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Application Of The Positive Deviance Method Within The Field Of Product Design

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APPLICATION OF THE POSITIVE DEVIANCE METHOD
WITHIN THE FIELD OF PRODUCT DESIGN

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2018

APPLICATION OF THE POSITIVE DEVIANCE METHOD
WITHIN THE FIELD OF PRODUCT DESIGN

by

CESAR E. VENEGAS, B.S.

THESIS

Presented to the Faculty of the Graduate School of
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-Cesar

Abstract

Positive Deviance (PD) is a method for social innovation that identifies and utilizes the knowledge found from statistical outliers within at-risk communities who succeed against all the odds, despite not having access to any additional resources. The PD method draws striking similarities to a product design methodology known as Human-Centered Design in which they share very similar principals. Similarities include the importance each method places on identifying the correct problem to address. Since it is not clear, from prior research, if the PD method is useful in the field of product development, this research seeks to explore this possibility. The PD methodology leads to the identification of Positive Deviants (PDs), which are individuals whose insights are more inclined to provide a clear understanding of the true problems their community is facing. Consequently, the PD method can increase the chance of finding sustainable solutions that meet the community's needs. In contrast, typical design teams tend to look to the average members of a community to help identify the issues they are facing. In doing so, design teams may miss the insight of these positive deviants, which could result in the identification of an inaccurate definition of the problem and the development of an incorrect solution.

Seeing that there is potential in the benefit of outliers driving innovation our research study was developed to explore this potentiality. The goal of this research was to understand if Positive Deviants generate the majority of overall and latent needs during the Needs Analysis portion of the design process. The second question the research aimed was to determine if Positive Deviants generate the majority of the solutions and are they of more value than solutions of other community members. To answer the proposed research questions, we used portions of the PD method to define a shared problem within the targeted community via a focus

group. The information gathered from the focus group was used to discover outliers within the community. Ultimately, these outliers were interviewed using product design and development techniques. Once interviews were concluded, we identified the needs of each participant (members of the community and PDs) and analysis was conducted.

The results of this study show that Positive Deviants (PDs) produced more latent needs than their peers (university students) when addressing the issue of living a healthy lifestyle. Another finding was PDs discovered the majority of general need expressed by the entire group. The study also aimed to understand if PDs would yield the majority of solutions within their population. The PDs did not produce the majority of solutions discovered in the study. Although, the solutions they proposed were of higher quality seeing that they were simple, replicable, and already being implemented by the PDs.

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Chapter 1: Introduction and Literature Review

Introduction

As markets become more saturated, maintaining a competitive advantage becomes increasingly more challenging. The use of innovation has become a widely accepted practice across many industries to improve competitive advantage and ensure marketplace longevity. Innovation is necessary for the development of a new product or service that meets the demands of a changing marketplace or to address the needs of a particular customer segment (Johnson, 2001). One of the ways that companies have been able to harness the benefits of innovation is through product design.

Innovative product design is so critical to a company's success that designing new products can be seen as a key battleground that all companies must master to remain in business (Otto & Wood, 2001). To be innovative, a design must provide value to its users in a novel way. Value, in this sense, can be defined as solving a certain problem or fulfilling a certain need and is delivered through the development of a product or service (Pynnönen et al., 2011). For example, in September 1996, 3M used a method of innovation known as Lead User Analysis to create a breakthrough in the area of surgical drapes. By November 1997, the team had come up with a proposal for three new major product lines and a new strategy that would take a revolutionary approach to treating infections (Von Hippel et al., 1999). This product innovation laid down the groundwork for future growth within the company.

There are varying philosophies as to how to achieve innovation. From an engineering and industrial standpoint, many companies have invested heavily in their research and development teams, alongside their product design teams, as one means of fueling innovation (Johnson, 2001).

These product development teams seek out innovative classes of users to help them gain insight into customer needs, which can potentially lead to novel discoveries. In the case of 3M's successful breakthrough, a technique known as Lead User Analysis was used to achieve a desirable outcome (Von Hippel et al., 1999). Lead User Analysis identifies cutting-edge users who push technology and products to their limits, thus experiencing needs that the average user will not encounter for several years to come (Von Hippel, 1986).

Another method used to innovate is known as co-creation. Co-creation is the act of collective creativity that is shared between two or more people (Sanders et al., 2008). In product design, this method brings in the user of a product or service and gives them the opportunity to create with the design team. Co-creation helps in improving customers' loyalty; reducing costs, increasing people's wellbeing, and organizing innovation processes more effectively (Steen et al., 2011).

Within product development, there are a variety of design methods engineers use to achieve desirable products and services. Traditional product design, which is common to most engineering projects, takes a product-centered approach (Blank et al., 2012). One product-centered method, known as the Waterfall Method (Saxena et al., 2016), is used within the field of Systems Engineering to aid in product development and combat the complexity inherent in completing sophisticated technical projects (Figure 1.1). As is highlighted in its name, this Waterfall Method requires that the criterion at each stage is met before the next phase can begin. Consequently, the best project types to utilize this methodology are the ones where the requirements are static and clearly stated (Lodha, 2016).

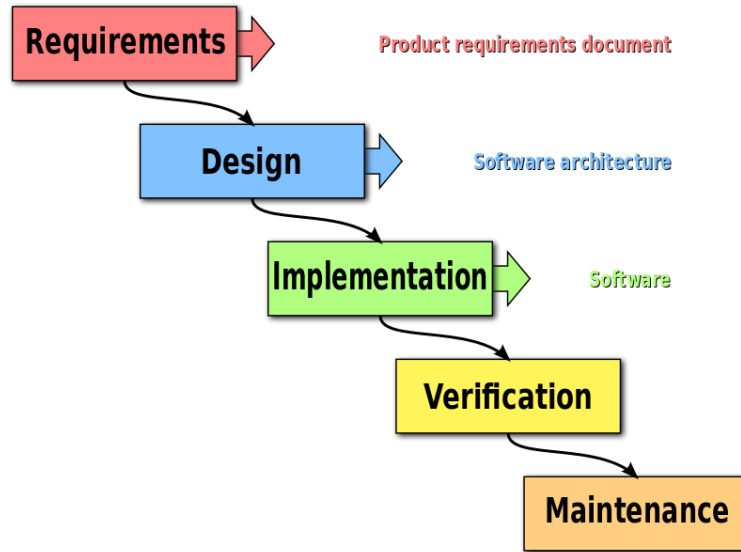


Figure 1.1- Waterfall Method of Product Design (Saxena et al., 2016)

The Waterfall Method does have some limitations. One disadvantage of using the Waterfall Method is designers cannot go back a step; if the Design phase has gone wrong, the design of the product can get very complicated in the Implementation phase (Saxena et al., 2016). During the Implementation phase, if the requirements are not appropriately defined, it can render the design useless thus rendering the whole project a failure (Raviselvam et al., 2014). The major disadvantage of using this method is that it can interfere with the company's innovation efforts. Since the waterfall method requires the criteria at each stage be met before proceeding, it reduces flexibility, iteration, and creativity. The ability to iterate during the product development process and allowing the design team to be creative is critical to innovation efforts (Howard et al., 2008). If the customer requirements or market conditions change, the waterfall method has no way of adapting. Methods such as Lean Thinking (Ries, 2011), Systems Thinking (Senge, 1990), and Design Thinking (Brown, 2009) were created to take a more human-centered approach to product design and counter the drawbacks of product-centered design.

Other methods push away from product-centered design methodologies towards those that are user-centered. User-Centered Design (UCD) focuses on optimizing the characteristics of the product, system, or service. This is achieved by using a set of fixed preconceived mental models and customizing the product to the end users' needs (Giacomin, 2014). One of the major differences when using the UCD approach is it places deeper emphasis on the analysis of the target audience (end user), which differs from a product-centered model. UCD is a technical and engineering-based design approach that derives these preconceived cognitive plans and schema from needs and requirements from particular users and how they interact with a specific tool or system. Adopting the point of view of a user of a specific tool or system is beneficial when designing functionalities. UCD is used in development methods, such as Agile Development, to understand how the user interacts with the system or technology (Gasson, 2003). While this method does consider user interactions with the system, it does not explicitly consider external factors, such as the individual's social system, implicit goals, human understanding and knowledge, business context, or application-specific cultures and practice (Gasson, 2003).

To make up for these limitations, the field of Human-Centered Design (HCD) was created. HCD is a process for designing and developing products and services that is grounded in information about the people who will use them (Greenhouse, 2012). The HCD method includes three phases: inspiration, ideation, and implementation (IDEO, 2015). These phases are nonlinear and iterative; therefore, it does not matter where you start. Figure 2 illustrates the various stages of a human-centered design approach. HCD, therefore, allows for more creative risk-taking because, unlike a product-centered approach, failure is built into the design process. HCD enables the design team to explore more innovative solutions that can lead to competitive advantage. As a result of the flexibility of HCD, external factors, such as the individual's social

system, implicit goals, human understanding and knowledge, business context, or application-specific cultures and practice, can be considered in the design of products and services.

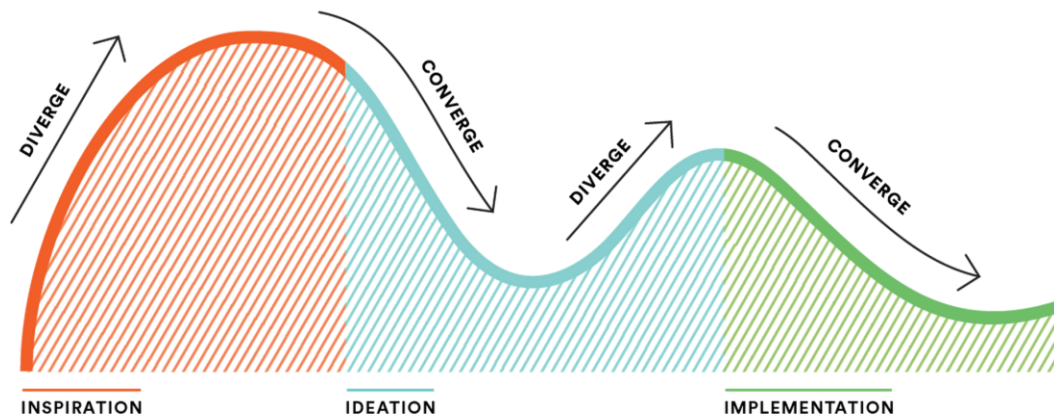


Figure1.2- Human-Centered Design Method of Product Design (IDEO, 2015)

Design Thinking is a philosophy of thought that utilizes human-centered design but focuses on driving both technical and social innovation. Design Thinking promotes a set of processes aimed at identifying issues, known as wicked problems, which are known to be complex and nonlinear. Environmental degradation, terrorism, and poverty are classic examples of wicked problems (Camillus, 2008).

Design Thinking plays a vital role in the use of Human-centered design. While Design Thinking is a philosophy of thought that focuses on social innovation and aims at uncovering the root-cause, HCD aids by takes into consideration the user of the product and how their experiences and environment affect their interactions (Greenhouse, 2012). Unlike the waterfall method, Design Thinking uses HCD to incorporate consumer insights in-depth and uses rapid prototyping to get beyond the assumption that block effective solutions (Brown et al., 2010). Businesses are embracing this method of human-centered design to drive innovation while

nonprofits are using Design Thinking to develop better solutions to social problems (Brown et al., 2010). However, Design Thinking and HCD are not the only approaches to social innovation.

As a method for social innovation Design Thinking uses HCD to generate sustainable solution and shares with PD an emphasis on understanding the people who face the problem being addressed. The International Development Enterprises (IDE) of India is one example of how Design Thinking was used to improve the lives of farmers in developing countries (Brown, 2009). Design Thinking was used to identify that these rural farmers require an investment in farming equipment that must be repaid many times over in just one growing season. Many of these farmers could not afford to invest in expensive farming equipment that would take decades to pay off which was the only alternative. Understanding the farms situation, IDE's design team developed a low-cost drip irrigation products designed to last only one or two seasons. The low cost allowed these farmers to reinvest the additional profits to reach economic sustainability faster and with less risk. The problem was discovered with the aid of the community members, but ultimately it was the design team that developed the solution. PD uses the same principle approach to understand the problem, although it empowers members of the community to create their own solutions.

Positive Deviance a Method for Social Innovation

Positive Deviance (PD) is another method for social innovation that relies on identifying extreme outliers that have experienced unexpectedly good outcomes despite the challenges they face. PD was born within the field of nutrition and helps identify extreme outliers within at-risk groups or communities (Zeitlin, 1991). In the early 90s, Monique and Jerry Sternin used PD to curtail malnutrition in children within small Vietnam villages (Singhal et al., 2013). Instead of asking the obvious question of, “What is broken and how can we fix it?” a new question was

framed, “Who in these villages is nourished when they shouldn’t be?”. Members of the community were encouraged to help identify people who fit in this outlier group, i.e., Positive Deviants. What they found, after interviewing these outliers, is that these parents were hand-feeding their children sweet potato greens and shellfish, all of which went against social norms. The mothers of these PD children from the small Vietnam villages were responsible for designing solutions around the needs and findings that the study produced. Members of the community, not experts, were entrusted with disseminating this information. Not only was this solution sustainable due to the community members' involvement, it was also innovative and resulted in the reduction of malnutrition by 74% (Marsh et al., 2004). This reduction of malnourishment in Vietnam is an excellent example of how positive deviance, another method embodying Design Thinking, relies on local expertise to uncover existing solutions (Brown et al., 2010).

Positive Deviants (PDs) succeed against all the odds and discover new ways of solving problems without any additional resources, usually by exhibiting unusual behaviors (Marsh et al., 2004). PDs are known for being extreme outliers that may hold keys or clues that can help drive innovation and help develop sustainable solutions. As mentioned above, these PDs were using ways of feeding children that were seen as odd or unusual. Their decision to choose to adopt such strange eating habits shows that the answer was within the community all along. It did not take an outside intervention to help this community, which could have been costly and ineffective.

Additional Methods of Social Innovation

Jugaad Innovation is a method that uses a bottoms-up approach to create innovative solutions within resource-deprived communities. Jugaad comes from a Hindi term that translates

to “cleaver solutions in the face of adversity” (Radjou et al., 2012). One example of Jugaad Innovation comes in the form of a product known as the Mitticool. The Mitticool is a simple clay refrigerator that keeps food cool without using electricity. An individual named Mansukh Prajapati, who never even finished high school, created the Mitticool. Prajapati was able to identify a need within his local community and develop a low-cost, sustainable solution using the principles of Jugaad. This product was developed through adverse circumstances and shows that adversity can be transformed into opportunity.

There are six basic principles to Jugaad: (1) seek opportunity in adversity, (2) do more with less, (3) think and act flexibly, (4) keep it simple, (5) include the margin, and (6) follow your heart (Bobel et al., 2012). The Jugaad mindset is focused on frugal innovation and innovation out of necessity. When adopting this mindset, those that are innovative are not necessarily concerned with the long-term adoption of the innovation, but these innovations can serve as a roadmap during the ideation portion of the design process and can give design team insights as to what to develop. Methods like HCD and PD take into consideration the adoption of the innovation and, more specifically, HCD takes into consideration the business context of the solution during the inspiration phase.

Although there are principles that overlap with those of HCD and PD, Jugaad can serve as a middle ground between both methodologies. One key principle that ties all three methodologies together is the looking at the margins. Within this principle, Jugaad takes a look at marginalized groups and identifies them as a whole new market. This differs from the one-size fits all approach that some companies use during their product development process (Radjou et al., 2012). Jugaad also utilized co-creation to develop better-fitting solutions, which is one of the many tools used in the ideation phase of the HCD process (IDEO, 2015).

