%) and e-books (17%), Cluster 2's secondary preferences were online purchases, (35%), and e-books, (15%). Cluster 3 ordered the most books on average but bought almost all of their books at the Bookstore or online. Cluster 4 preferred e-book access as it accounted for 42% of their purchase locations, refer to *Figure 9* for more information.

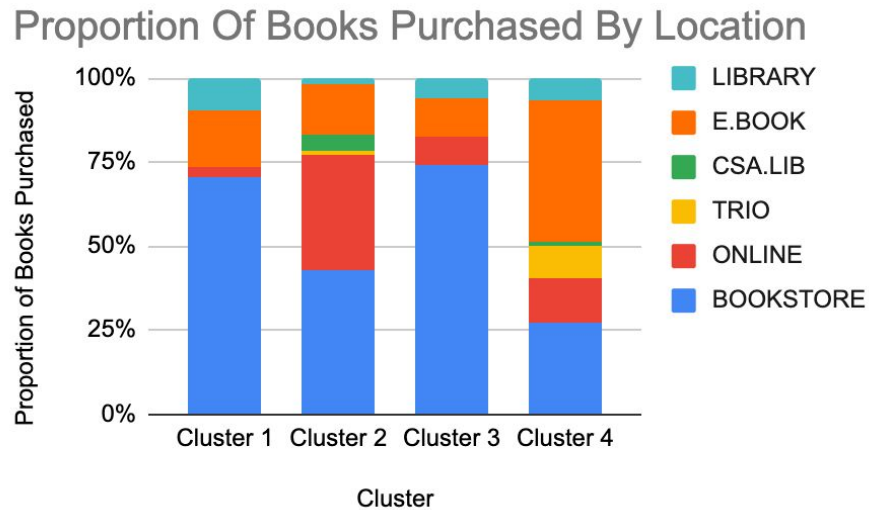


Figure 9: This figure shows the proportion of required books that students purchased or accessed for Winter Term 2020 from each location, by Cluster (n= 81).

Price-- Clusters 1- 4 50%, 56%, 45%, and 58%-- and convenience-- Clusters 1-4, 43%, 41%, 24%, 33%-- were the most important factors considered when purchasing textbooks for all Clusters, with price being considered by a higher number of individuals than convenience. However, Clusters 1, 2 were more similar than Cluster 3, and 4. Respondents in Clusters 1 and 2 only considered 3 factors: price, convenience, and where their friends buy their books. They valued price and convenience at a higher rate than Clusters 3 and 4, and considered ~1.74-1.77 factors in the textbook purchasing process.

Clusters 3, 4 both considered more than 3 factors. Cluster 3 considered ~2.23 factors on average, the highest value obtained. Cluster 4 had the lowest average at ~1.67 factors. Cluster 4's low average, despite considering more factors than Clusters 1 and 2, is likely due to the two special factors it contains. Two individuals wrote unique factors as free responses to the prompt: 1) How Necessary the Book Is and 2) They avoid purchasing on Amazon, refer to *Figure 10*.

Most Important Factors of When Students Buy Books By Cluster

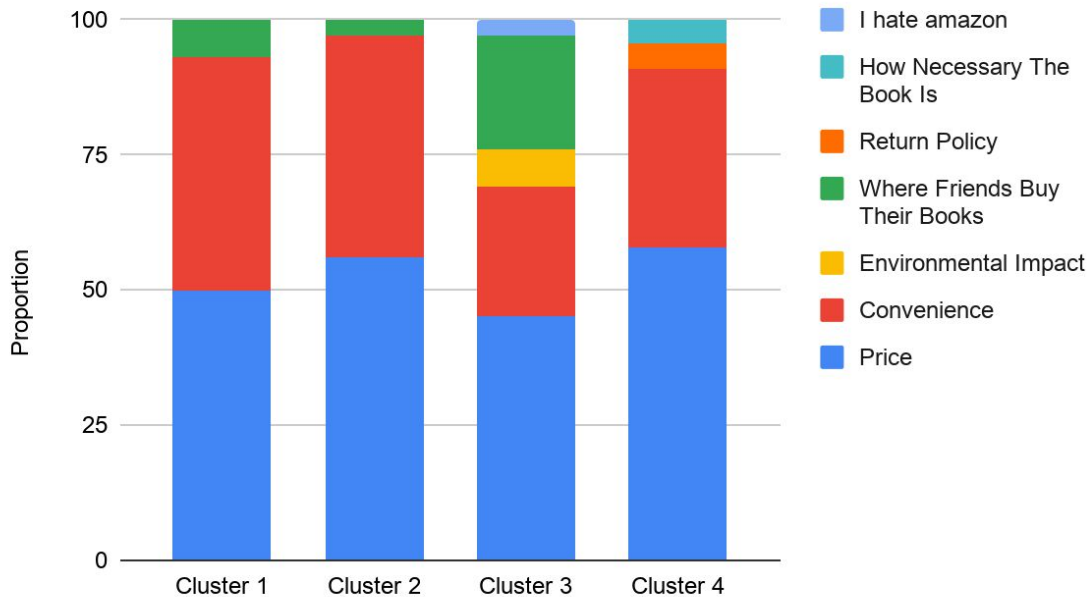


Figure 10: This figure displays factors which respondents consider to be the most important when deciding when to purchase their textbooks, (n = 81).

Waste Generation

When asked what packaging best described what their books arrived in this term 44% of students reported plastic envelopes, 30% “Not Applicable” or “None” , and 20% cardboard boxes. Thus, plastic envelopes accounted for 63% and cardboard boxes, 29%, of the students’ textbook packaging waste. Clusters 1 and 4 reported that “Not Applicable” or “None” at the highest frequency. All Clusters reported plastic envelopes at the second highest frequency, except Cluster 2, where plastic envelopes and cardboard boxes were produced in equal amounts, see *Figure 11*. Two students explicitly indicated shelved bookstore purchases. Others who reported not “Not Applicable” or “None” may have picked their textbooks up from the Bookstore, borrowed from a friend or library, an e-book, or another zero-waste book access option.

