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The Effectiveness Of An Online, Interactive, College Course In Energy Balance, Designed From A Framework Of Behavioral Theories

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THE EFFECTIVENESS OF AN ONLINE, INTERACTIVE, COLLEGE COURSE IN
ENERGY BALANCE, DESIGNED FROM A FRAMEWORK OF BEHAVIORAL
THEORIES

A Dissertation Presented

by

Simonne Eisenhardt

to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements
of the Degree of Doctor of Philosophy
Specializing in Animal, Nutrition, and Food Sciences

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Accepted by the Faculty of the Graduate College, The University of Vermont, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, specializing in Animal, Nutrition, and Food Sciences.

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ABSTRACT

During late adolescence and the transition to college, students often experience weight increases and significant lifestyle changes including the adoption of unhealthy eating habits and decreased physical activity levels. To address this concern, a science-based, interactive course, designed from a framework of behavioral theories was developed to target improvements in energy balance knowledge and determinants of dietary and physical activity behaviors. The objective of this study was to assess the effectiveness of this course using a comparison group pre-test/post-test design. Thirty-three undergraduate students, ages 18-25, participated in the course, while twenty-six students served as controls. Paired samples t-tests compared pre- to post- responses to knowledge assessments and self-perception surveys. Independent samples t-tests compared mean changes between the intervention and control group. Course evaluations were reviewed to determine to what degree behavioral strategies were perceived to influence student motivation to eat a healthy diet and engage in the recommended amount of physical activity. Significant increases were observed in energy balance knowledge (P < .001) and perceived behavioral control (P = .004) towards eating a healthy diet in the intervention group when compared to the control group. Diet and physical activity recalls and analyses were perceived by students to have the greatest influence on their motivation/ability to engage in the targeted behaviors. We conclude that an online, interactive, science-based energy balance course developed from behavioral theories can be effective at improving energy balance knowledge and dietary perceived behavioral control in a college population.
Material from this dissertation has been submitted for publication to Health Education & Behavior on August 18, 2014 in the following form:

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To The Greater Power that has blessed me with the skills, knowledge, strength, and perseverance to accomplish this goal - thank you! I have been blessed.

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CHAPTER 1: COMPREHENSIVE LITERATURE REVIEW

OVERWEIGHT AND OBESITY TRENDS

Over the past 20 years the prevalence of overweight and obesity in the United States has risen dramatically. Currently, it is estimated that more than two-thirds of American adults are overweight and approximately one-third are obese (Flegal, Carroll, Ogden, & Curtin, 2010). Although the rate of increase in adult obesity appears to be leveling, the magnitude of the problem has remained with nearly 80 million Americans over the age of 20 categorized as obese (Ogden, Carroll, Kit, & Flegal, 2012). The prevalence of overweight and obesity has also increased significantly in adolescence, one of three stages of development at greatest risk of obesity (Dietz, 1994). Currently, more than one-third of children and adolescents ages 12-19 have high BMIs ($\geq 85^{th}$ percentile for age), while more than one-sixth have very high BMIs ($\geq 95^{th}$ percentile for age) (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). This increase in prevalence of high BMIs in adolescence is of major concern as high BMIs in adolescence increases the risk of overweight or obesity in adulthood (Engeland, Bjørge, Tverdal, & Søgaard, 2004; Guo, Wu, Chumlea, & Roche, 2002).

Obesity in adolescents and adults is associated with an increased risk of psychosocial issues and adverse health conditions. Weight-related negative stereotyping during adolescence can result in lower levels of self-esteem and peer rejection (Puhl & Brownell, 2001). These weight-related psychosocial issues are shown to track into adulthood, evidenced in weight-related biases in college acceptance, prejudices in
funding opportunities, and possible discrimination through a lack of physical accommodations in public settings.

Adolescent obesity is also associated with an increased risk of diabetes and risk factors associated with cardiovascular disease including hypertension and elevated blood cholesterol levels. Some of these adverse health conditions originating in adolescence are thought to form the foundations for illness later in adulthood (Dietz, 1998). Adult obesity is associated with an increased risk of many adverse health conditions including cardiovascular disease, hypertension, diabetes, kidney disease, and obesity-related forms of cancer. Further, the risk of developing some chronic health conditions for individuals with higher levels of obesity is as much as 20 times higher when compared to adults of normal weight (Wyatt, Winters, & Dubbert, 2006).