Although looking at marginalized groups in at-risk communities is a key principle of Jugaad; extreme outliers are not identified utilizing this method. This is the advantage that PD can bring to the development process in which correctly defining the problem the community faces can help identify outliers who have solved the issue successfully. In turn, this helps a design team leverage the knowledge of the community and reduced the amount of recourses it takes to achieve viable solutions.

Positive Deviance Methodology

Much like HCD, the PD method is non-linear and can be modified to meet the environmental needs. There are suggested guidelines to follow when using this method, known as the “6 D’s of Positive Deviance”, and they are as follows (Marsh et al., 2004):

1. **Define the Problem** - Work with members of the community to determine the problem and the desired outcome.
2. **Determine Existence of Statistical Outliers** - Identify four to six people who have achieved an unexpected positive outcome, despite the lack of additional resources and against all the odds.
3. **Discover Uncommon but Replicable Behaviors and Practices** - Through interviews, understand and analyze the habits and behaviors that are being used by the PDs that lead to their successful outcome.
4. **Design Intervention** - From the information gathered from the previous step, design behavior-change activities to encourage the adoption of these new behaviors.
5. **Discern** - Monitor the implementation and the results.
6. **Disseminate** - Rely on PDs to spread habits throughout the affected community.

The critical characteristics of the overall PD method are social mobilization, information gathering, and accessible behavior change (Marsh et al., 2004). Social mobilization allows members of the community to become excited and engaged in solving the problem. It enables them to take ownership of the issue at hand, instead of receiving criticism for their inadequacies. Information gathering allows for the identification of transferable behaviors from these statistical outliers, which give a completely different perspective to the problem at hand. The PD approach shies away from the classical expert-driven approach and instead values the wisdom that lies within the community (Singhal et al., 2013). Lastly, the behaviors discovered using the PD method are affordable and accessible to every member (Marsh et al. 2004). Accessibility and affordance are achieved by discovering simplistic solutions that require only minor changes in habits or behaviors.

Although PD has many strengths, there are challenges that come when using this method. Letting members of the community solve their problems may be difficult for some social change practitioners and engineers alike. Engineers are often driven to create solutions focused on the technical requirements of a problem they perceive and may be ignorant of the actual problems people face (Norman, 2013). When people have trouble adopting a particular solution an engineering team has created, engineers become upset blaming the individuals for not knowing how the solution works. Thus, PD works best when the design team effectively takes a back seat and allows the members of the community to guide the project and define the problem at hand. The most challenging phase of the PD process is the dissemination phase as it is iterative and can take time. Much like HCD and Design Thinking, one way of dealing with this issue to go back and reframe the problem to gain a clearer understanding.

Positive Deviance vs. Human-Centered Design

There are distinct parallels between the methods of HCD and PD (Table 1.1). These two methods are similar in the way they approach complex problems and drive innovation. For one, there is great emphasis placed on defining or framing the questions or problems in both methods. The "Inspiration" phase in Design Thinking and HCD looks at members of a given community and tries to understand the problem they are facing. Bringing various stakeholders (experts, community members, and designers) together will lead to the development of a design challenge, which is very similar to Step 1 of the PD method, as described above. PD Step 2 determines the existence of outliers within the effected community, which aligns with activities used within Design Thinking. In the practice of Design Thinking, it is understood that extreme users, as well as extreme outliers, are responsible for driving innovation. Talking to people that are using a product or service to its extreme can spark creativity by exposing designers to unexpected use cases, hacks, and design opportunities (IDEO, 2015). The same is done within the field of PD; this method examines who is succeeding when they shouldn't be, i.e., those extreme outliers known as Positive Deviants. The PD methodology uses the knowledge of these outliers to determine replicable solutions. These behaviors are noted in Step 3 of the process in which the goal is to determine uncommon behaviors. The "Ideation" phase invites members of the community to aid with design efforts in HCD, which align with Step 4 of the PD process. Lastly, the "Implementation" phase allows members of the affected community to distribute these newfound solutions among themselves.

Table 1.1: Summary of Positive Deviance and Human-Centered Design Processes

The 6 D's of Positive Deviance	Human-Centered approach to Product Design
PD Step 1: Define the problem	Inspiration
PD Step 2: Determine the Existence of Statistical Outliers	
PD Step 3: Discover uncommon but replicable behaviors and practices	
PD Step 4: Design Intervention	Ideation
PD Step 5: Discern	Implementation
PD Step 6: Disseminate	

How does Positive Deviants Compare to other Innovative Users

Within the field of product development, there already exists one class of innovative users, much like PDs. As mentioned above, Lead User Analysis identifies extreme users who experience needs well before the bulk of the marketplace (Von Hippel, 1986). This type of unique user stands the most excellent chance of innovating and foreshadowing market demand. When it comes to diffusion of innovation, they are often ahead of the curve, thus experiencing problems in entirely different ways (Figure 1.3).

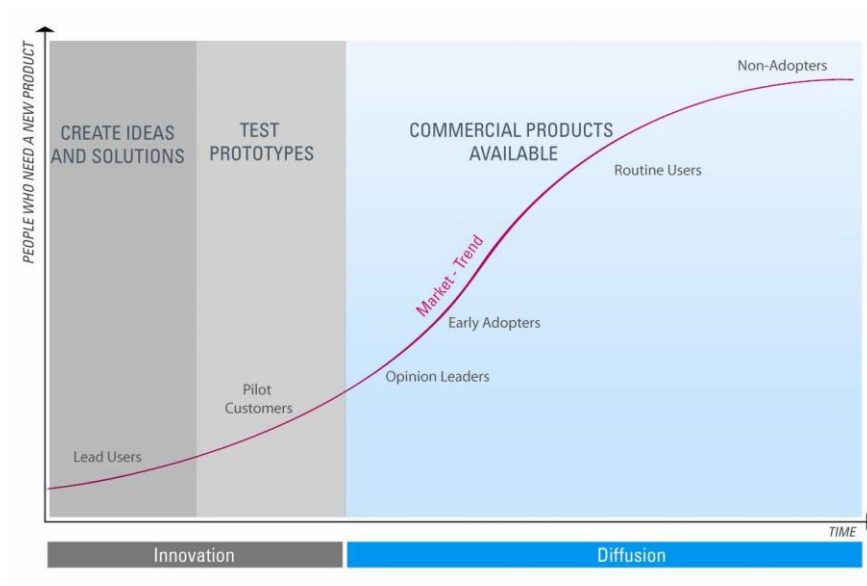


Figure 1.3- The Diffusion of a Product Concerning Time (Savio, 2014)

The drawback to using this method of user innovation is that it relies on expert opinions to define the criteria that are to be used for identifying these extreme users. Experts make a living discerning the deficits in a community, prioritizing the problems, and then trying to implement outside solutions to change them (Dura et al., 2009). Positive Deviance questions the role of outside expertise and values the wisdom that already exists within a community. Using this strength of the community can lead to advantages within the field of product design due to the fuller understanding of the problem that PDs poses due to their lived experience. Although LUA relies on an expert driven approach it does not mean that this method cannot lead to favorable results. LUs are known for developing innovative solutions and LUA is a viable method for identifying latent needs. PDs are capable of developing sustainable solutions and if they are capable of producing latent needs it could lead to both types of users sharing similar traits. This commonality could eventually lead to use of PD as a method for identifying LUs.

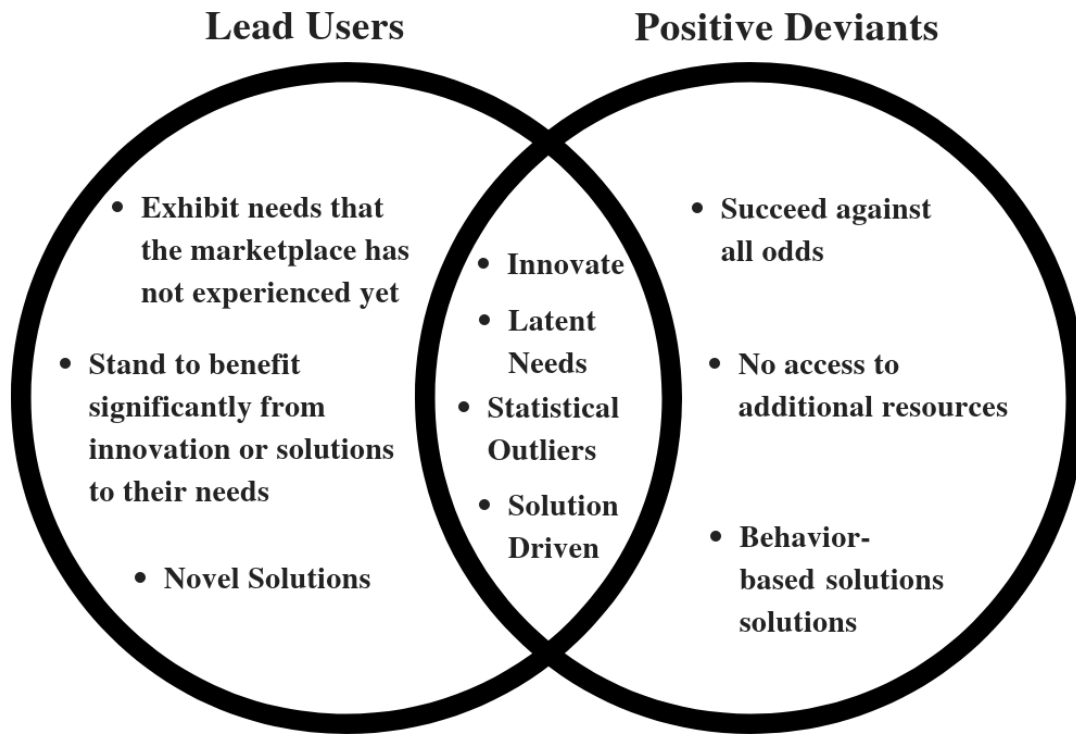


Figure 1.4- Difference and Similarities of PDs and LUs.

Each group of users has a set of defining characteristics. LUs are known to experience needs that the rest of the marketplace has not experience and stands to benefit significantly from receiving solutions to their needs (Von Hippel, 1986) seeing that they are at such extremes this drives them to develop novel solutions. PDs on the other hand are known for succeeding against all odd in at risk communities, innovate with no additional recourses, and develop more behavior-based solutions (Marsh et al. 2004).

The Impact of Positive Deviance in Other Fields

Over the past few years, PD has been finding its way into various technical fields. PD has been used to improve the Systems Engineering process and practices. Rebovich et al. (2009) studied Systems Engineering practitioners working with the Department of Defense (DoD) to help identify and determine those individuals who utilized the DoD System Engineering Guide

for Systems of Systems (SoS). SoS is a common approach to understand how systems engineering deals with the potential systemic ripple effects on constituent systems and helps aid in the decision-making process (Rebovich et al., 2009). In this study, PD was used to identify engineers who were effectively using the SoS. These individuals then helped created new guidelines as to how to implement these practices more efficiently across the organization.

Jerry Sternin has also suggested that PD can be an effective method for change management within large organizations (Pascale et al., 2005). Sternin argues that, within any organization or institution, there are individuals who are already doing things in a radically better way. If large companies are interested in initiating positive change within the company's culture, they could adopt these radically better practices that PDs are exhibiting. PD challenges the traditional schools of thought that believe problem-solving is best done by uncovering the root causes of the problems, hiring experts or importing best practices, and assigning strong leaders as champions of change (Pascale et al. 2005). Instead, PD allows the entire community to participate in collective problem-solving. This gives ownership to the community and empowers and motivates individuals to find solutions, rather than accept the status quo. This would not be possible if an individual or a small group of outsiders were responsible for directing the narrative of positive change in the community.

The Importance of Customer Needs in Product Design

A better understanding of the problem can, in turn, yield higher-quality customer needs, which serve as guidelines for successful product development. Knowing customer needs is critical to both product development and marketing. For, if a product-development team focuses too early on solutions, they might miss creative opportunities (Griffin et al., 1993). To combat this, there are a variety of methods used to understand the customer's needs successfully.

There are various types of customer needs that a design team can encounter when developing a new product. A customer need is defined as a problem to be solved in which these needs are either expressed or yet-to-be articulated (Anderson, 2017). Focusing on customer needs helps companies to plan short and long-term product development and allows design managers to determine which problems they should solve first (Patnaik et al., 1999). Common types of needs include general needs, direct needs, and latent needs (Otto & Wood, 2001). General needs are needs that apply to an entire customer segment. Direct needs can be seen as general needs, but are needs more focused on the customers' feelings about the product and its functionalities (Otto & Wood, 2001). Unlike direct needs, latent needs are needs that cannot be directly articulated by the customer (Slater et al., 1998). Both latent needs and direct needs can be considered general needs in some cases. Seeing that a need may be hard to uncover thus causing it to be seen as latent the general customer segment may be affected by the problem but not have the ability to articulate it thus causing it to be a general need. Hidden needs, such as latent needs, also impact the entire customer segment but are non-obvious and harder for customers to articulate. Consideration of all customer needs can dramatically improve the quality of the product, but the discovery of latent needs can increase the chance of successfully driving innovation (Otto & Wood, 2001).

There are a variety of methods used for identifying customer needs. Conducting customer interviews is one way of discovering high-quality needs. During these interviews, design teams have the option to implement interviewing techniques, such as the Like or Dislike method (Otto & Wood, 2001). Customers and users are asked questions about the product and feedback about their preferences are recorded by the design team (Otto & Wood, 2001). Surveys and focus groups can also be used to identify customer needs (Griffin et al., 1993).

The previous mentioned methods work well when quantifying customers' preferences, but they do little to identify the needs people cannot readily articulate, i.e., latent needs (Patnaik et al., 1999). The discovery of these latent needs can be seen as one of the significant sources of innovation because they are so difficult to discover and often go unnoticed. A design team that can successfully identify latent needs may be able to develop products that could provide a competitive advantage in a marketplace (Slater et al., 1999).

There are a variety of methods that can help design teams uncover latent needs. Probing during an interview can lead to valuable insights that will help discover latent needs. Probes are follow-up questions used to clarify a statement made by the participant during the interview process (Jackson et al., 2009). Observation also plays a critical role in uncovering latent needs of a user (Reunanen et al., 2014). Other methods, such as empathic experience design, rely on empathy to create an empathic experience for designers that allows the team to understand the struggles of the typical user and therefore articulate potential latent needs (Lin et al., 2007). When empathic experience design is used to simulate lead user experiences, regular users are turned into Empathic Lead Users as a means of uncovering latent needs. Allowing the designers to take on the role of Empathic Lead Users can help increase the number of latent needs discovered by 100% (Vaughan et al., 2014).

Positive Deviance in Product Development

Although the PD method has been used in various forms and fields to drive innovation, no attempts have been made to apply this method to the area of physical product design. Parallels can be drawn between PD and HCD, as we can see in Table 1.1 above, however, no prior studies have been found that implement PD in the field of engineering product design. Although, user-generated innovation is nothing new, seeing if the PD methodology can serve as a viable

alternative for design, in the area of physical product development, has not been proven.

Therefore, the purpose of this study is to see if this method can be applied in this field.

Research Question

The overall goal of this research is to understand how the PD method fairs as a product design methodology. To fully validate this claim, it is important to understand if PDs are even capable of producing latent needs and how well they produce needs and solutions during the needs analysis portion of product development. Therefore, the main research question for this Thesis is:

RQ 1: Do Positive Deviants generate the majority of overall and latent needs during the Needs Analysis portion of the design process?

RQ 2: Do Positive Deviants generate the majority of the solutions and are they of higher quality (behavior based and implemented) than solutions of other community members?