The check box question regarding what kinds of additional packaging (i.e. Tape, bubble wrap, plastic wrap, paper, and/or packing peanuts) arrived with their book purchases this term and yielded 109 boxes checked, n = 80. Between the Clusters, 61% of those responses indicate

the production of additional plastic waste, 37% “Not Applicable”, and >1% paper. In Cluster 1, one person said they did not remember any additional packaging. In Clusters 1-4, 0%, 97%, 80%, and 47% of boxes checked where indicated the generation of additional plastic waste.

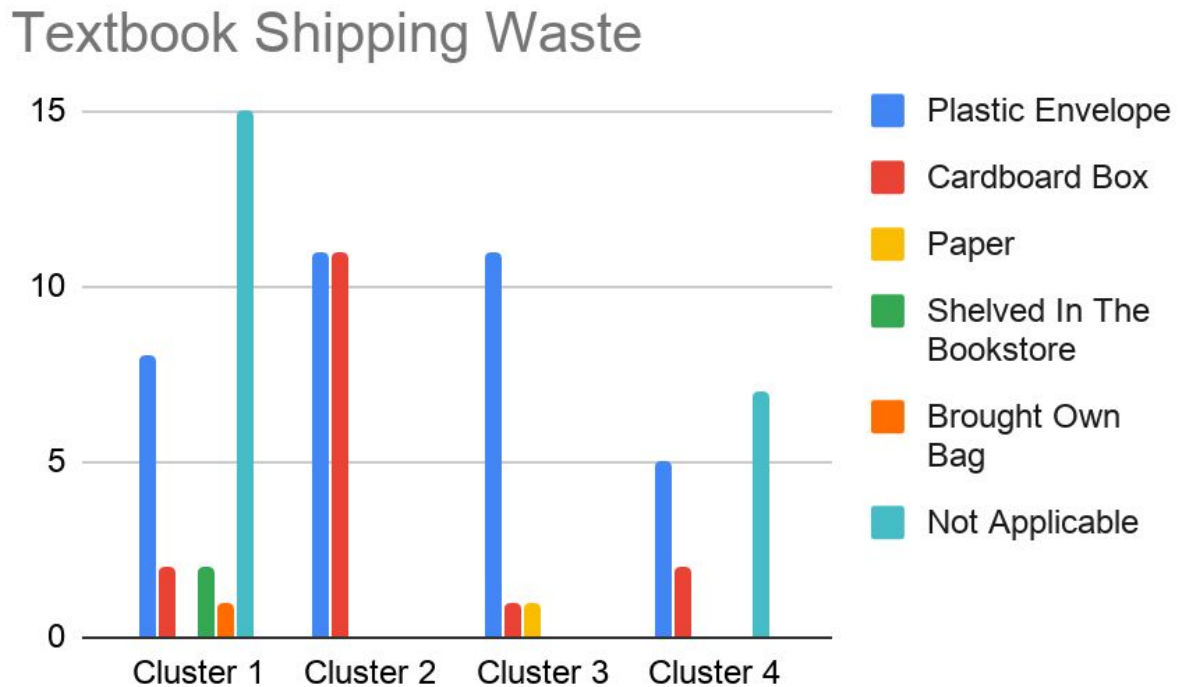


Figure 11: The packaging type that best describes what student’s textbooks arrived in this term, Winter 2020, by Cluster (n=81).

Student Package Receival Trends From the Carleton Post Office

Carleton College received 211,756 student parcels between Fall Term 2013 and Winter Term 2020. The regression line in *Figure 12* indicates a positive increase in student package receivals of ~ 35,461 packages per year ; 97% of the variance is accounted for by this model. Missing data for Winter and Spring Terms of 2017 were supplemented by adding the equivalent amount of packages received in Fall Term 2019; 95% of the variance is accounted for by the model without the Winter and Spring 2017 supplements, *see Appendix G*.

2014-2020 Student Package Receipts

With Winter And Spring Term 2017 Estimates

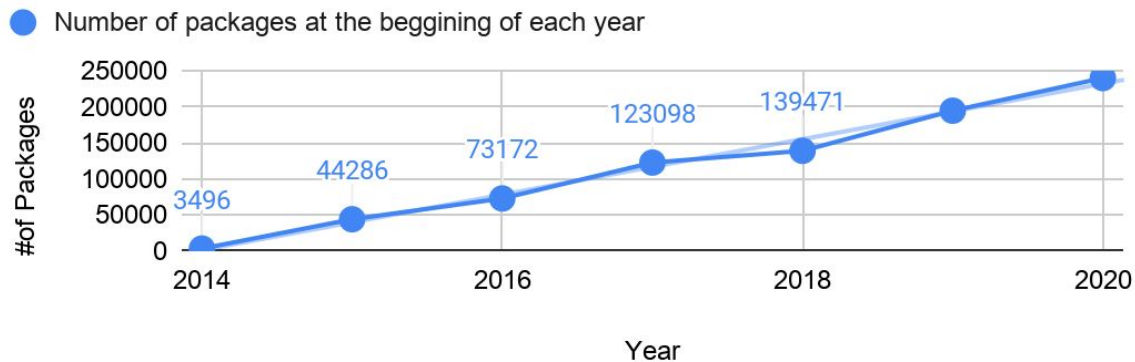


Figure 12: Trend in student packages received from the beginning of Winter Term 2020 to the beginning of Winter Term 2020 with substituted data for Winter and Spring Terms 2017 ($y = 35,461x + -7.14E+5$; $R^2 = 0.97$; $p = 3.65E -06$).