The increased prevalence of obesity in adults has also resulted in an increase in healthcare costs and reduced economic productivity. Medical expenditures for obese employees are found to be significantly higher than their normal weight counterparts (Finkelstein, DiBonaventura, Burgess, & Hale, 2010). In the U.S. alone, an estimated $147 billion dollars is spent each year on obesity-related healthcare (J. Levi, Segal, & Salay, 2012). The increased prevalence of obesity has also affected the economic productivity of the American workforce. Currently, an estimated 73 billion dollars in overall economic productivity is lost to obesity-related illnesses, absenteeism, and reduced work productivity (Finkelstein et al., 2010).

Finally, obesity is associated with a decreased life expectancy and obesity-related excess mortality. In a review of the National Health and Nutrition Examination Survey
(NHANES) 1971-2002 and US vital statistics data, obesity was found to significantly increase mortality from cardiovascular disease and obesity-related cancers (Flegal, Graubard, Williamson, & Gail, 2007). Some have estimated adverse health conditions associated with obesity to decrease life expectancy by as much as a 6-7 years (Peeters et al., 2003). For some of these adverse health conditions, the risk of mortality is increased with excess weight in adolescence, independent of adult weight (Must, Jacques, Dallai, Bajema, & Dietz, 1992). Reducing the risk of weight gain and obesity in adolescence through effective interventions would therefore reduce the risk of obesity-related adverse health conditions in adolescents and consequently in adults. Moreover, a reduction in the prevalence of obesity in adults would reduce the risk of premature deaths, increase work productivity, and ease the escalating healthcare costs associated with adult and adolescent obesity.

LATE ADOLESCENCE AND THE TRANSITION TO COLLEGE

In late adolescents, many young Americans experience significant lifestyle changes as they transition from a life of dependence to one of increased autonomy and independence (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). In 2012 alone, an estimated 66.2% of all high school graduates experienced this lifestyle change during the transition from high school to college (U.S. Bureau of Labor and Statistics, 2013). This transition is characterized by changes in social roles, habits, and responsibilities that can result in the adoption of unhealthy behaviors (Nelson et al., 2008). From a life course perspective, this period of transition may serve as a critical point for significant
changes in roles, responsibilities and behaviors, particularly if unanticipated (Wethington, 2005). The challenge of adopting healthy behaviors during this transition may be difficult for some students, as they often lack the strategies necessary to guide healthy lifestyle choices (Cluskey & Grobe, 2009).

Unhealthy lifestyle choices during the transition from high school to college can include the adoption of unhealthy eating habits and/or decreased physical activity levels. For some students, a decrease in energy expenditure relative to energy intake can result in a positive energy balance and weight gain (Wengreen & Moncur, 2009). In a recent meta-analysis of 3,401 students, researchers observed an average weight gain of 3.86 lbs during the freshman year (9 months) of college (Vella-Zarb & Elgar, 2009). Although this weight increase may seem small, it is more than 5 times the national average for adults over the same period of time (D. Levitsky, Halbmaier, & Mrdjenovic, 2004). In some studies, researchers observed a gradual increase in weight throughout the freshman year (Vella-Zarb & Elgar, 2009), while others observed more significant increases during the first semester (Anderson, Shapiro, & Lundgren, 2003). Students with higher than normal BMIs, at the onset of this transition, were found to be at greater risk of weight gain when compared to students with normal BMIs (Kasparek, Corwin, Valois, Sargent, & Morris, 2008). Students who are motivated to lose weight could find weight loss difficult, however, as they often do not adhere to current weight loss recommendations promoting modifications to both diet and physical activity behaviors (Lowry et al., 2000). Preventing this anticipated weight gain with effective health interventions that promote
healthy energy balance behaviors may support healthy weight maintenance during this high-risk period of transition in late adolescence.