The potential impact of this study is the belief that product development and design teams can benefit significantly from focusing their efforts on identifying small groups of outliers who:

- Positively deviate from the norm
- Have a stronger understanding of the problem and needs
- Make attempts at solving the issues
- Develop simple and sustainable solutions

Identifying the needs of the PDs and their solutions rather than spending time identifying the needs of an entire customer segment (in this case the community) may help cut down on time it takes to develop innovative products. PD Step 1 (Define) allows for the correct identification of the problem by the community and the definition of the problem the community faces. Allowing for the identification of outliers who have solved the problem will give clear perspective to

designers as to how sustainable solutions must be developed. In contrast, a design team may be tempted to skip over identifying outliers and rely on members of the impacted community to voice needs and challenges which in turn may lead to the development of less viable solutions and products. By using this method, a design team's efforts are better spent letting the customer segment define the problem and then spend resources on identifying the PDs.

In short, design plays a significant role in creating innovative products and services. Innovations can affect communities, process, products, and people in general. Although there are a variety of methods for achieving innovation, Design Thinking and HCD help create innovative solutions that aim at elevating the root cause and take into consideration those impacted by the problem. PD is a method of social innovation that aims to achieve the same goal but has never been used within the field of product design. To fully understand what the individual requires it is essential to conduct a thorough need analysis that will elicit high-quality needs, such as latent needs. The impact of this study can help designers and developers understand their customer segment in a more robust way, also it could lead to innovations that would usually go unseen since a small population of outliers may not be a target of the design team.

Chapter 2: Phase 1 Method

Overview of Methods

To answer the research questions described in the *Positive Deviance in Product Development and Research Question* section above, a study was designed, based on the application of the PD process in product development, that completes the following steps:

- **Define and develop the Positive Deviance problem statement during a focus group.**

The inspiration for this step comes from PD Step 1: Define, where designers partner with the community to define a problem statement. Holding a focus group allows designers to engage with the community on a personal level and more accurately define the problem at hand. Properly developing a PD problem statement in collaboration with the community helps minimize the impact of bias from the research team and allows the community to address the problem. Allowing community input paves the way for the identification of potential Positive Deviants.

- **Identify and locate Positive Deviants from the student body at UTEP through data analysis of survey results.**

The identification of statistical outliers comes from PD Step 2: Determine. Identifying the existence of PDs is an essential piece of the research. Developing specific metrics from the focus group and identifying individuals who fit the PD framework via surveys will identify these outliers. Identifying PDs within the community brings us one step closer to the realization of the overall research questions. In this particular study, students at the University of Texas at El Paso are the study's target population.

- **Interview various UTEP students, including those that are Positive Deviants, to identify unusual approaches and needs regarding maintaining a healthy lifestyle**

while in college. Unlike the previous steps, the needs driven interview process is borrowed from the field of product development which uses techniques focusing on uncovering latent needs. In addition to using product development techniques during interviewing; techniques from PD will be used to identify uncommon behaviors. During this phase, those that meet the PD framework will be asked to demonstrate or elaborate on their daily activities with the assumption that behaviors that they exhibit differ from their peers. Identifying the differences in needs between PDs and regular members of the community allows designers to understand how these two groups view the same problem. Also, during the interview phase, the potential for latent needs will emerge. Although the next step of the study will fully analyze these needs and determine the validity of *RQ1*. These ideas and solutions would not be available if this step is not conducted.

- **Assess the quality of the needs and solutions produced by each group (PDs and regular university students).** Once again, this needs analysis step is based on product development techniques. Only relying on information that interviews produce does not allow for the full understanding of the quality of needs and solutions (Lin et al., 2007). It is not until the needs are refined and analyzed will we be able to understand the quality of solutions and needs that each group yields. The quality of the needs will be determined by understanding which solutions are unique, behavior-based, and implemented by the individual. The result of this step will give a full understanding of how well PDs produce latent needs and if eliciting latent needs from this particular group is beneficial. One of the keys to understanding the benefits of PDs is to see if this small group of outliers produces the majority of latent needs that have the potential to drive innovation.

The methods utilized in completing these steps are divided into two phases. Phase 1 deals with the focus group and interviews conducted to determine the PD question/problem and identify potential PDs. In phase 2, a needs analysis of both the PDs and regular members of the same community (in this study, college students at UTEP) is conducted.

Phase 1: Identification of Research Problem and Identification of Positive Deviants

The aim of Phase 1 is to successfully define the PD question/problem (PD Step 1) and identify PDs in the student population (PD Step 2). In Phase 1, via collaboration with the community in focus groups, we lay the groundwork for identification of shared, specific problems to emerge. These are problems that the community is facing but has not figured out ways to solve or overcome. Understanding these problems and the restrictions associated with them helps develop a PD research question. From the results of this focus group, metrics are extracted and a survey developed to help with identifying PDs in the population.

To demonstrate the efficacy of this approach, the community/population of interest in this study is college students at UTEP. Maintaining a healthy lifestyle is critical to how well a student performs academically. Studies among school-age children showed student with a decreased overall diet quality were significantly more likely to perform poorly (Florance et al., 2008). The challenge of living a healthy lifestyle affects many students within universities as well. Studies investigating students' mental health have shown that, of 26,000 students from 70 colleges and universities in 2006, 6% of undergraduates and 4% of graduate students reported having seriously considered suicide in the previous 12 months (Drum et al., 2009). Research into the well-known "Freshman 15" has found that students are susceptible to weight gain during their first year of college (Mihalopoulos et al., 2008). A healthy lifestyle can be defined in a myriad of ways. For example, one may consider mental health a key to living a healthy life. Diet, mental

health, and other health issues are interconnected problems and trying to solve one independently could lead to an imbalance in another, making this a complex problem.

PD Step 1: Identify the PD Question (Overview)

The goal of this initial step was to invite various members of the community to define what a healthy lifestyle is and the challenges associated with maintaining said lifestyle. A focus group was used during this step, instead of interviewing community members individually. Having multiple individuals discuss a problem collectively allows for a richer dialogue to emerge, which could not be captured during one-on-one interviews (McCandless et al., 2018). The use of a focus group also helps bring the community together which is commonly used in the practice of PD and allows for collective ownership of the problem. The focus group also leads to the identification of an appropriate PD question by discussing the barriers that students face when trying to live a healthy lifestyle. Community members were directly responsible for expressing the challenges and establishing the definitions of what a healthy lifestyle means to them, which helped construct the PD question. By taking the challenges associated with healthy living and contrasting them with what it means to be healthy, a PD question that left room for the identification of someone who was succeeding when they should not became possible.

Define and develop the Positive Deviance problem statement during a focus group.

The following steps outline the process followed to conduct the PD focus group and identify the PD question. Results of these steps are in the section below, followed by the overall analysis of PD Step 1.

1. **Recruit student participants from various locations within the University.** Multiple individuals throughout the university, both undergraduates and graduate students, were

recruited via face-to-face meetings and flyers. The goal was to invite a diverse group of students to participate.

2. **Host the PD focus group.** The focus group lasted two days. One two-hour session was held each day. The activities completed in the sessions are summarized below and a detailed agenda of the PD focus group is included in *Appendix A*. Materials used during this focus group included sharpies, post-its, large pieces of paper (roughly 25 in x 30 in long), stickers of various colors, a device for voice recording, and a projector to present the material and focus group agenda.
3. **Establish what a healthy lifestyle is.** A method known as 1-2-4-All was used to help yield more insightful and meaningful feedback from group participants (McCandless et al., 2018). The first step of this method was to allow participants to reflect on the prompt: “What does a healthy lifestyle mean to you?”. Then participants got into pairs to discuss their answers. This discussion was rolled over into a group discussion. Post-Its were used to record insights, sorted by common themes, and later placed onto a blank sheet of paper so participants could visually connect with their responses.
4. **Determine the challenges that come with living a healthy lifestyle.** During this step, students formed one large group (in this case one group of four). A method known as Discovery and Action Dialogue (DAD) allowed for each member to engage in meaningful dialogue. The DAD method makes it easy for a group or community to discover practices and behaviors that enable some individuals to find better solutions than their peers to common problems (McCandless et al., 2018). A series of five questions, in accordance with the DAD method, were then asked of the participants to gain a fuller

understanding of the issues at hand. For a list of the questions see *Appendix B*. Insights were recorded, grouped by like terms, and visually displayed.

5. **Define the PD Research Question.** From the results of the 1-2-4 all and DAD methods, the researcher and community members had enough information to form a PD inquiry question. The PD research question was defined by the students using the collaboratively generated challenges they faced and the limitations that they experienced when trying to solve these issues.

Results and Analysis of the PD Step 1: Focus Group

1. **Recruit student participants from various locations within the University.** The initial aim was to recruit at least ten students. Only four of the 40 participants invited were able to participate in the focus group. Table 2.1 gives a breakdown of the demographics of the students who participated in the focus group.

Table 2.1: Demographic Breakdown of PD Focus Group

Demographic Information from PD Focus Group		
Gender	Classification	Major
F	Sophomore	Political Science
M	Sophomore	Engineering
M	Junior	Engineering
M	Senior	Engineering

2. **Establish what a healthy lifestyle is** – Post its from the 1-2-4-All method explaining the challenges facing students were collected and categorized during the focus group by the participants with the aid of the facilitator. Each student was given four circular stickers and asked to vote on which categories they felt were the most important to them. Participants were split on some areas, but the themes of sleep and well-balanced diet were agreed upon by the majority of the group to be the two major categories that contributed to a healthy lifestyle, each receiving three votes. Schoolwork-life balance and

mental health were also crucial to the students seeing that two votes were initially placed in each of these categories. Participants were directed to vote on their top three categories and use their fourth sticker to break the tie. After the tiebreaker vote, schoolwork-life balance was determined to be the third most important category. Other categories that were not deemed as important included emotional health (one vote), sexual health (zero votes), physical health (zero votes), and environmental health (one vote). Table 2.2 shows the breakdown of the categories and how the group voted on their relative importance.

Table 2.2: Healthy Lifestyle Voting Breakdown from PD Focus Group.

Healthy Lifestyle Focus Group Results	
Name of Health Issue	Number of Votes
Physical Health	0
Sexual Health	0
Environmental Health	1
Emotional Health	1
Mental Health	3 (After Tiebreaker)
Balanced Diet	3
Sleep	3
Schoolwork-Life Balance	5 (After Tiebreaker)

Figure 2.1 shows the results of the focus group with metrics associated with each category (discussed in the next step). Allowing votes ensured that no one person's personal bias would dictate which category the participants choose. Overall the participants agreed that sleep, well-balanced diet, and schoolwork-life balance is what defines a healthy lifestyle for students here at UTEP. When it came to defining the characteristics of a healthy lifestyle, students created the following figure (Figure 2.1).

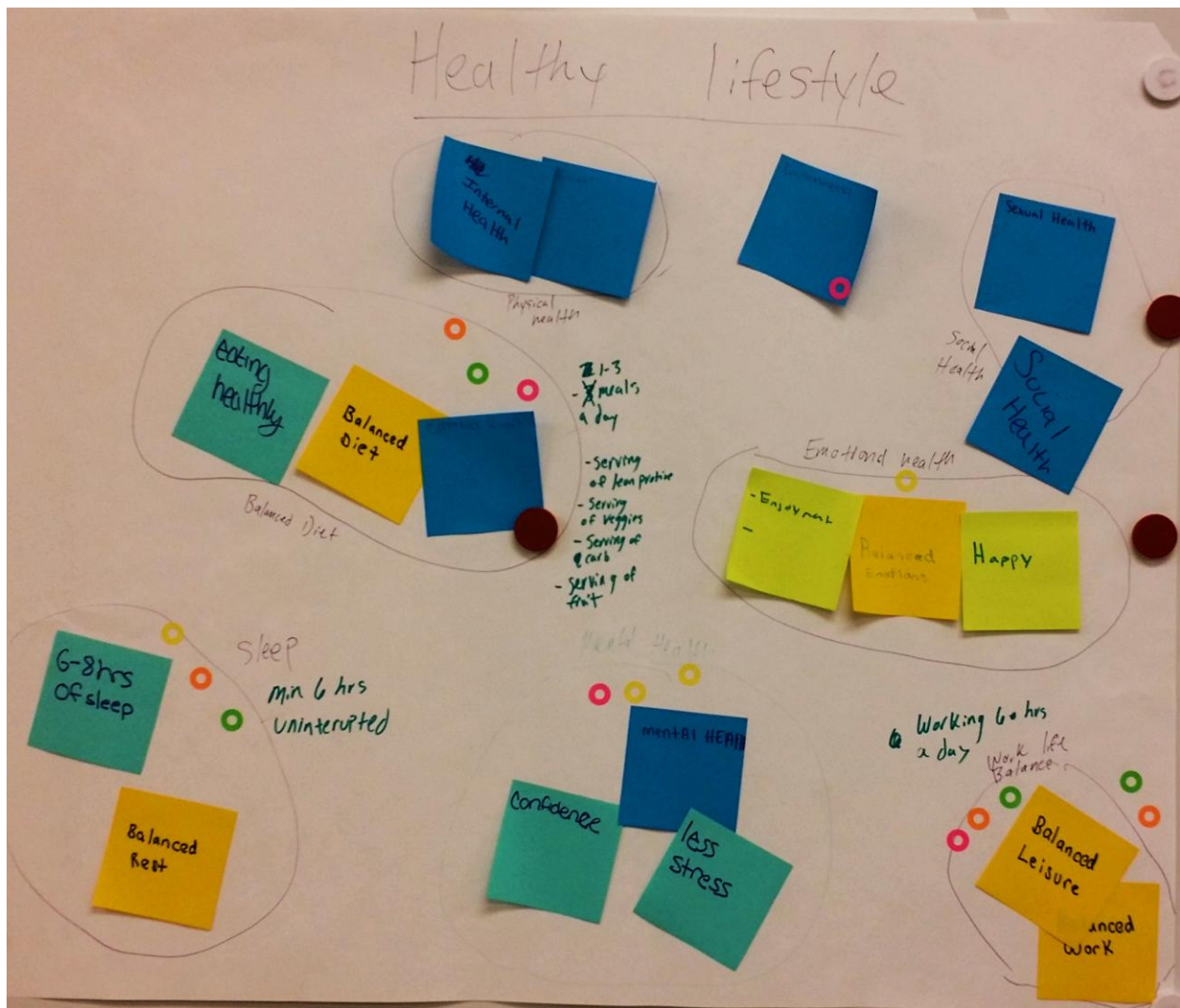


Figure 2.1- Healthy lifestyle and metrics as defined by UTEP students in which the circular stickers represent participant votes.

3. **Determine the Metrics for a Healthy Lifestyle.** After establishing these categories (Figure 2.1), metrics were established for each category to further define and quantify what the categories mean. Five-minute discussion on each category helped identify these metrics in which participant relied on their own personal experiences to help to determine each metric. These metrics are used in creating the survey in the next phase of the study and used to identify PDs. The participants determined that a minimum of 6 hours of sleep would be needed to be healthy. Experts suggest roughly 7 hours per night on a regular

basis to promote optimal health (Badr et al., 2015). For a well-balanced diet, participants determined that at least 1, but no more than 3, meals a day with a serving of protein, vegetables, carbohydrates, and fruit was essential. The USDA suggests one cup of vegetables and fruits, five ounce of protein, three ounces of grain, and one cup of milk daily (USDA, 2018). For the schoolwork-life balance category, participants concluded that working no more than 6 hours a day on school-related work was essential to maintaining a healthy lifestyle. Schoolwork-life balance included studying, homework, and other school-related activities but did not account for time spent in class. Studies have suggested working 7 hours a day for 200-220 days per year will allow for an increase in the quality of education for students (Gardner et al., 1983). Metrics that experts defined closely resembled those that students determined. The metrics were slightly less than what experts recommended this could be due to the fact that these recommendations were adapted to meet the lifestyles of the students.