According to the Carleton Post Office manager, any package receipt data from before Fall 2013 was incomplete and recorded by hand. When they made their package receipt process electronic in 2013, they began to record student packages from all mail services (i.e. FedEx, UPS) and not just those that arrived through USPS. Making the package receipt system electronic allowed the Post Office to better keep track of parcels and parcel notifications; they now notify students about their package arrival via email instead of by handwritten notes put into their mailboxes. However, the student package trend above does not include plastic wrapped packages that are small enough to put into students' mailboxes instead of recording electronically. Further, the Post Office does not record all packages ordered by faculty and staff [Perkins, 2020].

The Post Office Manager noted that most student packages arrive at the Post Office during the first week of classes, as students ship in items they need for the upcoming term. Winter Term 2020 is the second term that the Post Office began receiving packages directly from Amazon, instead of through UPS or FedEx as discussed in the literature review above [Perkins, 2020].

Carleton Post Office received ~9,952 student packages during the first five weeks of classes in Winter Term 2019; ~2,740 packages were received within the first week of classes. Carleton’s Post Office received ~9,488 student packages during the first five weeks of classes in Winter Term 2020; ~2,853 packages were received within the first week of classes, as shown in *Figure 13*. The survey revealed that 10 of the 35 students who said their books came in plastic envelopes, also bought their books during the first week of the term; this is 12% of all students surveyed. If 12% of students ordered their books during the first week, and at least one of their books arrived in a plastic envelope, a minimum of ~245 of the packages received by the Post Office during Winter Term 2020 can be attributed to this margin of textbook purchases.

2019-2020 First Five Weeks Winter Term

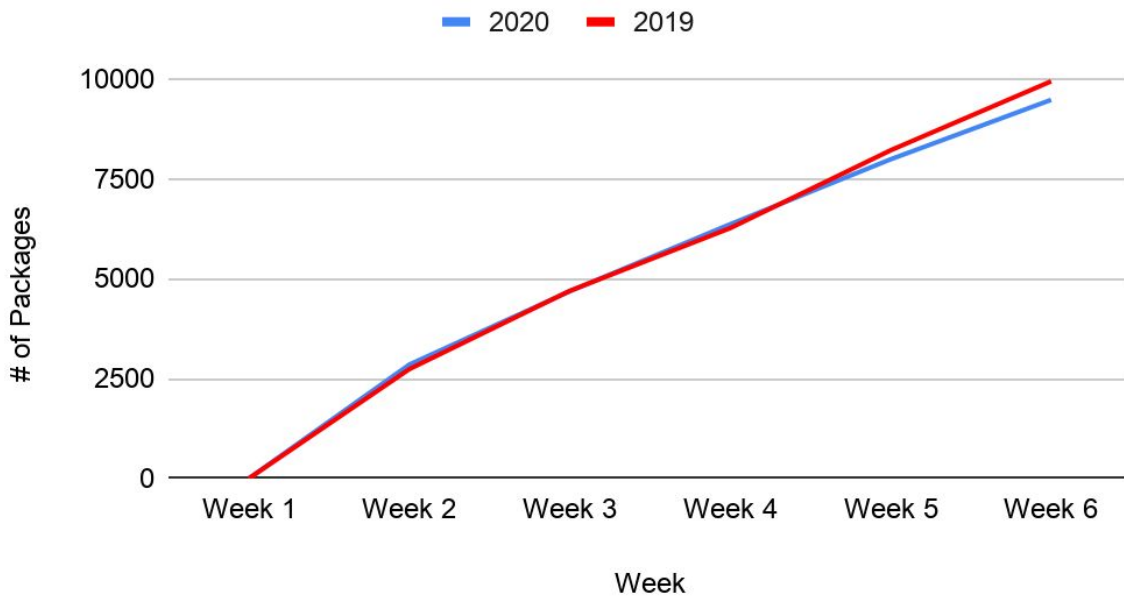


Figure 13: The graph above compares the amount of student packages received by the Carleton Post Office from the first day of classes in Week 1 to the first day of Week 6 in Winter Term 2019 and 2020. ~2740 student packages were received in Week 1 of Winter Term 2019 and ~2853 student packages were received in Week 1 of Winter Term 2020.

Discussion

The purpose of this study was to assess Carleton students' propensity for pro-environmental behavior by testing for associations between students' values, textbook purchasing habits, and willingness to pay more for textbooks to protect the environment. We also aimed to investigate the relationship between students' textbook purchasing habits and the package waste stream generated at Carleton College.

Descriptive Qualities of Carleton Students

The 36% response rate determines a general representation of Carleton students in this study [Jones and Owens, 2003]. The majority of student respondents identify as first and second years and use she/her pronouns. A respondent body of this nature is not unexpected based upon findings of previous studies [Ku and Zaroff, 2014]. Though students felt relatively obligated to purchase their textbooks each term, only 50% of students reported purchasing all required texts. The other 50% of students who do not purchase their textbooks may include those who access materials from varying non-purchase access options.

The Aspiration Index test revealed that the vast majority of Carleton students are intrinsically minded individuals. Further, most of them have intrinsic index values that were considered statistically significant in a 97.5% confidence interval. We noticed that our cronbach's score is below what is considered an indicator of internal reliability of our Aspiration Index results. However, this is likely due to our unusually high response frequency of intrinsically minded individuals. We speculate this high intrinsic response rate reflects the actual aspirations of the Carleton student body, but there may be merit in considering that intrinsic individuals may be more likely to respond to a survey about environmental habits due to their higher propensity to participate in pro-environmental behaviors. However, our findings do not support literature arguing for this relationship between intrinsic aspirations and pro-environmental behaviors.