Many college students, as a result of unhealthy eating habits, do not meet current nutrient intake recommendations. In a national survey of 129 postsecondary schools, 64% of students reported consuming less than 3 total servings of fruit and vegetables per day (American College Health Association, 2011). Approximately 5% reported consuming 0 servings of fruits and vegetables per day. For some students, a low level of fruit and vegetable consumption observed in the freshman year continued into the sophomore year with no discernible improvements in motivation to adopt healthier behaviors (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). For other students, the level of fruit and vegetable consumption observed in the freshman year was similar to the levels of consumption observed in their senior year (Racette, Deusinger, Strube, Highstein, & Deusinger, 2008), suggesting that dietary habits established in the freshman year tend to persisted throughout the college years. Although a decrease in fruit and vegetable consumption was not found to be associated with weight increases in some studies (Kasparek et al., 2008), fruits and vegetables are good sources of many vitamins and minerals that are essential for good health and the reduced risk of some chronic diseases (Harding et al., 2008; Hung et al., 2004). Moreover, consuming a healthy diet containing essential nutrients can also support optimal cognitive functioning, learning, and behavior by preventing nutrient deficiencies (Dani, Burrill, & Demmig-Adams, 2005). Encouraging the consumption of fruits and vegetables and promoting
nutrient-dense foods would reduce the risk of nutrient deficiencies and promote healthy dietary habits throughout the college years.

For many students, the transition from high school to college can also result in a decrease in physical activity levels. This decrease is often more precipitous in males than females, partly due to a higher level of physical activity in males during the high school years (Kwan, Cairney, Faulkner, & Pullenayegum, 2012). In a national survey of 129 postsecondary schools, 23% of all students reported engaging in less than 30 minutes of moderate exercise per week (American College Health Association, 2011). For men, this decrease in physical activity levels tends to continue to decline throughout the college years and into young adulthood (Kwan et al., 2012). For some females, a decrease in energy expenditure during this transition period was associated with a positive energy balance and weight gain (Jung, Bray, & Martin Ginis, 2008). The risk of weight gain was shown to be decreased for students engaging in physical activity, particularly for those who exercised more frequently, independent of intensity (Kasparek et al., 2008).

Motivating college students to engage in physical activity most days of the week, even at lower intensities, would promote healthier lifestyles throughout the college years and energy balance for the prevention of weight gain.

Energy imbalances resulting from reduced physical activity and consuming an unhealthy diet may also lead to body fatness; another concern in college populations. In a longitudinal study, researchers found that nearly 75% of female and 28% of male college students did not meet recommendations for body fat percentages, while approximately 25% of female and 3% of male college students did not meet fitness
recommendations (Sacheck, Kuder, & Economos, 2010). Although higher percentages of body fat and lower fitness levels affected male and female students differently, both were found to be associated with the increased risk of metabolic risk factors. To reduce the levels of body fatness, students could engage in physical activity. Regular physical activity is shown to reduce the risk of many chronic diseases such as cardiovascular disease, type II diabetes, osteoporosis, and some forms of cancer as well as reduce body fat percentages (Warburton, Nicol, & Bredin, 2006).

Overweight and obesity during the college years can also increase the risk of chronic disease. In a recent study on a predominately white northeastern campus, researchers observed elevated blood pressures in approximately 60% of male and 20% of female students (Morrell, Lofgren, Burke, & Reilly, 2012). In addition, nearly 10% of male and 3% of female students met the criteria for metabolic syndrome; a group of risk factors associated with obesity and the increased risk of diabetes (Lorenzo, Okoloise, Williams, Sterrn, & Haffner, 2003). Risk factors for metabolic syndrome include increased central adiposity and dyslipidemia. It also includes elevated blood pressure, fasting blood glucose levels, and insulin levels. In this study, the prevalence of one or more criterions for metabolic syndrome was significantly higher in overweight or obese students when compared to normal weight students (Morrell et al., 2012).

Encouraging the consumption of nutrient-dense food items and increasing physical activity behaviors among college students would therefore support lower adiposity and the reduced risk of adverse health conditions. Further, improving diet and physical activity behaviors would promote energy balance and may result in weight
maintenance throughout the college years. Effectively promoting behavioral change in these energy balance variables is paramount. To achieve this though, it is important to first understand the perceived motivators and risk factors for these behaviors in a college population.