4. **Determine the challenges that come with living a healthy lifestyle.** During this step with the aid of the DAD method, everyone was allowed to talk for roughly 1 minute on questions that pertained to the challenges they faced while maintaining a healthy lifestyle. The facilitator was able to write insights and keywords as the conversation went on, grouping similar insights across participants. This was done after each question was concluded per individual. While the individual participant was sharing their insights Post-its were placed on a blank sheet to allow student to confirm each insight. All members along with the aid of the facilitator grouped insights based on themes. These themes were then abstracted to develop categories. The categories, which were the most densely populated, were then considered the most pressing challenges. School, more specifically

keeping up with class work and grades, an individual's environment (i.e., accessibility to food, clean air, and transportation), and responsibility in which students were required to take on either a new roll at work or within their household were the three categories that yielded the most insights and discussion (Figure 2.2). Work, money, social life, and hobbies were also categories that affect student's healthy lifestyle but did not yield as many insights.

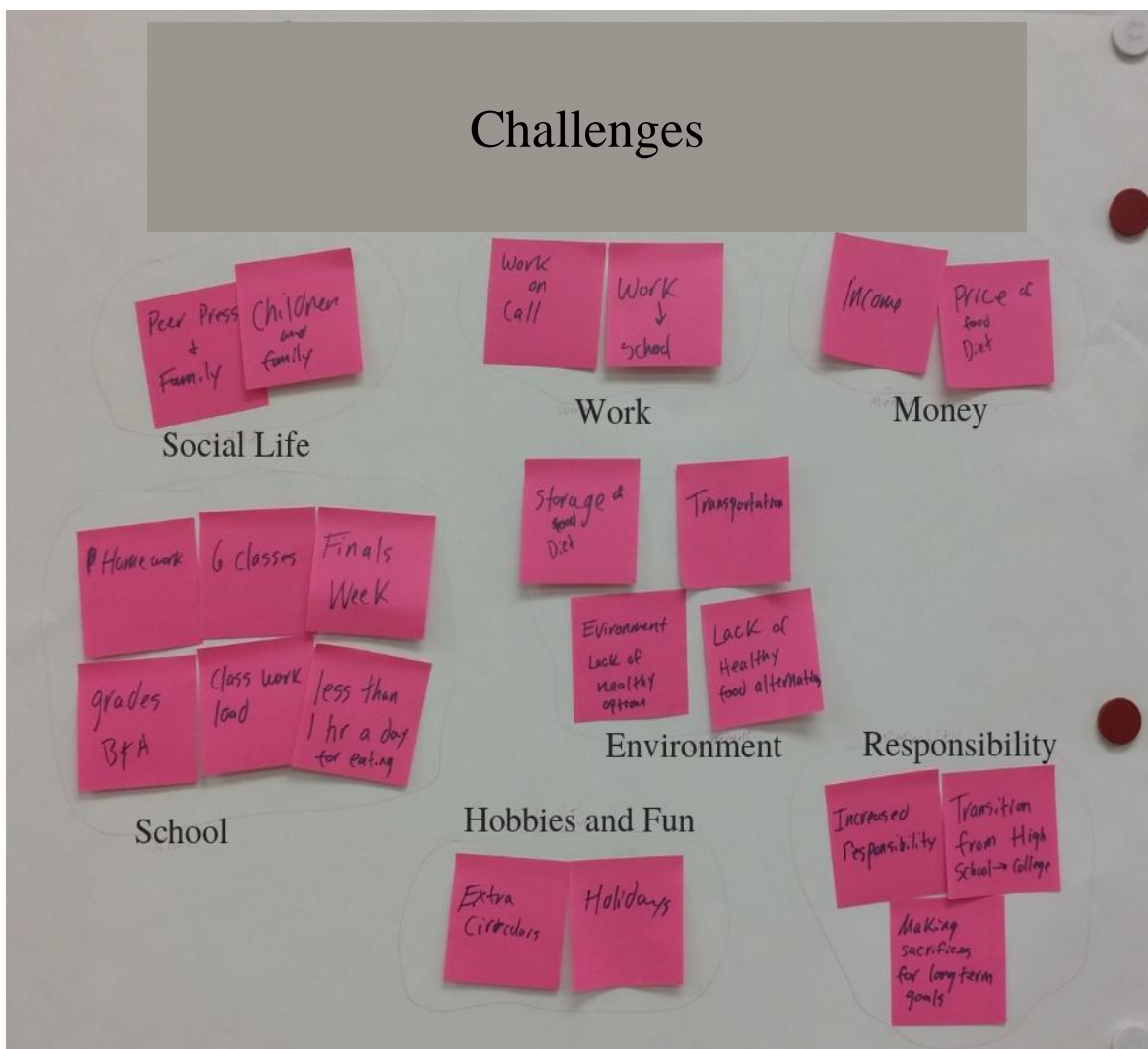


Figure 2.2- Challenges UTEP Students Face When Living a Healthy Lifestyle

5. **Determine the Metrics for Challenges to living a Healthy Lifestyle.** The group once again identified metrics for each challenge. Participants were then asked to confirm if this was the case in which they all agreed. Each category had a variety of insights developed by the group. Initially, insight that could easily be turned into a quantifiable metric were targeted and prioritized but other groups of challenges has insights that were still very abstract which meant the participants had to further define the meaning. Determining the challenges to quantify was confirmed with the group after the DAD method was concluded. The participants came to a consensus via group discussion on which challenges affected them the most. A vote at this time was not necessary seeing that participants were sharing very similar insights. A list of the challenge categories (Figure 2.2) and their meanings are described below. Where appropriate, the metric identified by the group is also described.

- **Social Life-** Friends and family interfere with their ability to study, eat well, and sleep.
- **Work-** The amount of time they spend at work or working interfered with their abilities to study, plan proper meals, and get to bed at a decent time.
- **Money-** The amount of income affects the quality of food that they can buy. Sleep and schoolwork were not perceived as being affected by this challenge.
- **Hobbies and Fun-** Special occasions, such as holidays, were challenges expressed by the students to be detrimental to their eating patterns and extracurricular activities would sometimes cut into the amount of time they had to study.

- **Environment-** The student's access to healthy food options, how close they were to a grocery store, and how they could get to a grocery store affected how well they ate. Also, how they went about studying and where they slept was affected by their environmental conditions. Of the insights in this category, transportation was chosen as a pressing issue to turn into a metric. Two of the members of the focus group agreed that this was one of the biggest issues that they faced when eating healthy. With the help of the focus group, this metric was ultimately defined as individuals who relying on public transit and live over 1 mile away from any bus stop.
- **Responsibility-** An increase of responsibility meant that they were transitioning from a familiar environment to a completely unfamiliar environment (i.e., high school to college). During the focus group, this was express to be one of the reasons why it was difficult for them to complete tasks for school since some of the structure they previously experienced was gone. Three insights were developed in this category and a metric was created. Transitioning from High School to college was determined to be the only insight that could be quantified. The increase in responsibility was broadened and translated to any students that have experienced a life-changing event, such as a new job or started graduate school.
- **School-** School was seen as a challenge that impacted sleep more than schoolwork balance and diet. The category of school yielded the majority of the insights at six. From the results of the focus group, the metric for the challenge of course load was derived from the insight of 6 classes being a major challenge

seeing that this was the obvious quantifiable metric. It was later determined to be 15 credit hours for undergraduates or 6 credit hours for graduates as a challenge to their healthy lifestyle.

6. **Defining the PD Research Question-** A well-defined research question will reflect specific metrics that pertain to the challenges students face and what they agreed upon definition of what a healthy lifestyle is (Marsh et al., 2004). The PD question should also leave room for a specific outcome to be achieved. These two caveats were considered during the formulation of the PD question. The research question was put together based on two factors. Understanding what a healthy lifestyle is and the challenges that inhibited an individual from achieving a healthy lifestyle. From the challenges discovered and the metrics of success articulated by the focus group, the following PD question was formulated:

Are there any students who are:

- *Taking five classes (15 hours)*
- *Do not have a vehicle or live more than a mile away from a bus stop*
- *Have just recently graduated high school, started a new job or started graduate school*

Who can:

- *Get a minimum of 6 hours of sleep*
- *Eat at least 1 up to 3 meals a day (with one portion of fruits, veggies, carbs, and protein at each meal)*
- *Spend no more than 6 hours on school-related work?*

- **PD Step 2:** Identify the Presence of PDs (Overview)

The goal of PD Step 2 is to identify four to six people who have achieved an unexpected positive outcome despite the lack of additional resources and against all odds. Identifying the existence of PDs is a critical part of the study. Successfully identifying a PD will pave the way to developing a solution to the problem this community faces. Creating a survey aimed at

identifying PDs is was the main focus of PD Step 2. The survey allowed for an easy collection and analysis of data. The results of the survey helped significantly narrow down the population where potential PDs can be identified.

Identify and locate Positive Deviants from the student body at UTEP through data analysis of survey results.

The following section outlines the process that was used to administer the survey and determine the existence of PDs within the community of UTEP students. The process is as follows:

1. **Designing the survey around PD inclusion criteria-** As stated in Phase 1, the PD question should have quantifiable metrics that will easily transfer over to survey questions. For example, in this experiment, the group defines 6 hours of sleep as healthy; the survey should reflect a question investigating how many people get 6 hours of sleep. Using this method the following survey question was developed, “How many hours of sleep do you get per night on average during the school year?” Answers to survey questions were mainly multiple choice and answers to the previous question included “6 or less”, “6 to 8”, or “More than 8”. There were two questions that required individuals to input their answers manually. In total there were seven possible questions that could be answered. Qualtrics, an online survey tool, was used to collect participant responses. For the survey questions used for this experiment see *Appendix C*. The survey could be completed on a phone or computer and took 2-5 minutes to complete.
2. **Distribute the survey-** After the survey was successfully created, it was distributed via face-to-face interactions with 123 students within the university. Tracking demographic data and information was not of importance for to study.
3. **Determining Participants’ PD status based upon survey results-** During this portion of the study, we identified which participants met the PD criteria and which participants

did not. To determine the PD criteria, a scoring metric was developed to determine who was and who was not a PD. The questions and answers in the survey were designed around the metrics identified within the PD research question. The survey was also designed with the expectation of at least one individual that would achieve a score of 100 on the survey, which meant they met the PD framework completely. Each question contained at least three answer choices, which were all weighed differently. Some answers were more inclined to support the PD framework than others. The distribution of points was as follows:

- 1 Point- Inclined to fit PD framework
- .5 Points- Nearly meets PD framework
- 0 Points- Does not meet PD framework

Each individual was asked the same seven survey questions. Every participant answered all seven survey questions. During the seven survey questions asked, if an individual answered in a way that met the PD framework a follow up question would appear in addition to the seven original questions. These follow-up questions investigated the individual's PD habits in further detail. Participants could answer up to nine questions in total. The additional question would positively affect the individuals' PD status because follow-up questions would further confirm their PD behaviors, which would give them additional points. Points associated with the questions an individual answered (i.e. 1 point, .5 points, 0 points) were then summed up and divided by the number of questions the participants answered in the survey. The final number yielded the PD status in the form of a normalized rating seeing that some survey participants answered more than the minimum of seven questions.

4. Identify the community outliers- Target values needed to be created to help uncover community outliers. Before defining target values, participants were grouped into one of three categories: PDs, Potential PDs (PPDs), and Non-PDs (NPDs). Organizing the participants within these groups allowed for the quicker identification of the outliers. Grouping would later play a vital role when conducting the needs analysis portion of the study. PDs were considered individuals with a rating higher than 90%. Individuals who were between 90%-70% were considered PPDs. Anything lower than 70% was considered a NPD. Typically, PDs should only account for 1% of the population (Marsh et al., 2004) but since none of the participants scored 100% the window was opened to 90%. The PPD window was based on the minimum score (70%) that a participant could receive while still exhibiting PD characteristics in at least one of the three categories. With this metric in play, it allowed for the identification of four to six participants, which was recommended based on the Positive Deviance literature (Marsh et al., 2004).

Results for identifying PDs

1. **Analysis of the survey data-** Figure 2.3 illustrates the results from the scored survey data:

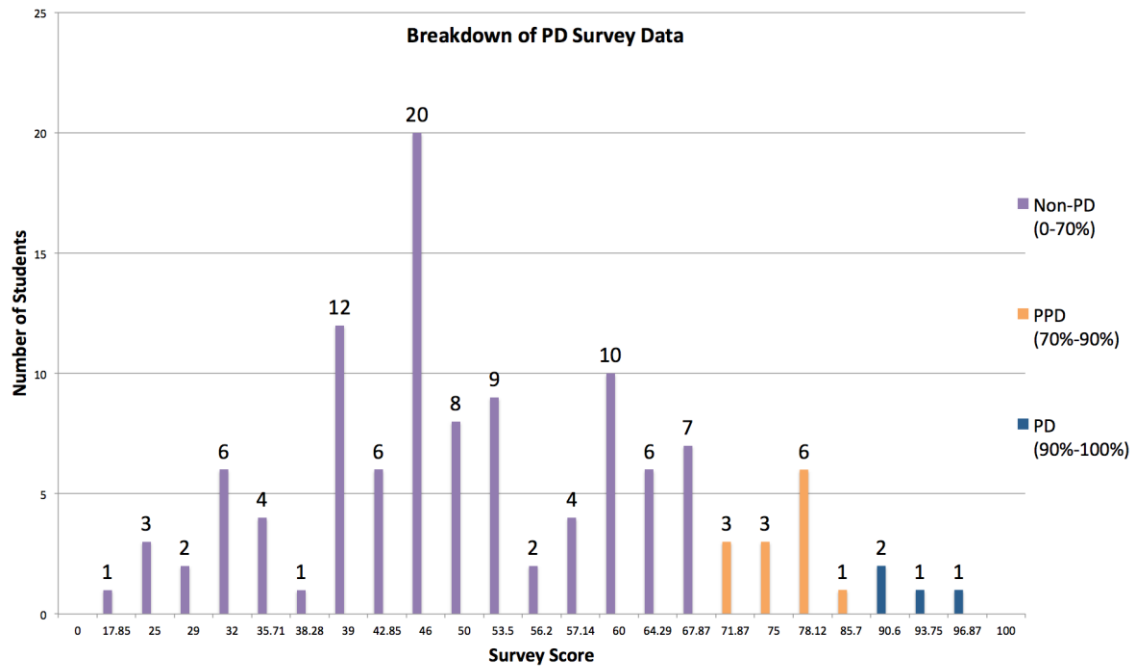


Figure 2.3- Breakdown of Survey Results

2. **Identify the statistical outlier-** After the PDs were categorized only four students met the PD framework, which is consistent with the PD literature.

Chapter 3: Methods for Phase 2

Phase 2: Conduct thorough needs analysis from both Positive Deviants and regular members of the community.

Phase 2 of the experiment dealt with exploring the needs of the PDs successfully identified in Phase 1 with NPDs and PPDs of the same community. During Phase 2, we invited both PDs and regular members of the community to participate in one-on-one interviews. During the interviews, PDs were asked a series of questions to reaffirm their PD status. Both PDs and other participants were asked opinions on the challenges they experience when living a healthy lifestyle. The purpose of this phase was to extract needs (i.e. problem to be solved in which these needs are either expressed or yet-to-be articulated (Anderson, 2017)) from PDs and regular members of the community. These needs were later analyzed and compared in the Needs and Data Analysis portion of this experiment.