Knowledge as an Indicator of Willingness to Act Environmentally

The vast majority of Carleton students lack knowledge of the Post Office reuse bin and what happens to plastic packaging after disposal. This notable lack of awareness may explain why a largely intrinsic community that reports care for the environment, does not consider the plastic packaging generated when deciding when and from where they will purchase their textbook. It does not explain why all save one student reported to care for the environment, but far fewer expect themselves to change their habits to act in such a manner regardless of personal convenience. Though some students attempt to behave environmentally by recycling their packaging, plastic packaging that is recycled or placed in the re-use bin will all go to landfill. The only sustainable method for disposing plastic packaging on Carleton's campus is reuse, and only 6.2% reported to do this.

Some highly intrinsic individuals knew about the Post Office disposal bin, but they also lacked an understanding of what happens to their waste after they dispose of it. This is likely because simply throwing something in a bin is convenient. Engaging in care for the environment through research is challenging to do and takes time. This perspective validates the literature that argues, providing waste bins on campus with consistent and easily recognizable branding--like the tri-bins- makes waste disposal more convenient. Furthermore, convenient waste disposal may make people more likely to engage in pro-environmental behaviors than simply having knowledge about the impacts their consumption habits have on the environment. This raises some questions about the relationship between individuals' intrinsic values and the role convenience plays in helping them realize their aspirations.

Aspiration Index and Willingness to Pay

Students on average are willing to pay less than \$20 more to minimize the volume of plastic packaging waste generated from their online sales. Our k-means Clustering allowed us to take a microscope to the association between Aspiration Index and willingness to pay for textbooks. Though literature suggested that intrinsic individuals would be willing to pay more to purchase sustainably, the k-means results indicated that there was no strong association between

the two. We tried to account for the fact that Carleton is a relatively homogenous community of primarily intrinsically motivated individuals by separating our intrinsic respondents into high and low intrinsic aspirations. However, this method did not reveal consistent differences between the willingness to pay of high versus low intrinsic individuals. Students in Cluster 3, the primarily low intrinsic individuals, were more willing to pay than those in Cluster 2, one of the two Clusters with a high intrinsic majority. Willingness to pay does not increase for highly intrinsic individuals.

Though this finding is not in line with those from other studies claiming a strong relationship between intrinsic and extrinsic aspirations and willingness to pay, our study contributes to the larger body of research by suggesting that the relationship does not follow when considering stratified levels of intrinsic aspirations and willingness to pay. These results also suggest that the relationship, between intrinsic aspirations and propensity toward pro-environmental behavior, may vary based on the type of good being consumed and the type of sacrifices needed to interact with the good in a more sustainable way.

How The Textbook Market Influences Willingness to Pay

Price is considered by a higher number of individuals than convenience as the most important factor considered when purchasing textbooks for all Clusters. The values of the members of Clusters 1 and 2 were more similar to each other than those of Clusters 3 and 4. Respondents in Clusters 1 and 2 only considered three factors: price, convenience, and where their friends buy their books. They value price and convenience at a higher rate than Clusters 3 and 4; and they had the closest factor average, at approximately 1.74-1.77 factors considered in the textbook purchasing process. Clusters 3 and 4 both considered more than three factors. Cluster 3, the low intrinsic individuals, had the highest Cluster average, approximately 2.23, and was the only Cluster that considered environmental impact when purchasing books. Literature suggests that the high intrinsic individuals--namely those in Clusters 1 and 2-- would be less likely to consider price and convenience than low intrinsic and extrinsic individuals. However, as previously mentioned, all Carleton students considered price and convenience when purchasing textbooks regardless of their aspirations.

The similarity in number of factors considered when purchasing books may be attributed to the monopolistic nature of the textbook market we discussed earlier. Many Carleton students feel obligated to purchase their books for classes each term. Exorbitant textbook prices force students to consider price and convenience when purchasing their books when they otherwise may not. The relationship between intrinsic aspirations and willingness to pay despite personal convenience is not the same in our study as it has been in other studies that compare intrinsic behaviors and willingness to consume sustainably. Wang et al, [2019] showed that intrinsic individuals were more likely to consume a more sustainable food item when presented with an environmentally friendly and non-environmentally friendly option. However, the fact that chocolate is a good of leisure while textbooks are a good of need, and that students have to go through an extensive process (compared to choosing a chocolate bar) may account for why intrinsically minded individuals in our study appear to showcase more extrinsically minded values like price, convenience, and low probability of backing up their care for the environment with action. Our study reveals that the relationship between Aspiration Index and propensity to consume environmentally may be subject to circumstantial variables like how necessary the item is to the individual and how much money or time one has to sacrifice to consume said item more sustainably.

Textbook Purchasing Habits

Our survey inquired about both students' typical textbook purchasing habits and their habits when purchasing required books for this, Winter term 2020. The two most important factors students considered when purchasing their textbooks were price and convenience. This supports literature that claims price is an important part of the student book purchasing process.

Students purchased 4-5 purchased required texts this term and tend to purchase their books before the term or during the first week from the Carleton Bookstore. This finding aligns with the Bookstore's records on student's purchasing habits from the past three years. Most students bought their books from more than one location. Online retailers were the second most popular method for purchasing textbooks; Amazon was the primary online retailer used. Student preference for Amazon book retailing is important to note, as the company recently shifted to

using plastic envelopes as their main packaging material. Students also ordered books from Abebooks, Chegg, eBay, Thriftbooks, and Barnes and Noble.