PD Step 3: Interview PDs and other members of the community. The goal of this step was to interview PDs and other members of the community to discover uncommon behaviors (Marsh et al., 2004) as well as unique and latent needs (Otto & Wood, 2001). The Discover portion (PD Step 3) of the PD process was modified to mirror a traditional needs analysis (Otto & Wood, 2001) that a design team would conduct to understand the needs of a given customer segment. Methods used during PD Step 3 in this study were common during the PD process, although interviews to gathering needs and determining their quality adds another component to this step. The utilization of a Customer Interview form (*Appendix E*) and a Needs Hierarchy (Otto & Wood, 2001) lists are two methods traditionally used in product design and adapted in PD Step 3. The following section explains the process used to discover the behaviors and needs of each group.

Interview various UTEP students, including those that are Positive Deviants, to identify unusual approaches and needs regarding maintaining a healthy lifestyle while in college.

1. **Identify Potential Participants-** Individuals who indicated willingness to participate via survey response were contacted and follow-up interviews were scheduled. From the students who consented to participate in this interview, only nine participants were interviewed. Table 3.1 shows the demographic information of the participants who were interviewed during this study and their PD, PPD, and NPD group assignment.

Table 3.1- Demographic Breakdown of Interview Participants

Demographic Information from PD Interviews			
Participant ID	Gender	Classification	Major
PD 1	M	Graduate Student	Engineering
PD 2	F	Senior	Liberal Arts
PPD 1	M	Graduate Student	Engineering
PPD 2	F	Graduate Student	Engineering
NPD 1	F	Senior	Engineering
NPD 2	M	Sophomore	Engineering
NPD 3	F	Senior	Biology
NPD 4	M	Senior	Engineering
NPD 5	F	Freshman	Kinesiology

2. **Conduct interviews** – Each participant completed a one-on-one interview in the Empathic Design Studio (E225) at the UTEP. The interviews were semi-structured and used open-ended questions. Questions were created and designed around the three categories of sleep, diet, and schoolwork-balance (For interview questions see *Appendix D*). Participants were also asked questions framed around identifying products or peculiar methods they use to help improve their overall health status were asked. A list of questions was prepared in advance, but the prepared list was used more as a guide. In total eight questions were asked to regular participants. PDs were asked ten. The additional two questions asked of the PDs were questions aimed at confirming their PD status. Multiple ad-hoc follow-up questions were included and aimed at probing specific

statements the participant made in the hopes of uncovering latent needs. The interviews lasted 43 minutes on average (minimum of 32 and a maximum of 61) and were recorded for future analysis.

3. **Translate interview responses to needs-** During the interview, notes were taken using a Customer Interview Sheet (Appendix E), which helped to organize and capture customer statements. After each interview was concluded, the use of the customer interview sheet and audio recording aided in translating customer statements into needs. A few guidelines were used during the needs translation process (Otto & Wood, 2001):

- Express the customer statement in terms of what the product must do, not how the product might do it.
- Use positive, not negative phrasing.
- Express the need as an attribute of the product.
- Do not use “must” or “should” in the statement.

As a general guideline, needs extracted should resemble general design parameters (functionality, aesthetics, ease of use), themes (problems, ideas, concepts), or referents (objects) (Smith-Jackson et al., 2009).

Using the Customer Interview Sheet method is explained by Otto & Wood as a method that enables design teams to identify essential design parameters successfully (Otto & Wood, 2001). The Customer Interview sheet allowed for the successful collection of customer statements to be translated into needs. For example, a student would state, "I use a fan when I go to sleep. The noise helps me fall asleep." which then could be translated into Needs Background Noise. Each recording was played back to

ensure nothing was missed during the interview and bring each of the customer statements into context to extract more exact needs.

4. **Create a list of needs for each individual participant-** After significant needs were developed using the Customer Interview Sheet, they were translated into a Needs Hierarchy list. The Needs Hierarchy list helped placed them into three distinct categories needs about sleep, diet, and work-life-school balance. Placing needs into a Needs Hierarchy list would prove to be important when determining the amount of total needs across all individuals and would be required for further needs analysis. Individuals that were interview had their own Needs Hierarchy list developed for them. Needs were then tallied up and compared with each corresponding group.

PD Steps 4-6: Not a focus of this study, we were not interested in developing solutions and disseminating them throughout the community.

Results of Needs Identification

Individual PDs outnumbered their peers when it came to producing needs (Figure 3.1). On average, PDs yielded 17.5 total needs for sleep (STDEV 4.9), 24.5 needs for diet (STDEV 3.5), and 21 needs for schoolwork-life balance (STDEV 1.4). In contrast, PPDs yielded 4.5 total sleep needs (STDEV 0.7), 13 needs for diet (STDEV 1.4), and 17.5 needs for schoolwork-life balance (STDEV 17.5). Lastly, NPDs produced 6.6 for sleep (STDEV 2.7), 11 needs for diet (STDEV 3.6), and 8.2 needs for schoolwork-life balance (STDEV 3.9) on average.

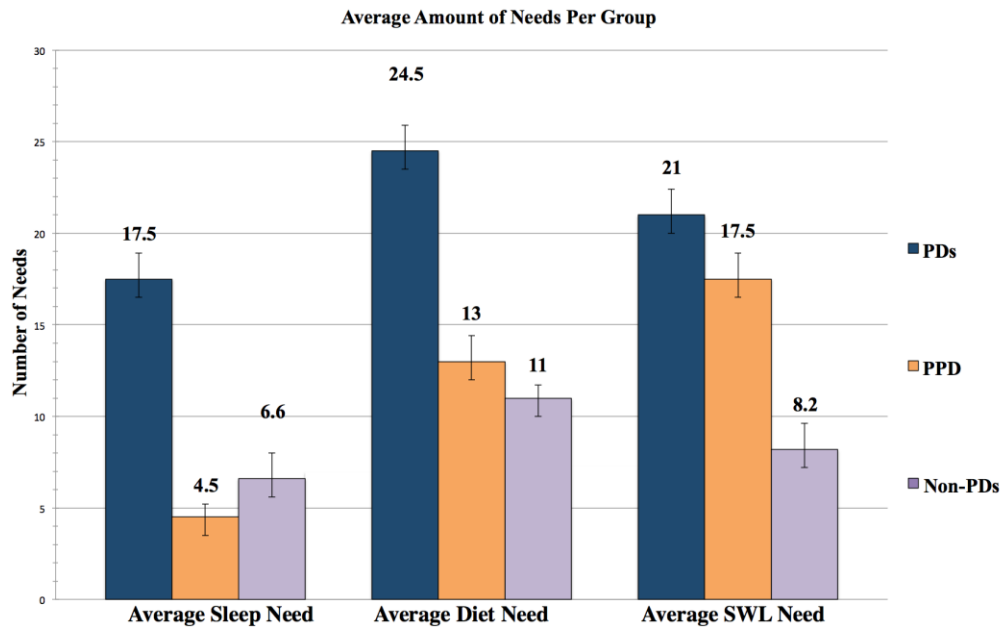


Figure 3.1- Average Number of Needs Produced by Each Group

Categories were developed based around what criteria the PD focus group defined to be a healthy lifestyle for students. The Sleep Needs category was focused on understanding what each group needed in order to achieve a restful night's sleep (6 hours of sleep) and what were some of the challenges associated with getting a restful night's sleep. The Diet Needs category dealt with understanding what individuals needed to achieve a well-balanced diet (One serving of fruits, vegetables, protein, and carbs). Lastly, the Schoolwork- Life balance (SWL) asked participants what each of them needed to achieve a balanced school schedule (Taking 15 school credit hours and working no more than 6 hours a day on school-related work).

Identifying the highest number of needs shows us which participants yield the most needs during the interview process. Seeing the data from each individual allows us to understand trends and determine if PDs are worth interview by a design team. Both PDs produced the overwhelming majority of needs during the interview process (Figure 3.2). PD01 produced 61

while PD02 produce 65. Potential PPDs and NPDs produced roughly the same number of needs ranging from 37 (PPD02) all the way to 17 (NPD02).

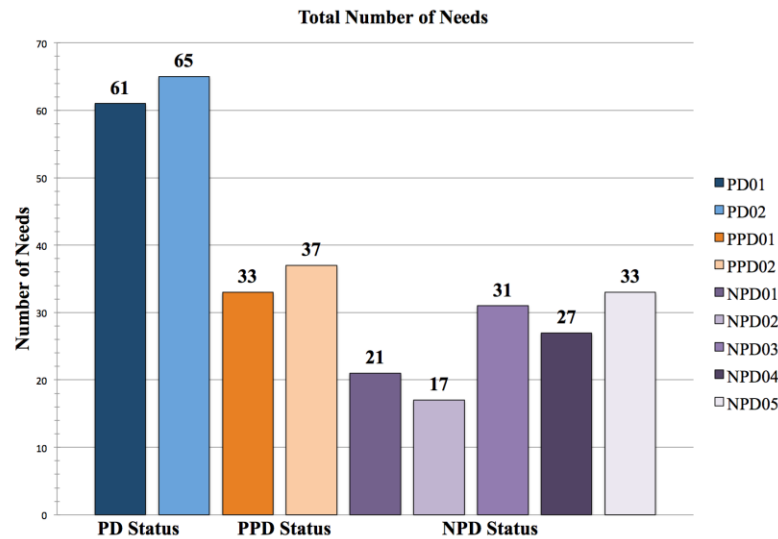


Figure 3.2- Total Number of Needs Produced by Each Participant.

For every category, the trends were very similar (Figure 3.3-3.5). The highest number of needs produced came from a PD in this category at 21 (Figure 3.3). The highest for NPDs was at ten needs, and for PPD five was the highest in this category (Figure 3.3).

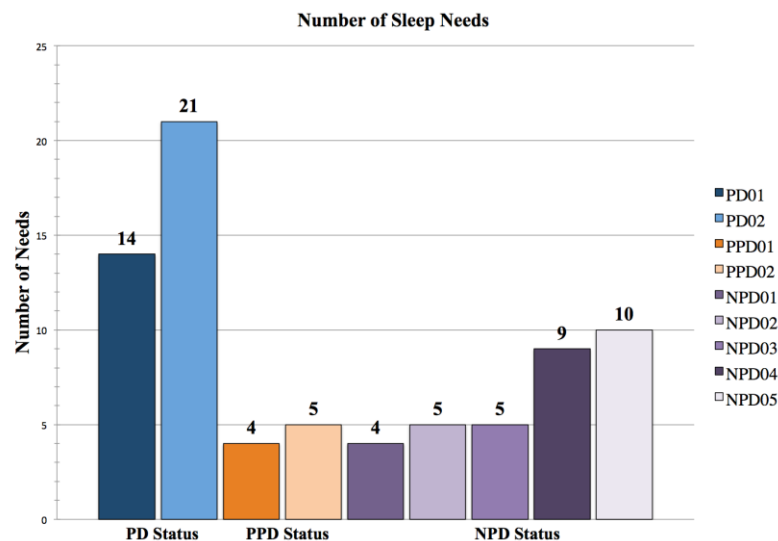


Figure 3.3- Total Number of Sleep Needs Produced by Each Participant.

Once again, the highest number of needs produced came from a PD in this category at 27. The highest number of needs produced by PPDs was 14, and for NPDs it was 17 (Figure 3.4).

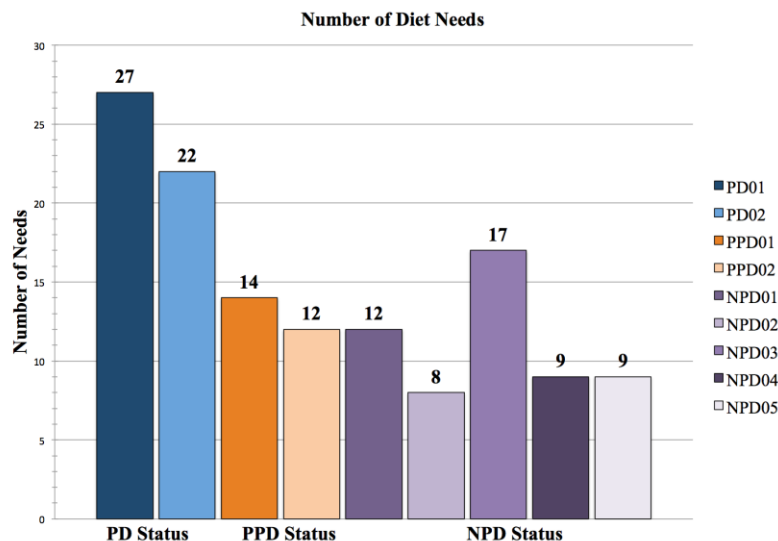


Figure 3.4- Total Number of Diet Needs Produced by Each Participant

The last and final category, which is schoolwork-life-school balance PDs, produced 22 needs, which were the most, the highest number a PPD produced was 20, and the highest for an NPD was 14 (Figure 3.5):

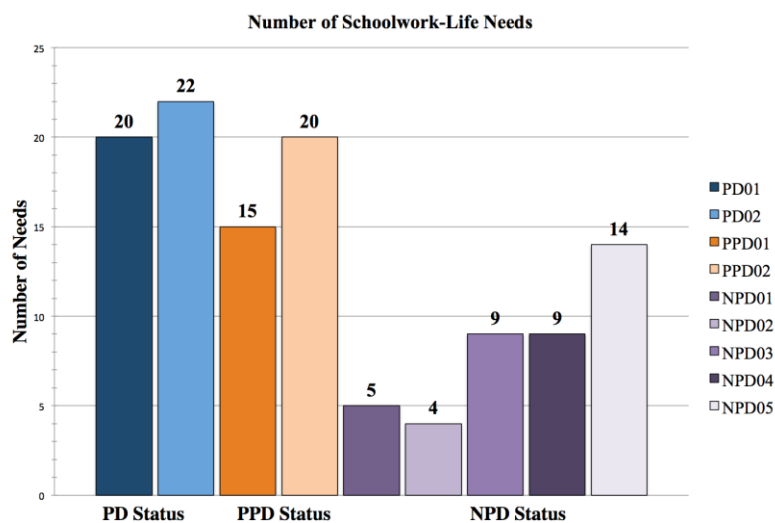


Figure 3.5- Total Number of SWL Needs produced by Each Participant

It is important to note that these were total need mentioned by each individual before the needs analysis (which will uncover latent needs and unique solutions) but still a stable trend could be established from the data. In every category, PDs expressed more needs than their peers. The only category where there was no obvious difference was in work-life-school balance in which PPDs yield similar results.

Chapter 4: Needs and Data Analysis

Needs and Data Analysis

The goal of this portion of the study was to decipher which group of participants produced the highest quality needs, i.e., latent needs. In addition to latent needs, discovering which group provided the largest number of solutions was of interest. The identification of low-cost and replicable solutions will not only help the design team and engineers understand the problem, but the product developed will also fit the needs of the individual more effectively. The previous phase of the experiment allowed for the discovery of needs, but they remained unanalyzed and only partially organized. During this portion of the experiment, data collected from the interviews were organized, processed, and analyzed. This process was broken down into three iterations to ensure all needs produced were accounted for, identified, and grouped correctly. This step is not part of the traditional PD process but is an integral part of the product design process (Otto & Wood, 2001). This step of the experiment was a critical step to answer the proposed research questions.