Notably, Clusters 1 and 2 had the most similar purchase patterns. While the second most popular book access locations for Cluster 1, were the library and e-books, Cluster 2's secondary preferences were online purchases and e-books. Cluster 2 purchased about as many books online as they did at the Bookstore, giving them the highest proportion of books purchased online between all the Clusters. Cluster 3 ordered the most books on average but bought almost all of their books at the Bookstore. Cluster 4 was the only Cluster that did not buy most of their books at the Bookstore; they instead preferred e-book access. Cluster 4 also had the highest distribution of book access locations. All usage of the CSA library or TRIO⁴ textbook access fell within Clusters 2 and 4; more respondents used the CSA library in Cluster 2 and more used TRIO in Cluster 4.

Reducing Plastic Packaging Waste

Students were asked what packaging type best matched what their books arrived in this term. Many students (~30%) reported no waste production when purchasing books for classes in Winter 2020. This finding can be attributed to the portion of textbooks purchased from the Carleton Bookstore, where books are shipped in bulk boxes and shelved, instead of being individually packaged and sent directly to students. Plastic Envelopes (P.E. 's) were the largest reported waste bi-product from textbook purchases this term, at 44% of responses and accounted for over 60% of reported shipping waste. Cardboard boxes were the second largest bi-product of these purchases at 28.6% of reported waste; such high production of cardboard waste may warrant further investigation. P.E. 's generated during the first week of classes account for 12% of all waste generated by student book purchases. If we extrapolate the numbers of reported plastic envelope production provided by this sample, to the entire Carleton student body, it would mean that every term, Carleton students generate ~923 plastic envelopes when purchasing required textbooks. Thus, ~2768 plastic envelopes are generated each academic year; and ~251

⁴ A Carleton service which works through the Bookstore to help provide underrepresented students purchase textbooks

are generated during the first week of classe, every term. We also asked them about additional types of shipping waste their textbooks were shipped with; a majority of student responses (61%) indicated that additional plastic wastes, such as packing peanuts or tape, were included in their shipment. The prevalence of P.E. and additional forms of plastic packaging indicates that Carleton student textbook shipments produce a substantial amount of plastic shipping waste.

Cluster 1, who preferred accessing their books from the Bookstore and library, generated an amount of waste comparable to that of Cluster 4, who preferred e-books. On the other hand, Clusters 2 and 3 generated the most waste overall (based on packaging type and not additional packaging). Both of these Clusters strongly preferred online purchasing as a secondary option to the Carleton Bookstore. This means that online book purchases have a prominent contribution to the plastic shipping waste stream. Thus, we find that accessing required texts as e-books, though the Carleton Bookstore, or by using the CSA and Gould libraries are the most effective ways to reduce plastic waste generation from student textbook purchasing.

Management of Shipping Waste at Carleton

The steady rise in the number of students' packages received by Carleton's Post Office supports the previously stated hypothesis that Carleton, like many other HEIs, can expect students' online purchasing to become a greater burden to the schools waste management goals. The estimations of plastic envelopes generated in this study at Carleton's campus only include those regarding textbooks, however, as the Post Office general manager stated, textbook packages typically end after the first few weeks of a term. Packages that the College receives after those weeks could have a significant impact on the total estimated number of plastic envelopes generated at the school, as Amazon, and other online retailers, have increased plastic envelope usage for all items and not just those related to textbooks. Further, for the purposes of this study, the Post Office data does not include data on packaging waste generated faculty and staff members of the campus. With this consideration, we expect the plastic envelope generation to be higher than the Post Office trends depicted in the results section.

As the volume of packaging waste generated from online sales is only expected to rise, it is in the best interest of the College to begin investigating the actual volume and reasons for

generation of this waste. Carefully recording packaging data by material and source would be a beneficial first step in achieving this goal. This process may be made difficult with the Post Office's current method for recording packages; most of the faculty and staff packages are not recorded and the data is spread amongst several different Excel sheets. While the newly organized student packaging data used for this study can be shared for the Post Office and Sustainability Office to analyze for waste management purposes, expanding this data to include faculty and staff packages may prove to be an arduous task. According to our discussion with the Sustainability Office, individual departments make online purchases for work related items so regularly that starting to record the mass of packages that are currently accounted for may overwhelm the Post Office staff--especially considering the estimated 35,461 yearly increase in student package receipts. Communication between the Post and Sustainability Office will be needed to manage the steadily growing package waste stream, and accomplish the College's waste management goals.

Implications and Future Studies

This study has a number of implications for Carleton College and other HEIs, and leaves space for future studies to be done about sustainability on campuses worldwide. We discovered that Carleton has a community which cares for the environment, yet the individuals of the community do not all behave as such in the manner of textbook purchases. This could be explained by a number of factors like knowledge, class year, financial stress, etc. To investigate whether knowledge is a factor, a future study could test if an increase in student's knowledge about the deleterious effects of shopping online changes their behavior. Our study also indicated that intrinsic and extrinsic respondents behave in ways outside of the manner they were characterized. For example, one extrinsic respondent was willing to pay more to be sustainable, and low intrinsic individuals were willing to pay than some highly intrinsic individuals. Our study did not test students' willingness to pay more for sustainably packaged books directly against their major. There may be particular majors in which students are willing to pay more for sustainable consumerism than others, so a future study could investigate that relationship. Based upon participants of our study, if Carleton's bookstore informed students of the environmental

impacts caused by their purchases of course materials online rather than in-store, students would be willing to pay *some more* money. They could achieve this educational goal by working in tandem with the Sustainability Office. As the average amount is only ~\$13, it may prove difficult for the Carleton Bookstore to use any price alteration to their advantage. Our project centers around the generation of plastic shipping waste due to textbooks, future studies can expand and include plastic shipping waste from all goods, to create an approximate total of waste generated at the school.

Conclusion

Carleton College is not exempt from the trend of increased package receipt at HEI's. Our analysis reveals that the school has experienced a sharp increase in student package receipts in the last 6 years; the number of packages received, as well as the associated waste, is only expected to continue to increase without proper management. Though the Sustainability Office has done a commendable job in its initiatives to divert unnecessary waste from landfill, this study reveals an urgent need for them to address the estimated 2768 plastic packages entering the waste stream annually to reach its goals of Zero-Waste by 2030. Though students order packages online for a range of reasons, our investigation into the textbook waste stream proved the possibility for targeted plastic packaging reduction efforts by the Sustainability Office. This is possible by investigating the factors that influence online purchases of things a student typically purchases. Our discussions with the Sustainability Office, Post Office and Bookstore reveal that tackling this effort will hinge on interdepartmental communication and increased engagement with the student body on how to consume more sustainably.

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Appendix

A: The Survey

A. Getting to know you:

The following question will help us know who you are.

1. How do you identify?

- A. He/Him
- B. She/Her
- C. Ze/Zir
- D. They/They
- E. Prefer Not Say

F. Other:

2. What's your class year?

- A. First Year
- B. Second Year
- C. Third Year
- D. Fourth Year

3. How old are you? [i.e: 18]

4. Which class(es) are you registered for this term?

- A. SPAN 102
- B. BIOL
125
- C. BIOL
240
- D. HIST
138
- E. PHIL
226

B. Aspiration Index

Rate the following statements on level of personal importance to you:

1. Knowing and accepting who you really are

Not At All Important 1 2 3 4 5 Very Important

2. Sharing your life and experiences with another

Not At All Important 1 2 3 4 5 Very Important

3. Helping those in need when at all possible

Not At All Important 1 2 3 4 5 Very Important

4. A well paying job

Not At All Important 1 2 3 4 5 Very Important

5. Achieving a 'look' you've been after

Not At All Important 1 2 3 4 5 Very Important

6. Having many friends in several social groups

Not At All Important 1 2 3 4 5 Very Important

7. How important do you feel that it is to correctly sort your waste?

Not At All Important 1 2 3 4 5 Important

C. Your book purchasing habits

We would like to ask you some questions about your book purchasing habits.

1. Do you purchase the textbooks required for every class you take?

- A. Yes
- B. No

2. When do you typically purchase your books?

- A. Before the term begins
- B. During first week of classes
- C. I dont --> please explain

2. On average, how many books do you buy per term? (please circle one)

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5 or more

3. Where did you get your textbooks for this term?

(select the quantity derived from each source) 1 2 3 4 5 6 or more

- A. Online Retailer (print)
- B. Bookstore (Print)
- C. Trio
- D. Csa Libe

E. E-book/ online pdf Library

4. What proportion of the books you buy are from Carleton's bookstore/ online?

- A. 100% bookstore
- B. 100% online
- C. 20/80
- D. 30/70
- E. 40/60
- F. 50/50
- G. other: please specify

5. Have you ever obtained textbooks by purchasing from other students or received them as "hand me downs" (e.g.)?

- A. Yes
- B. No

6. How often have you obtained books through friends via payment or free?

- A. Every term
- B. Twice per academic year
- C. Once in collegiate career
- D. Never

7. Once the term is over, what do you do with your textbooks?

- A. Keep them
- B. Sell them
- C. Give them to my friends

9. After the term what do you typically do with your textbooks?

- A. I throw them out
- B. Donate them
- C. Mail them back to the online retailer
- D. Return them to the bookstore
- E. Keep them for another class
- F. Other:

10. Which of the following factors are the most important for you when purchasing a textbook? (Please rank in order of importance)

- The price of the textbook
- Convenience
- Environmental impact
- Where your friends buy their books

Other:

11. Pre-ordered books come in plastic wrap: Are you aware that you could turn your used packaging into the bookstore ?

- A. Yes
- B. No

13. Purchasing textbooks is a significant financial burden for me

- A. True
- B. False

14. Who typically purchases your textbooks each term?

- A. A family member
- B. Myself
- C. A friend
- D. I do not purchase textbooks
- E. Other:

16. Which of these best describes the packaging material your textbook(s) arrived in?

- A. Cardboard
- B. Plastic
- C. Paper
- D. Other:

17. Are you aware that you can put your used packaging outside of the bookstore for re-use?

- A. Yes
- B. No

18. What do you normally do with the packaging materials your books arrive in?

- A. Throw them away
- B. Bring them to the Post-Office packaging materials disposal
- C. I don't remember
- D. N/A

E. Other:

19. Do you know what happens to plastic envelopes after you throw it away?

- A. Yes
- B. No

E. The Ecologicals Impact of Shipping Waste

“Your decision of buying the books you need for your classes has an impact on the environment in a number of ways. The choices we make influence what goes into the environment we live in. In this part of the survey, we would like to ask you a few questions about your knowledge and awareness of the waste generated from textbook purchasing. There are no “right” or “wrong” answers. We are only interested in understanding the relationship between your choices and the sustainability practices of the college.”

Please consider this statement when completing the following questions.

- 1. I would be willing to change my consumption habits to help protect the environment.**
 - A. True
 - B. False
- 2. I care about the environment.**
 - A. True
 - B. False
- 3. I predict that I would go out of my way to purchase the more sustainable option regardless of the personal costs or convenience.**
 - A. True
 - B. False
- 4. Below are average bookstore prices for required texts by subject. Please indicate how much more than the stated price would you pay to be a more sustainable textbook consumer:**

History [\$20]

- A. \$10 More
- B. \$20 More
- C. \$30 More
- D. \$40 or More
- E. I do not consider price when purchasing the more sustainable option

Biology [\$250]

- A. \$10 More

- B. \$20 More
- C. \$30 More
- D. \$40 or More
- E. I do not consider price when purchasing the more sustainable option

Spanish [\$200]

- A. \$10 More
- B. \$20 More
- C. \$30 More
- D. \$40 or More
- E. I do not consider price when purchasing the more sustainable option