Iteration Overview

In the first iteration, the Needs Hierarchy List of each participant was used to organize and group similar needs across all three categories derived previously (sleep, diet, and school-work-life balance). Using the Needs Hierarchy list, we were able to identify every single need mentioned throughout all interviews conducted. This would ultimately lead to the discovery of latent needs; needs not identified by the traditional user group (Vaughan et al., 2014, Otto & Wood, 2001, Slater, et al, 1999). The goal of the second iteration was to see if needs and latent needs from the previous iteration could be further refined into meaningful groups. The last iteration was once again to confirm that all of the needs were reduced and could no longer be

refined. The third iteration was the most critical, so an emphasis on explaining the method, analysis, and results will be explained below. This step also separated needs from solutions and tracked which group was responsible for mentioning each solution or need.

Assess the quality of the needs and solutions produced by each group (PDs and regular university students).

1. **Use Needs Hierarchy List to develop a Master Needs Lists-** In each iteration, a list of all needs for each category (sleep, diet, and schoolwork-life balance) was created using the Needs Hierarchy List (See *Chapter 3 Create a Needs Hierarchy List*) of each participant. Each iteration focused on reducing the redundancy of needs and encoding needs by grouping like terms. Using the Needs Hierarchy List, we identified the needs mentioned by counting how many times it was said and who said it. Counting needs would help with the identification of latent need and decipher needs from solutions. In total, three lists were created based on each category mentioned above. These lists would come to be known as Master Needs Lists. Three iterations of refinement were needed to reduce and categorize all needs and to ensure data was as accurate as possible.
2. **Decipher needs from solutions-** the refinement process that developed the Master Needs Lists lead to the identified solutions. Typically, needs were worded in more of an abstract manner. The solutions needed to be more detail oriented and specific. For example, a need closely resembled, "Needs Peace of Mind" whereas a solution resembled "Needs Mediation Before Bed." These two were similar, but the second was an action that helped solve the need in question. Once solutions were deciphered from needs, they were tracked to see which group had referenced said solution and tallied. Properly identifying solutions helps determine the quality of each solution and the difference between PD

solutions and solutions from the general community (*RQ2*). Solutions were analyzed based on whether they were behavior based and which group was implementing them or not.

3. **Identify which group produced the most latent needs-** Once all the needs from the Master Needs Lists could not be refined down any further and solutions were extracted, those needs only mentioned once were considered latent needs (needs not expressed by the traditional user group). Determining needs only mentioned once leads to the identification of latent needs (Vaughan et al., 2014). The identification of latent needs would determine whether PDs produce higher quality needs or needs that could lead to innovations compared to other community members (*RQ1*).
4. **Determine the total amount of needs and solutions mentioned by each group-** The total number of needs a group mentioned was then tallied. A percentage of how many needs mentioned by each group was then calculated for overall needs and latent needs. The total number of solutions mentioned was found using the same method.

Results

1. **Total needs and latent needs identified per category-** The following tables (Table 4.1, Table 4.2, Table 4.3) show the Master Needs List which displays needs that were discovered throughout the entire interviewing process and accounts for redundancies. The list is followed by Venn Diagrams that show the number of latent needs produced. Master Needs Lists for all three categories are reported in this section.

Within the Sleep Category, participants identified a total of 19 needs across all groups (Table 4.1). Out of those 19 needs, PDs identified 15 (80% of total), PPDs

identified eight, and NPDs identified 12. Overall, PDs identified 80% of all needs gathered which was the most of any group.

Table 4.1- Master Needs List for Sleep Category by each Participant Group

Sleep Needs	PD (n=2)	PPD (n=2)	NPD (n=5)
1 Needs Exercise	x	x	x
2 Needs Consistent Sleep Schedule	x	x	x
3 Needs Peace of Mind	x	x	x
4 Needs Peaceful Environment	x	x	x
5 Needs Limited Electronic Use	x		x
6 Needs Routine	x	x	
7 Needs Reminders		x	x
8 Needs to be Productive	x		x
9 Needs Undisturbed Sleep	x	x	x
10 Needs Time Management			x
11 Needs Accountability		x	x
12 Needs Mental Exhaustion	x		x
13 Needs Privacy	x		
14 Needs to eat a Balanced Meal	x		
15 Needs Cooperative Community and Environment	x		
16 Needs Place to Sleep and Study			x
17 Needs Healthy Environment	x		
18 Needs Clean Environment	x		
19 Needs Motivating Routine	x		
	15	8	12
	80%	40%	60%

For the Sleep Category, PDs identified six latent needs, PPDs identified zero, and NPDs identified two (Figure 4.1). All groups combined contributed a total of eight latent needs. Latent needs are displayed in bold numbering.

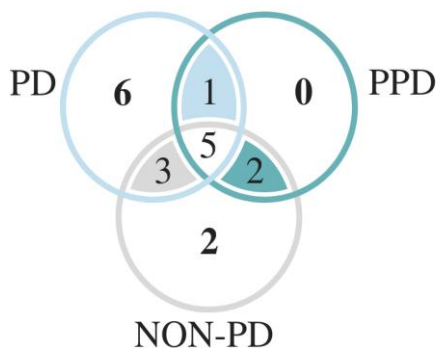


Figure 4.1- Latent Needs for the Sleep Category

For the Diet Category, the three groups identified a total of 26 needs (Table 4.2). Out of those 26 needs, PDs identified 20; PPDs and NPDs identified 16 needs respectively. In this category, PDs identified 80% of all needs.

Table 4.2- Master Needs List for Diet Category by each Participant Group.

Diet Needs	Time Mentioned	PD (n=2)	PPD (n=2)	NPD (n=5)
1 Needs Convince	9	x	x	x
2 Needs Effective Food Storage and Transportation	7	x	x	x
3 Needs Nutrient Dense Food	7	x	x	x
4 Needs Simplicity	6	x	x	x
5 Needs Affordability	6	x	x	x
6 Needs Large Volumes of Food	6		x	x
7 Needs Healthy Food Options	5	x	x	x
8 Needs Variety	5	x		x
9 Needs Portion Control	4	x	x	x
10 Needs Consistency	4	x	x	
11 Needs Access to Nutrition Knowledge	4	x	x	x
12 Needs Set Eating Schedule	3	x		x
13 Needs Time for Planning	3	x		x
14 Needs Meal Planning	3	x		x
15 Needs Schedule	3		x	x
16 Need Morning Meal	2		x	
17 Needs Group of Like Minded People	2	x	x	
18 Needs Taste	2			x
19 Needs Reminders of what Needs to be Bought	2	x	x	
20 Needs Calorie Tracker	2			x
21 Needs Discipline	2	x	x	
22 Needs to Stay Active	1		x	
23 Needs Compatibility with Environment	1	x		
24 Needs Access to Staples	1	x		
25 Needs Restful Sleep	1	x		
26 Needs Access to Water	1	x		
Total by Group		20	16	16
Amount Identified		80%	60%	60%

PDs identified four latent needs in this category and were once again the top producer.

The other two groups (PPDs and NPDs) produced two latent needs for this category.

Figure 4.2 shows the latent needs discovered by each group in the Diet Category.

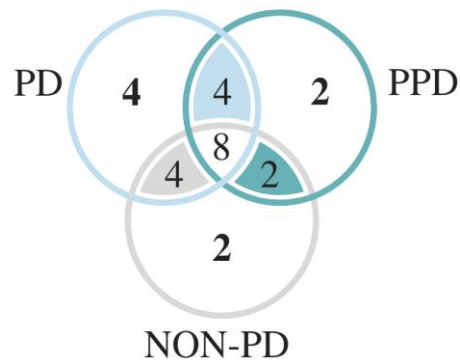


Figure 4.2- Latent Needs for the Diet Category.

PDs only identified about half of the 29 needs from within the diet category at 50%. The amount of needs identified is 30% lower than needs identified in the previous two categories. PPDs produced the majority of the needs within this category at 60%. PDs only identified 15 out of the 29 needs while PPDs identified 18 and NPDs identified 17.

Table 4.3- Master Needs List for Schoolwork-Life Balance Category.

SWL Needs	Time Mentioned	PD (n=2)	PPD (n=2)	NPD (n=5)
1 Need Effective Organization	9	x	x	x
2 Needs Dedicated Time Off	7	x	x	x
3 Needs Flexibility	6	x	x	x
4 Needs Time Management	6	x	x	x
5 Needs Compartmentalized Schedule	6	x	x	x
6 Needs Less Difficult Curriculum	5		x	x
7 Needs Consistency	5	x	x	x
8 Needs Work that Allows for Daily Accomplishments	5	x	x	
9 Needs Gradual Improvement	5	x	x	
10 Needs Peace of Mind	3		x	x
11 Needs Comfortable Environment	3	x	x	
12 Needs Reward System	2			x
13 Needs Goal Setting	2	x		x
14 Needs Meaningful Work	2		x	
15 Needs Accountability	2		x	
16 Needs Coping Mechanism	2		x	
17 Needs to be Familiar with Work	2	x	x	
18 Needs Cooperative Community	2	x		
19 Need Simplicity	2		x	x
20 Needs Shorter Commute	2			x
21 Needs Stimulants	2			x
22 Needs Access to Funding	2		x	x
23 Needs Dedicated Time to Exercise	2	x		
24 Needs Form of Automation	1			x
25 Needs to Work During Commute	1			x
26 Needs Ability to Multitask	1			x
27 Needs to be Physically Healthy	1		x	
28 Needs Group of People Working Towards Common Goals	1	x		
29 Need to Spend Time Outdoors	1	x		
Total by Group		15	18	17
Amount Identified		50%	60%	60%

Four Latent needs were identified by PDs in this category, which was one less than NPDs

who identified the majority at five latent needs and PPDs identified four latent needs.

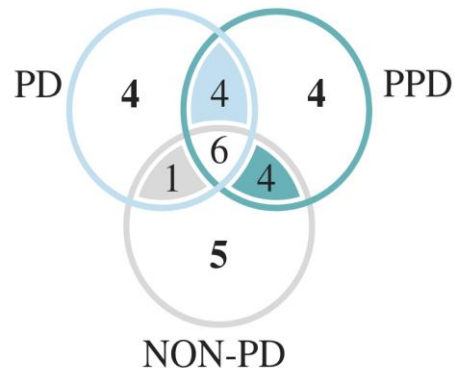


Figure 4.3- Latent Needs for Schoolwork-Life Balance.

3. **Total amount of needs identified by each group-** Table 4.4 shows the number of total needs identified from all three categories. PDs found 50 of the 74 needs collected from all three categories. The other groups only found 42 (PPDs) and 45 (NPDs). The average was 60% of needs over all three groups in which PDs identified 70%.

Table 4.4- Total Amount of Needs Mentioned by Each Group

	All Groups	Total PD	Total PPD	Total NPD
Total Needs	74	50	42	45
Amount Identified	100%	70%	60%	60%

4. **Identify which group produced the highest amount latent needs-** Figure 4.4 helps further illustrate the amount of unique and latent needs that each group produced for each category. PDs identified 50% of all latent needs and 14 in total from all categories. PPDs identified a total of six, while NPDs discovered nine. Note in the figure below that the numbers bolded refers to latent needs discovered

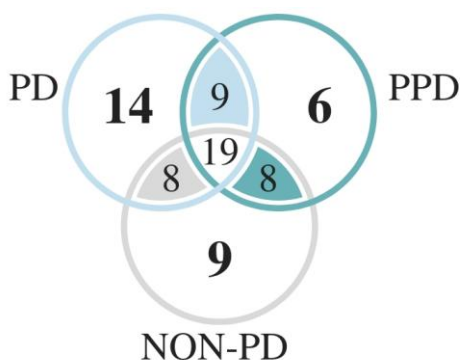


Figure 4.4- Latent Needs Extracted from All Categories

5. **Decipher needs from solutions-** Much like the Master List of Needs created for each category, solutions were organized in a similar table to draw comparisons easily. The following tables represent the potential solutions that were deciphered from needs.

Table 4.5 shows solutions for the Sleep Category. PDs only identified 60% of the solutions, which was less than what NPDs produced at 80% of solutions identified. Out of the 11 solutions identified PDs discovered seven, NPDs identified nine, and PPDs identified zero.

Table 4.5- Solution for the Sleep Category.

Sleep Solutions	PD (n=2)	PPD (n=2)	NPD (n=5)
1 Meditation	x		x
2 Use Diary Before Bed			x
3 Temperature Regulation	x		x
4 Dark Room	x		x
5 White noise	x		x
6 Headphones	x		x
7 Sleep Mask	x		
8 Time for Planning in the Morning			x
9 Stop Drinking Water Before Bed	x		
10 Sleep Aids			x
11 Read Before Bed			x
Total by Group	7	0	9
Amount Identified	60%	0%	80%

PDs only discovered 2 unique solutions for the Sleep category where NPDs produced the most producing four, while PPDs produced zero.

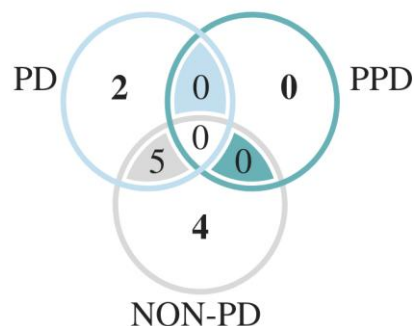


Figure 4.5- Unique Solutions from the Sleep Category.

In the Diet, Category PDs identified 60% of all the solutions, which is the same amount of solutions identified by NPDs. Both PDs and NPDs identified four unique solutions while PPDs identified three. Table 4.7 elaborates on the finding of the Diet Category.

Table 4.6- Solution for Diet Category

Diet Solutions		PD (n=2)	PPD (n=2)	NPD (n=5)
1	Pre-Prepared Meals	x		x
2	Quick Cooking Meals		x	
3	Smoothies	x	x	
4	Buy in Bulk	x		
5	Smaller Food Packages		x	x
6	Light Meals	x		x
7	Easy Recipes For Home			x
Total by Group		4	3	4
Amount Identified		60%	40%	60%

All groups produced the same amount of unique solutions within the Diet Category. Each group only produced one unique solution.

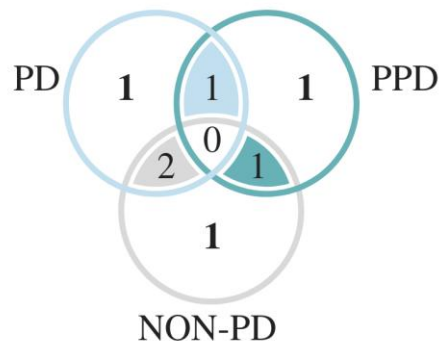


Figure 4.6- Unique Solutions from the Diet Category.

Lastly, all groups produced the same amount of solutions at 60% identified or 7 solutions in total; but PDs produced one additional unique solution. Figure 4.7 shows the solutions derived from the schoolwork-life balance category.

Table 4.7- Solution for Schoolwork-Life Balance Category

SWL Solutions	PD (n=2)	PPD (n=2)	NPD (n=5)
1 Difficult Things First		x	x
2 Daily Routine	x	x	x
3 Set Limits		x	x
4 Dedicated Time from Work	x		x
5 Proper Daily Planning	x		
6 Set Priorities	x	x	x
7 Task Reminders	x	x	
8 Time Estimators for Work	x		x
9 Low Stress Work		x	x
10 Feel Relaxed		x	
11 Morning Workout	x		
Total by Group	7	7	7
Amount Identified	60%	60%	60%

PDs produced the greatest number of unique solutions within this category mentioning two (Figure 4.7). The next highest number of unique solutions produced was the PPDs at one unique solution identified, and NPDs produced zero.

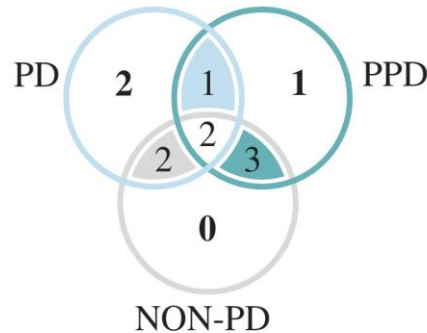


Figure 4.7- Unique Solutions from the Schoolwork-Life Balance Category.

- Identify which group produced the highest amount of unique solutions-** Once again the number bolded refers to unique solutions. From all three categories, PDs tied with NPDs with five unique solutions identified, PPDs produced two. PDs and NPDs both identified 40% of the unique solutions expressed; PPDs generated 20% of the unique solutions.

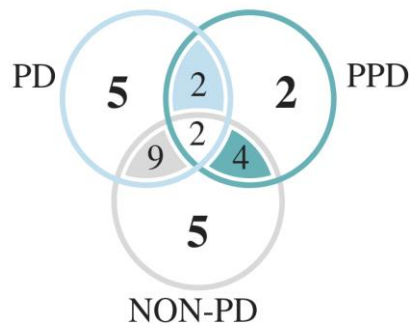


Figure 4.8- Unique Solutions extracted from all categories.

7. **Determine the total amount of solutions mentioned by each group-** Table 4.9 shows the total amount of solutions generated by all groups and each group individually. PDs produced 60% of all solutions identified for all three categories. NPDs produced the most at 70% of solutions identified, and PPDs produced 30%.

Table 4.8- Total amount of Solutions Mentioned by Each Group

	All Groups	Total PD	Total PPD	Total NPD
Total Solutions	29	18	10	20
Amount Identified	100%	60%	30%	70%

8. **Determine the quality of solutions mentioned by each group-** The following tables illustrate the quality of solutions presented by each group. The quality of the solution is based on if it is or is not a behavior and whether the solutions are being implemented or not. After the potential solutions were separated from the needs, the use of the customer interview form along with the recorded interviews gave context to the solution. Participants would mention if they were using the product or behavior to solve their problem. If the solution

was not being implemented the participant would mention having access to the particular solution would be beneficial.

Table 4.9- Quality of Solutions for all Groups

Unique NPD Solutions		Behavior Solution	Other Solution	Implemented	Not Implemented
1	Use Diary Before Bed	x		x	
2	Time for Planning in the Morning	x			x
3	Easy Recipes For Home		x		x
4	Sleep Aids		x	x	
5	Read Before Bed	x		x	
Implementation Rate		60%	40%	60%	40%
Unique PPD Solutions		Behavior Solution	Other Solution	Implemented	Not Implemented
1	Quick Cooking Meals		x		x
2	Feel Relaxed	x			x
Implementation Rate		50%	50%	0%	100%
Unique PD Solutions		Behavior Solution	Other Solution	Implemented	Not Implemented
1	Sleep Mask		x	x	
2	Stop Drinking Water Before Bed	x		x	
3	Buy in Bulk	x		x	
4	Proper Daily Planning	x		x	
5	Morning Workout	x		x	
Implementation Rate		80%	20%	100%	0%

NPDs had an implementation rate of 60%, i.e., the group was implementing three out of the five unique solutions they expressed (Table 4.9). From the unique solutions that PPDs exhibited only one was behavior based and both of the solutions were not being implemented. PDs had an implementation rate of 100% and only one out of the five unique solutions was not behavior based.

Chapter 5: Discussion

Discussion Overview

The purpose of this study was to understand if the PD method could be used as a viable alternative to traditional design methodologies. To determine whether this is a viable option, the following research questions were addressed: ***RQ 1:** Do Positive Deviants generate the majority of overall and latent needs during the Needs Analysis portion of the design process?* ***RQ 2:** Do Positive Deviants generate the majority of the solutions and are they of higher value than solutions of other community members?*

From the data collecting and analyzed during this study, several insights were concluded. The following sections outline the findings from the study and explain the implications.

Positive Deviants generate the majority of overall and latent needs during Needs Analysis.

From the analysis of the data gathered, we can conclude that PDs were, in fact, capable of producing the majority of overall and latent needs. The number of needs identified by each PD was an average of 63 total needs (Figure 3.2) while PPDs only produced 35 total needs on average and NPDs produced 25.8 needs on average.

Within this study, PDs gave a large number of the expressed needs, which is noteworthy because only two PDs were interviewed. From a product development standpoint, this signifies that targeting only PDs (Around 1% of the customer segment) through an interview can produce a substantial portion of the customer segment needs. Only targeting PDs during the needs discovery process could significantly cut down the time it takes to discover useful and meaningful needs, which can be very resource intensive.

PDs were also responsible for producing a large portion of the needs identified during the needs analysis process. This in turn further supports the claim mentioned in the previous

paragraph. After the refinement process, PDs produced a significant portion of the needs identified by the entire group. Overall, PDs discovered the majority (68%) of the needs in all three categories (Table 4.4). The next group with the highest number of discovered needs was the NPDs at 61%. When it came to each category, PDs exhibited the majority of needs in two of the three, 79% in sleep and 77% in the diet category.

In comparison, PPDs discovered 41% in sleep, 62% in diet, and 62% in schoolwork-life. NPD discovered 63% in sleep, 62% for diet, and 59% in schoolwork-life. In the third category, schoolwork-life balance, PDs identified only 51% of the needs where PPDs identified the majority of the needs at 62%. PDs underperforming in this category could be due in part to the fact that PPDs met the PD framework in this particular category closer than the actual PDs. If this is the case, it might have enabled PPDs to express the needs in further detail. Another explanation is that PPDs and NPDs needed solutions for schoolwork-life balance more than another category thus being able to verbalize more needs.

PDs also articulated more latent needs than other groups. PDs finding more latent needs were the expectation of this study, and the results confirm this finding. PDs producing more latent needs stays consistent in every category except for Schoolwork-Life Balance (Table 4.4). The findings show that 29 total latent needs were discovered across all groups; eight in sleep, eight in diet, and thirteen in schoolwork-life balance. PDs exhibited a total of 14 latent needs, PPDs determined 6, and NPDs determined 9. In a similar study utilizing the empathic lead user method to extract latent needs, the result yielded around five to eight needs depending on the various user groups (Vaughan et al., 2014). Based on previous studies and the definition of what a latent need is, the number of latent needs discovered from each category in this study is acceptable.

Overall, PDs produced the majority of the unique and latent needs. Schoolwork-Life Balance was the only category where they did not outperform their peers (Table 4.3), but there was not a drastic difference. There are two major reasons as to why this result occurred. The first is that both PDs did not meet the PD framework 100%. Although both PDs were in the range to be considered a PD the small portion that they did not meet could have affected this category in particular. Other groups such as NPDs and PPDs may have fit the PD framework more closely in this particular category as mentioned above.

The second explanation is that PDs may have felt they have solved this particular problem, thus not feeling compelled to articulate needs. The other two groups may have been experiencing issues with schoolwork-life balance at that the time of the interview. Thus, the amount of not only latent needs, but general needs as well was easier to express. NPDs may have been more desperate for solutions, thus requiring them to think outside the box and seeing the problem as a novel experience may have guided them to express more latent needs. The difference in perspective is also echoed with PDs and PPDs as well. PDs may have had a different perspective and may have been more solution-oriented seeing that they have already solved the problem. Because of this PDs may not have seen the urgency in verbalizing as many latent needs. In contrast within the sleep and diet categories, PDs may have outperformed their peers because they had more experience with solving issues within these two categories. Both PDs explicitly stated how vital having a positive environment was and recollected experiences where their environments both negatively affected there diet and sleep. The PDs did not specify the same issue within the schoolwork-life balance category.

When it comes to general observations the first general observation made is that transportation was not as big of a limitation to diet for the PD population as first theorized, but it

was a challenge nonetheless. PDs were able to frequently visit the grocery store, although they mentioned that they needed to plan because public transit could be limited depending on the time of day. Planning was something that other individuals did not face, although some PPDs and NPDs mentioned keeping a grocery list. Having to plan could have attributed to their PD success because traveling to get groceries not only required foresight it required logistical planning which may have played an essential role in achieving a healthy schoolwork-life balance. It is also worth mentioning that one of the PD behaviors solved one of the latent needs address by NPD. One NPD mentioned that they needed the ability to study on their way to school while the PD identified a way of achieving this. One particular PD who used public transit was able to utilize the time to study for classes while waiting to reach their destination. Accessibility to quick, healthy food around campus seemed to be a more significant concern for the community. The need for a supportive environment was something PDs would later go on to address.

When it came to restful sleep having a form of obligation in the morning was found to be critical for all members of the community. A meaningful routine played a critical role in achieving this step. PDs, PPDs, and NPDs all commented on the importance of having a peaceful environment when getting a restful night sleep. The assumption was that school would play a significant role in effecting ones sleep pattern, which it did. Achieving restful sleep was only alleviated by having a healthy schoolwork-life balance in which the individual did not feel overburden and could achieve peace of mind successfully at the end of the day before bed. Seeing that most of the initial assumptions made did not come to fruition, the importance of doing a customer needs analysis is critical when trying to develop solutions and products.

Positive Deviants did not generate the majority of solutions but were of higher value than solutions of other community members.

The assumption behind this study was that PDs would produce the majority of the solutions discovered. This is because, as outlined in the literature review, PDs succeed against all odds and discover new ways of solving problems without any additional resources, usually by exhibiting unusual behaviors (Marsh et al., 2004). It can be concluded, because of their success at overcoming particular problems, PDs understand problems in greater detail. A fuller understanding of the problem could lead to their ability to identify latent needs and develop solutions is higher. The ability to produce solutions that can easily be expressed gives a product development teams a head start when developing novel products.

As shown in Table 4.8, PDs produced the second highest number of solutions (62%) while NPDs produced the highest (68%) and PPDs the lowest (34%). Therefore, in this study, PDs did not generate the most solutions. NPDs also produced the highest number of unique solutions within each category, but only one more than the PDs produced overall. Seeing that PDs did not produce the majority of unique solution partially invalidated our initial hypotheses. The conclusion that can be drawn here is that NPDs produced the majority of the solutions, but when taking into consideration that five members produced these solutions, whereas there were only two PDs who were able to match the output of NPDs nearly, the trade-off of relying on solutions PDs produce may be worthwhile in the innovation and design process. One explanation for NPD out performing PDs may be that NPDs were so overwhelmed with all aspects of the problem they had a solution mindset and articulated their feelings accordingly. When talking to students that meet the NPD framework, a majority of them seemed stressed and were not particularly focused on fixing the underlining problem or expressing needs but were concerned with how they were going to finish their school work by the end of the day.

In addition to the number of solutions generated, there is value in understanding the quality of solutions that each group produced. Although PDs did not produce the majority of solutions, the ones they did identify were of higher quality than the other group's solutions. In this study, higher quality refers to whether the solutions are already developed and implemented or not. Another determining factor of quality is if the solution is behavior based or resource intensive. The majority of solutions that the PDs identified were behavior based and did not require additional resources. For example, within the Schoolwork-Life Balance category, PDs produced a behavioral solution to the need for time management an issue that affected all three groups. The solution from PDs was “Proper Daily Planning” versus another solution, which was “Task Reminders” which is more resource intensive and came from NPDs. These sorts of solutions are characteristic of PDs in the literature (Singhal et al., 2009). In contrast, solutions that were uncovered by NPDs, in most cases, required access to additional resources, such as sleep aids or time management tools.

Another example of the difference in the quality of solutions was that the majority of solutions produced by NPDs and PPDs were mostly solutions they would like to see implemented into a design as opposed to solutions they were already implementing. Having this information is useful, but what may make a more significant impact is having solutions that are already being experimented with and implemented. The solutions that PDs provided were solutions they had already implement within their lives, whereas the solutions from other groups were merely suggestions.

A meaningful routine was necessary for achieving a healthy schoolwork-life balance. Routine was first identified and expressed by a PPD and later confirmed by both PDs. NPDs were not able to fully articulate this solution, although they unknowingly describe it when asked

to recall a time when they were achieving a healthy schoolwork-life balance. The fact that PPDs mentioned the solution of a routine was not surprising seeing that they had very similar characteristics to the PDs. Since PPDs were able to articulate this solution in greater detail could have been the reason why they outperformed PDs in this category when expressing needs. Although, this might have been the case PDs were able to provide further insight as to what the cause of the problem is. PDs mentioned that routine is essential but also addressed that not having a proper environment or community support efforts to maintain a routine become increasingly difficult.

The overall environment seemed to play a critical role in all three categories. The environment was confirmed in the focus group along with other challenges that students face when living a healthy lifestyle. Once again PDs were able to confirm this challenge and made attempts to solve these issues, typically by making minor adjustments to their living habits. Identifying PPDs also proved to be worthwhile because they gave insightful solutions as well but they were not fully articulated as the PDs. NPDs could produce solutions, but they were not being implemented either because they were not familiar with the problem or they were currently facing healthy lifestyle challenges as of the interview. Seeing that this was a complex problem and most of the solutions were interconnected it seems that all members were at various phases of achieving meaningful solutions. Being at different phases brings up the question of whether one's PD status could change over time and if PD status could be seen on a continuum.

Study Limitations

While the findings of this study support the original hypotheses, there are a few limitations that are worth identifying. One limitation is the number of participants in the initial focus group. Only four students participated in the focus group. As a result, a full and diverse

representation of the university was not met. However, this does not seem to have been a significant limitation in the study as all the issues addressed in the focus group were later confirmed within each interview. Understanding if the PD method could be used in practice was one of the goals of this study in which the results validated this assumption. In retrospect the amount of focus group participants was not a major impact seeing that favorable results were still collected.

Another limitation was the PDs interviewed did not entirely fit the PD criteria defined in the initial survey. PD01 met 90.60% of the PD criteria, and PD02 met 94% of the PD criteria. There were a few others that met the criteria more closely but did not consent to participate in follow-up interviews.

Additional limitations to the study were that only one researcher facilitated the data collection and analysis. Although multiple passes through the data (i.e. needs refinement process) were conducted, it did not allow for multiple perspectives on what each need or solution meant. Interpreting the data in this manner may have led to some bias decisions made by the independent researcher. Not having additional researchers analyze the data fall short of having inter-rater reliability for this study. Lastly seeing that PD steps 4-6 were not conducted, the full efficacy of the proposed solutions may still be in question.

Implications of Findings

When it comes to design, the PD method may prove to be a viable alternative to the traditional product development process. Given that the goal of design, and customer needs analysis specifically, is understanding customer problems and develop a novel product, introducing PDs into the process could help reduce the time it takes to innovate since PDs are capable of producing a large number of direct and latent needs with fewer interviews. Therefore,

relying on PDs may be useful because it can help cut down time spent in identifying high-quality needs and solutions.

Using the PD process will also allow community members, or in the case of product development a customer segment, to have a role in helping designers identify which issues or problems they should focus on and appropriate methods for addressing them. Allowing the community to decide allows for more autonomy for the community during the design process and could yield higher adoption rates and lead to more frequent innovations. The higher adoption rate would be to the fact that the solutions developed from this method are exactly what each community member is seeking. Design teams could utilize this method to develop excellent solutions that will positively impact those who are affected.

Implementing product design techniques into the field of PD also has beneficial implications. From the research, identifying needs helps bring a systematic method to better understand the community members and how they are solving the problems. A needs analysis method can help improve PD Step 3 (Determine) by taking solutions or needs from members that are not PDs which may sometimes be overlooked by PD practitioners. By identifying latent needs for not only PDs but also the community as a whole it may lead to quicker implementation rates within PD Step 5 (Disseminate) seeing that a holistic view of the community members is taken into consideration.