Philosophy [\$20]

- A. \$10 More
- B. \$20 More
- C. \$30 More
- D. \$40 or More
- E. I do not consider price when purchasing the more sustainable option

5. I intend to change my consumption habits to protect the environment

- A. Yes
- B. No

G. Awareness Of Your Consumption

1. I feel obligated to purchase my textbooks each term.

Strongly Agree 1 2 3 4 5 Strongly Disagree

2. I often think about the waste my book purchasing generates.

Strongly Agree 1 2 3 4 5 Strongly Disagree

3. I often think about the waste generated from other goods I consume.

Strongly Agree 1 2 3 4 5 Strongly Disagree

4. **My conscience bothers me whenever I see the amount of waste generated by my consumption habits.**

Strongly Agree 1 2 3 4 5 Strongly Disagree

5. **People in my life whose opinions I value are ____ about generating waste from buying books.**

Are Concerned 1 2 3 4 5 Not Concerned

6. **People in my life whose opinions I value would ____ to reduce the waste they generate from buying books?**

Try 1 2 3 4 5 Not Try

7. **When it comes to generating waste in purchasing books, how much do you want to do what your friends think is important?**

Not At All 1 2 3 4 5 Very Much

8. **Reducing the waste generated from purchasing books is**

Extremely Good 1 2 3 4 5 Extremely Bad

9. **Generating waste for the purpose of my education is**

Extremely Harmful 1 2 3 4 5 Extremely Beneficial

10. **Considering the waste you generate in purchasing books, please CIRCLE one response for each statement:**

For me to try to minimize my waste from my book purchasing habit is

Possible 1 2 3 4 5 Impossible

Feasible 1 2 3 4 5 Infeasible

Difficult 1 2 3 4 5 Easy

11. **For me, trying to minimize my waste from my book purchasing habit is**

Harmful 1 2 3 4 5 Beneficial

Good 1 2 3 4 5 Bad

Enjoyable 1 2 3 4 5 Unenjoyable

12. **I think that it is my moral obligation to try to minimize the waste I generate from my book purchasing habits.**

Strongly Agree 1 2 3 4 5 Strongly Disagree

13. **I think that it is my moral obligation to try to minimize the waste I generate from my consumption of all goods.**

Strongly Agree 1 2 3 4 5 Strongly Disagree
14. I feel responsible for the waste generated by my consumption habits.

Strongly Agree 1 2 3 4 5 Strongly Disagree

15. It is mostly up to me whether or not I try to reduce the waste I generate from purchasing books.

Strongly Agree 1 2 3 4 5 Strongly Disagree

16. Trying to reduce the waste I generate from book purchases will require expensive changes.

Extremely Likely 1 2 3 4 5 Extremely Unlikely

17. Trying to reduce the waste I generate from other purchases will require expensive changes.

Extremely Likely 1 2 3 4 5 Extremely Unlikely

18. Reducing my book-related waste is

Inconvenient 1 2 3 4 5 Convenient

Thank you for taking our survey!

B: Aspiration Index R- Code

Calculate the mean scores of each question

```
summed<-rowSums(data[,c("I1","I2","I3","E1","E2","E3")])
```

```
averaged<- summed/6
```

Subtract by over mean

```
data$I1subtracted<- data$I1-averaged
```

```
data$I2subtracted<- data$I2-averaged
```

```
data$I3subtracted<- data$I3-averaged
```

```
data$E1subtracted<- data$E1-averaged
```

```
data$E2subtracted<- data$E2-averaged
```

```
data$E3subtracted<- data$E3-averaged
```

```
#Checked work using library(dplyr) select(dataset,colname,colname) source
```

Flip Extrinsic Score

```
data$E1subflip<- data$E1subtracted* (-1)
```

```
data$E2subflip<- data$E2subtracted*(-1)
```

```
data$E3subflip<- data$E3subtracted*(-1)
```

```
#Checked work using library(dplyr) select(dataset,colname,colname) source
```

Average Intrinsic(sub) and reversed Extrinsic(subflip) scores:


```

sumIE<-rowSums(data[,c("I1subtracted", "I2subtracted", "I3subtracted", "E1subflip", "E2subflip", "
E3subflip")])
avgIE<- sumIE/6 #this is the A/I score
Add score to data frame + summary stats
data$AI.Score<- avgIE
summary(data$AI.Score
DTRY= data[-c(65),74] #gets standard deviation of A/I score
> View(DTRY)
> sd(DTRY)
[1] 0.3834606
summary(DTRY) #Checked work, same as summary for AI.Score
  Min. 1st Qu.  Median   Mean 3rd Qu.   Max.
-0.5000 0.1667 0.5000 0.5312 0.8333 1.1667
Reclassify respondents as intrinsic or extrinsic
avgIE[avgIE>0]<-"Intrinsic"
avgIE[avgIE<0]<-"Extrinsic"
avgIE[avgIE== 0]<-"Neither"
data$AI.Type<-avgIE #added it data frame. Note avgIE was used above but is no longer
numeric #Summary of Intrinsic/Extrinsic Ratio ---automatically removed the na value thus data
is from 77/78 respondents
AI<- table(data$AI.Type)
AI
Extrinsic Intrinsic  Neither
      5      70      5
prop.table(AI) #shows the proportion of students who where I or E
Extrinsic Intrinsic  Neither
 0.0625  0.8750  0.0625
summary(AI)
Number of cases in table: 80 #shows that the n/a response was not included in proportion
calculation
Number of factors: 1
CRONBACHS ALPHA source
I.E<-data.frame(data$I1subtracted,data$I2subtracted,data$I3subtracted,data$E1subflip,data$E2s
ubflip,data$E3subflip) #create new dataframe with I/E scores that have been subtracted by the
over mean; extrinsic scores were reserved as well
cronbach(I.E)
$sample.size
[1] 80
$number.of.items