Future Work

Since this research is still in its infancy, a few more experiments will be needed to confirm the PD methods viability. For one, understanding how capable PDs are when it comes to developing novel solutions compared to other community members. Therefore, one area of future work for this research would be to conduct steps four through six of the PD process based

on the needs generated from this experiment. Steps four through six will allow us to explore PD's product design acumen and how well these products are adopted throughout the community, versus other solutions developed from outside the community. Another approach would be to allow the PDs to develop solutions and compare them to traditional design teams to see which group produces more innovative designs overall.

Chapter 6: Conclusion

This study sought to show that Positive Deviants are able to produce more latent needs than typical, non-PD, and users in their community during the needs analysis process. Overall, PDs identified the majority of over all needs (70%) discovered by the entire group. Drawing on this conclusion, we see that even though PDs make up a small minority of the community, they are capable of producing a large number of general and latent needs. The benefit in discovering PDs is potentially high seeing that only two members were required to exhibit so many insightful needs. Using only a few individuals can imply that the PD method has value when trying to understand a problem that the community faces. Design teams can benefit from utilizing this method by placing more emphasis on identifying outliers. PDs will allow the design team to focus on what is working with regards to limitations thus fueling innovation efforts.

The second finding of the study shows that, although PDs were not able to produce more solutions than the other groups, the solutions they did produced were of higher quality. As mentioned in the discussion, PDs gave more low-resource intensive behavior-based solutions whereas most of the solutions produced by NPDs required additional resources. Also, the solutions that were being expressed by the PDs were solutions that they had already implemented within their lifestyles. When trying to solve complex problems, understanding the solutions in existence could help a design team avoid over-engineering solutions and keep the solutions simplistic and accessible to all members of the community.

Lastly, we found that PDs do share similar qualities to other innovative users such as lead users. Their likelihood was confirmed by their ability to produce latent needs and solutions to the problem they were facing. There are minor differences when it comes to comparing both PDs and LUs. To gain a richer understanding of these differences and to confirm this question, more

research is needed. This research does lay the foundation for further study on the similarities and differences between PDs and LUs.

Overall, the findings of this study are significant to the field of both Product Development and Positive Deviance. The PD method can yield significant results when it comes to driving innovation and creative solutions. Design teams could utilize this method to cut down on time it takes to uncover unique or latent needs. Also, if used correctly, PDs could aid in the design efforts by making the products produced more encompassing and easily accessible by those the design is targeting. In the field of Positive Deviance, use of the traditional needs analysis method could help the PDs identify more unique needs and help them gain perspective to aid in the development of innovative products and services, as well as social solutions for the community at large.

Appendix A

AGENDA

Focus Group

Application of Positive Deviance within the field of Product Design

University of Texas at El Paso June 2018

1. Welcome – Cesar Venegas, Researcher at the University of Texas at El Paso (Systems Engineering) *5 mins*
2. Introduction of Meeting and Signing of Consent Script (verbal explanation) *10-15 mins*
3. Introduction of Participants – Please introduce yourselves (pseudonyms), your major, and briefly share some of your interests. *5-10 mins*
 - a. Speed Networking- Get the entire group to walk around for 10-15 seconds making eye contact. Stop with person you see introduce yourself. (30 secs each person) 3 Rounds
 - b. Regroup- Share a few stories from group.
4. Brief introduction of Positive Deviance and how it work. Give Brief Presentation *10 mins.*
5. Introduce the topic of the focus group: *Problems students face when it comes to maintain a healthy lifestyle. 20 mins*
 - a. Define what a healthy lifestyle is using the 1-2-4 method.
 - b. Reflect on what a healthy lifestyle means to you. (Use sticky notes to record) 1-2 mins
 - c. In groups discuss what a healthy lifestyle means (Have the other person talk for the other person). 2 mins per person
 - d. In groups of 4 agree what a healthy lifestyle is in each group 2 mins per person (10 mins)- use post it's to organize
 - e. Have all groups come post most important or key concepts on the board and define what a healthy lifestyle is.
6. Please share some of your primary, or major challenges when it comes to eating healthy and losing weight? Break off into groups of 5 and have a post-it for every question *50 mins*

7. Positive Deviance problem statement workshop.
 - a. Have members of the focus group help develop the PD problem statement.
 - b. Open up focus group for discussion of the problem statement.
 - c. Have all participants agree on finalized PD problem statement.
8. Thank you for taking the time to participate in this important process!
 - a. Would you like to participate in One-on-One interviews?
 - b. Do you know anyone who fits the PD criteria? Can you refer us to them?
8. Conclusion of Focus group. Any additional question, comments, or concerns are permitted at this time

Appendix B

Discussion and Action Dialog Questions

1. What are some of the challenges or barriers you've faces while maintaining a healthy lifestyle?
2. Have you ever live a healthy lifestyle? What caused you to fail?
3. What were some of the normal behaviors you believe attributed to your success? What were some of the uncommon behaviors?
4. What would you consider additional resources that aided to maintaining a healthy lifestyle? Do you have access to these resources?
5. Do you know other people who have had unexpectedly good outcomes? Who and Why?

Appendix C

1. How many hours of sleep do you get per night on average during the school year?

- ☐ 6 hours or less
- ☐ 6-8 hours
- ☐ More than 8

2. How many meals on average do you eat per day during the school year?

- ☐ Less than 1
- ☐ 1-3 meals
- ☐ More than 3

3. How many hours a day do you spend on school-related work (i.e. studying, homework, group assignments, tutoring, class, etc.)?

- ☐ 5 hours or less
- ☐ 6-7 hours
- ☐ More than 7 hours

4. Which of these do you receive at least one serving of at each meal? (Choose all that apply)

- ☐ Fruits
- ☐ Vegetables
- ☐ Carbs
- ☐ Protein

5. How many course credit hours during the semester do you usually take?

6. What is your primary mode of transportation?

- ☐ Own Vehicle
- ☐ Parents or Friends
- ☐ Public Transit
- ☐ Other

6.1 Please provide your primary mode of transportation (i.e. walking, bike riding, Uber etc.).

6.2. How far do you live from the nearest bus stop?

- ☐ Less than 1 mile
- ☐ Roughly 1 mile
- ☐ More than 1 mile

7. Have you recently experienced any of the following life-changing events recently?

- ☐ Graduated High School
- ☐ Started a new job
- ☐ Started Graduate School
- ☐ Other
- ☐ None of the above

7.1. Please explain what event you have experienced.

Appendix D

Application of Positive Deviance within the field of Product Design. (Needs Analysis interview)

1. Can you please give me a brief description of your history with health and wellness in regards to sleep, eating, and work-life balance?
 - a. What does it look like to maintain a healthy lifestyle?
 - b. How important is maintaining a healthy lifestyle to you?
2. Can you tell me a story of a time when you were achieving or not achieving a restful night sleep, eating a well-balanced meal, and maintaining a work-life schedule?
 - a. What were you doing differently?
 - b. What did you need to make it work?
 - c. Why did you stop?
 - d. Did you use any products to aid you?
3. What do you find the most challenging about achieving a restful night sleep, eating a well-balanced meal, and maintaining a work-life schedule?
 - a. Why?
4. How has the limited transportation affected your ability to achieve a restful night sleep, eating a well-balanced meal, and maintaining a work-life schedule?
5. How many times a week do you go grocery shopping?
 - a. How do you get there?
 - b. What are some of the things that prevent you from going?
 - c. How have you been able to solve this?
6. How often do you eat 1-3 meals a day?
 - a. What are some of the frustration you find when you try to eat a well-balanced meal?
 - b. What are some of the solutions you've used in the past to eat 1-3 meals?
7. How many time a week do you get 6 or more hours of sleep?
 - a. How do you achieve this sleep?
 - b. What are some of the things preventing you from getting sleep?
 - c. What are some of the solutions you've used?
8. How has taking on more responsibility affect your ability to achieving a restful night sleep, eating a well-balanced meal, and maintaining a work-life schedule?
 - a. Why?
 - b. How have you been able to overcome these challenges?

9. How does school affect your ability to sleep or eat a well-balanced diet?
 - a. How many hours do you take? What year are you in college?
 - b. Are there any unusual habits that you've used in the past? What are some of your time management solutions?
 - c. Do you remember a time where you had a good work-life balance? What were you doing?
10. Any other thoughts you'd like to share about maintaining a healthy lifestyle?

Appendix E

Customer Interview Sheet

Project Name				
Participant Data				
Participant ID		Interviewer		
Willing to follow up?		Date		
Location				
Type of User (their words)				
Question/ Prompt	Customer Statement	Interpreted Need	Weight	Activity

Bibliography

- Anderson, A. M. (2017). *Product development and management: Body of knowledge*. Chicago, IL: PDMA.
- Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., ... & Martin, J. L. (2015). Recommended amount of sleep for a healthy adult: a joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. *Journal of Clinical Sleep Medicine*, 11(06), 591-592.
- Blank, S., & Dorf, B. (2012). *The startup owner's manual: The step-by-step guide for building a great company*. BookBaby.
- Bobel, I. (2012). Jugaad: A New Innovation Mindset. *Journal of Business and Financial Affairs*, 1(4).
- Brown, T. (2009). Change by design.
- Brown, T., & Wyatt, J. (2010). Design Thinking for social innovation. *Development Outreach*, 12(1), 29-43.
- Camillus, J. C. (2008). Strategy as a wicked problem. *Harvard business review*, 86(5), 98.
- Drum, D. J., Brownson, C., Burton Denmark, A., & Smith, S. E. (2009). New data on the nature of suicidal crises in college students: Shifting the paradigm. *Professional Psychology: Research and Practice*, 40(3), 213.
- Dura, L., & Singhal, A. (2009). Utilizing a positive deviance approach to reduce girls' trafficking in Indonesia: asset-based communicative acts that make a difference. *Journal of Creative Communications*, 4(1), 1-17.
- Gardner, D. P., Larsen, Y. W., Baker, W., Campbell, A., & Crosby, E. A. (1983). *A nation at risk: The imperative for educational reform* (p. 65). United States Department of Education.
- Gasson, S. (2003). Human-centered vs. user-centered approaches to information system design. *Journal of Information Technology Theory and Application (JITTA)*, 5(2), 5.
- Giacomin, J. (2014). What is human centred design?. *The Design Journal*, 17(4), 606-623.
- Greenhouse, E. S. (2012). Human-centered design. Retrieved from *Livable New York*: <http://www.aging.ny.gov/LivableNY/ResourceManual/DemographicAndSocialTrendsI>, 9.
- Griffin, A., & Hauser, J. R. (1993). The voice of the customer. *Marketing science*, 12(1), 1-27.

- Hanski, J., Reunanen, M., Kunttu, S., Karppi, E., Lintala, M., & Nieminen, H. (2014). Customer observation as a source of latent customer needs and radical new ideas for product-service systems. In *Engineering Asset Management 2011* (pp. 395-407). Springer, London.
- Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). Describing the creative design process by the integration of engineering design and cognitive psychology literature. *Design studies*, 29(2), 160-180.
- IDEO, D. K. (2015). The field guide to human-centered design.
- Jackson, E. K., Seifert, D., Dahlweid, M., Santen, T., Bjørner, N., & Schulte, W. (2009, July). Specifying and composing non-functional requirements in model-based development. In *International Conference on Software Composition* (pp. 72-89). Springer, Berlin, Heidelberg.
- Johnson, D. (2001). What is innovation and entrepreneurship? Lessons for larger organisations. *Industrial and commercial training*, 33(4), 135-140.
- Lin, J., & Seepersad, C. C. (2007, January). Empathic lead users: the effects of extraordinary user experiences on customer needs analysis and product redesign. In *ASME 2007 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. 289-296). American Society of Mechanical Engineers.
- Lodha, A. (2016). Agile: Open Innovation to Revolutionize Pharmaceutical Strategy. *Imperial Journal of Interdisciplinary Research*, 2(12).
- Marsh, D. R., Schroeder, D. G., Dearden, K. A., Sternin, J., & Sternin, M. (2004). The power of positive deviance. *Bmj*, 329(7475), 1177-1179.
- McCandless, Keith, and Henri Lipmanowicz. "Liberating Structures - 1. 1-2-4-All." *Principles*, 28 June 2018, www.liberatingstructures.com/1-1-2-4-all/.
- McCandless, K., & Lipmanowicz, H. (n.d.). Liberating Structures - 10. Discovery & Action Dialogue (DAD). Retrieved June 23, 2018, from <http://www.liberatingstructures.com/10-discovery-action-dialogue/>.
- Mihalopoulos, N. L., Auinger, P., & Klein, J. D. (2008). The Freshman 15: is it real?. *Journal of American College Health*, 56(5), 531-534.
- Muto, J. (2014, October 28). Innovation – the Lead User Way. Retrieved October 3, 2018, from <http://www.highstartgroup.com/innovation-lead-user-way/>
- Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Constellation.
- Pascale, R. T., & Sternin, J. (2005). Your company's secret change agents. *harvard business review*, 83(5), 72-81.

- Patnaik, D., & Becker, R. (1999). Needfinding: the why and how of uncovering people's needs. *Design Management Review*, 10(2), 37-43.
- Pynnönen, M., Ritala, P., & Hallikas, J. (2011). The new meaning of customer value: a systemic perspective. *Journal of Business Strategy*, 32(1), 51-57.
- Radjou, N. (2012). *Jugaad Innovation: A frugal and flexible approach to innovation for the 21st century*. Random House India.
- Raviselvam, S., Noonan, M., & Hölttä-Otto, K. (2014). Using elderly as lead users for universal engineering design. *Universal Design*, 366-375.
- Rebovich, G., DeRosa, J. K., & Norman, D. O. (2009, March). Improving the practice of systems engineering: Bootstrapping grassroots success. In *Systems Conference, 2009 3rd Annual IEEE* (pp. 323-326). IEEE.
- Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. Crown Books.
- Sanders, E. B. N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, 4(1), 5-18.
- Savio, C. (2014, October 28). Innovation – the Lead User Way. Retrieved November 28, 2018, from <http://www.highstartgroup.com/innovation-lead-user-way/>
- Saxena, A., & Upadhyay, P. (2016). Waterfall vs. prototype: Comparative study of sdlc. *Imperial Journal of Interdisciplinary Research*, 2(6).
- Senge, P. (1990). The fifth discipline: The art and science of the learning organization. *New York: Currency Doubleday*.
- Singhal, A., & Dura, L. (2009). *Protecting Children from Exploitation and Trafficking: Using Positive Deviance Approach in Uganda and Indonesia*. Save the Children in collaboration with Social Justice Initiative.
- Singhal, A. (2013). Positive deviance and social change.
- Slater, S. F., & Narver, J. C. (1998). Customer- led and market- oriented: let's not confuse the two. *Strategic management journal*, 19(10), 1001-1006.
- Steen, M., Manschot, M., & De Koning, N. (2011). Benefits of co-design in service design projects. *International Journal of Design*, 5(2).
- USDA. (n.d.). Choose MyPlate. Retrieved November 24, 2018, from <https://www.choosemyplate.gov/>

Vaughan, M. R., Seepersad, C. C., & Crawford, R. H. (2014, August). Creation of empathic lead users from non-users via simulated lead user experiences. In *ASME 2014 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. V007T07A048-V007T07A048). American Society of Mechanical Engineers.

Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management science*, 32(7), 791-805.

Von Hippel, Eric, Stefan Thomke, and Mary Sonnack. "Creating breakthroughs at 3M." *Harvard business review* 77 (1999): 47-57.

Wood, K. L., & Otto, K. N. (1999). *Product design*. Upper Saddle River, NJ: Prentice Hall.

Zeitlin, M. (1991). Nutritional resilience in a hostile environment: positive deviance in child nutrition. *Nutrition Reviews*, 49(9), 259-268.

Curriculum Vita

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