```

```

[1] 6
$alpha
[1] 0.4962068 #cronbachs alpha score
BINING THE AI SCORES
-1.0,-0.8,-0.6,-0.4,-0.2, 0, 0.2,0.4,0.6,0.8,1.0,1.2,1.4,1.6,1.8,2.0
hist(AI, breaks= c(-1.0,-0.8,-0.6,-0.4,-0.2, 0, 0.2,0.4,0.6,0.8,1.0,1.2,1.4,1.6,1.8,2.0 + ))
library(CarletonStats) #bins histogram by .2
boot(~AI.Score, data= data) #bootstrap AI Scores

** Bootstrap interval for statistic

Observed AI.Score : 0.53125
Mean of bootstrap distribution: 0.53103
Standard error of bootstrap distribution: 0.04246
Bootstrap percentile interval
  2.5%   97.5%
0.4458333 0.6145833 #reveals .61 and are more than 2sd away from the mean and should be
considered high intrinsic
View(AI)
which(AI>1.0)
[1] 10 41 43 70 79
which(AI>.60)
[1] 5 8 10 11 13 14 16 20 24 30 31 32 33 34 35 36 38 39 40 41 43 45 46 49 50 52 54 58
[29] 62 63 64 66 70 71 73 74 77 79

```

C: Optimal Number of Clusters R-Code

Optimal Number of Clusters

```

install.packages("factoextra")
fviz_nbclust(data, kmeans, method = "wss") +
+ geom_vline(xintercept = 4, linetype = 2).# Creates the graphic and draws line at study's
optimal grouping

```

D: K-Means R-Code

```

Data Prep
library(dplyr)

```

```
df2 <- mutate_all(data, function(x) as.numeric(as.character(x))) # turn all values into numerics
df2[is.na(df2)] <- 0 #Remove NA's
data<-scale(df2, center = TRUE, scale = TRUE) #Scale the data
Run Tests
set.seed(30) #sets the seed
install.packages("tidyverse")
library("tidyverse")
install.packages("factoextra") #source source
Library("factoextra")
All4<- kmeans(data, 4) #This is how you run the test
fviz_cluster(All4 , data = data) # created graphic of the clusters
means4<- All4$centers # exports all cluster centers into a new data frame
means4<-as.data.frame(means4)
final_df4 <- as.data.frame(t(means4))
summary(final_df4) # code to make a data frame where each cluster is a row and its cluster
means are in the columns
```

E: Post Office Regression R- Code

```
WithOmodel<-lm(WithO~Year, data=data)
#linear model for data with Without 2017
supplements
Withmodel<-lm(With~Year, data=data)
#linear model for data with With 2017
supplements
summary(WithOmodel)
summary(Withmodel)
```

Output ----->

```
Call:
lm(formula = With ~ Year, data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-16145 -10589  -1003   6643  21687

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -71403913   4434899  -16.10 3.65e-06
Year          35461         2199   16.12 3.62e-06

(Intercept) ***
Year          ***
---
Signif. codes:
  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 14250 on 6 degrees of freedom
Multiple R-squared:  0.9774,    Adjusted R-squared:  0.9737
F-statistic: 260 on 1 and 6 DF,  p-value: 3.618e-06

> WithO1model<-lm(WithO~Year, data=data)
> summary(WithO1model)

Call:
lm(formula = WithO ~ Year, data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-22336.3  -8961.4   707.1   6817.6  18925.9

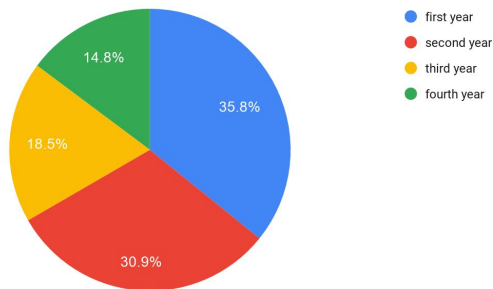
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -60321079   4621959  -13.05 1.25e-05
Year          29957         2292   13.07 1.24e-05

(Intercept) ***
Year          ***
---
Signif. codes:
  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

F: Respondents' Class Years and Gender Identities

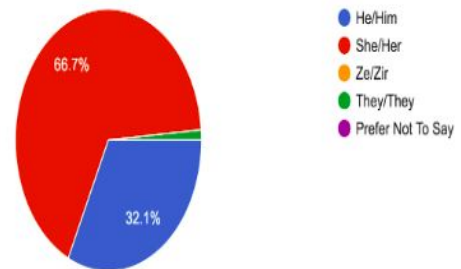
Respondents Class Years

81 Responses



How do you identify?

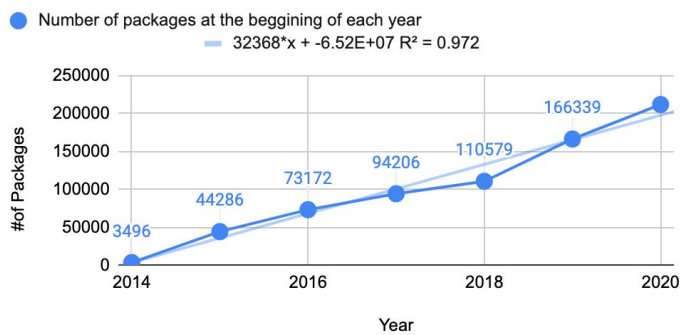
81 responses



G: Student Package Receipts Without Winter and Spring 2017

2014-2020 Student Package Receipts

Without Winter and Spring Term 2017 Estimates



From Result Section: Student package receipts trends without data from Winter and Spring 2017.