**BEHAVIORAL AND ENVIRONMENTAL RISK FACTORS**

Many behavioral and environmental risk factors are thought to influence the dietary habits, physical activity levels, and weight maintenance behaviors of college students. The nature of these influences tends to be complex with varying degrees of impact and influence on each and every student. Most college students realize that weight maintenance is associated with consuming a healthy diet and staying physically active (Greaney et al., 2009). Moreover, most acknowledge that engaging in these healthy behaviors is a choice, influenced by motivation and self-control (LaCaille, Dauner, Krambeer, & Pedersen, 2011). However, choosing to engage in healthy behaviors can be difficult if students perceive the influence of barriers toward engaging in these behaviors to be stronger than the influence of enablers. Further, for some college students, these barriers and challenges are unanticipated and they lack the skills and strategies to overcome them, particularly those skills necessary for selecting and preparing a healthy diet (Cluskey & Grobe, 2009; Smith-Jackson & Reel, 2012).

Although the degree of influence may vary, many students report similar risk factors associated with eating an unhealthy diet, being physically inactive, and gaining weight. For example students often perceive a lack of social support and self-discipline
to negatively influence their efforts to maintain a healthy weight (Greaney et al., 2009; LaCaille et al., 2011). Some of the major perceived barriers to staying physically active for college men include a lack of motivation and time (Walsh, White, & Greaney, 2009). In addition, some females are uninspired to use the gym, often noting unfavorable experiences and discomfort with the environment (Nelson, Kocos, Lytle, & Perry, 2009). Some of the major risk factors perceived to influence unhealthy eating habits include the increased availability of unhealthy food options, binge-eating, buffet-style dining, alcohol consumption, taste, cost, and stress (Greaney et al., 2009; Walsh et al., 2009; Nelson et al., 2009). In addition, marketing campaigns specifically targeting college students, often promote the consumption of unhealthy food items including fast food, sports beverages and energy drinks (Nelson et al., 2008). Finally, the convenience of computer-based social interactions may substitute for more physically active forms of communication and socialization, resulting in a decrease in physical activity (French, Story, & Jeffery, 2001).

On a college campus, these computer-based sedentary behaviors may be further increased as a result of academically-driven computer time.

Many of these dietary risk factors may also serve as cues to consume food and beverages in excess of energy needs. In one study, researchers found that young adults were uninfluenced by portion sizes when determining how much food to consume in a single eating occasion (D. A. Levitsky & Youn, 2004). Such behaviors in an environment of excess food availability and undetermined portion sizes, as seen in college cafeteria buffets, may increase the risk of overconsumption. In the United States, standard portions of some foods items and beverages have increased over the past 50
years, particularly the portion sizes of food items associated with the fast food industry (French et al., 2001). The accessibility of large portions of fast food on a college campus may result in overconsumption. Further, the cost and convenience of pre-prepared foods is reported by some students to be a barrier to eating a healthy diet (LaCaille et al., 2011). Social events, particularly those involving alcohol consumption, are often found to promote snacking or binge eating (Nelson et al., 2009). Alcohol alone, if consumed frequently or in excess, can add a significant number of calories to the diet. Finally, some students found emotional cues, such as boredom or stress, to promote overconsumption (Nelson et al., 2009). Perhaps for these students, increasing awareness of internal and external cues and enhancing self-regulation and coping skills would support healthier responses and reduce the risk of overconsumption.

A perceived lack of time is often found to be a major barrier to engaging in physical activity and maintaining a healthy weight in a college population (LaCaille et al., 2011; Walsh et al., 2009). With the increased demands of college life and academic schedules, some students find it difficult to prioritize eating a healthy diet (Nelson et al., 2009). Students often identify self-control as a critical strategy in maintaining a healthy diet and staying physically active (LaCaille et al., 2011), yet for some students, this strategy is seldom used. Research has shown that if students plan ahead and self-regulate their behaviors, they are more apt to consume a healthy diet and stay physically active (Strong, Parks, Anderson, Winett, & Davy, 2008). Perhaps the perceived lack of time reported by college students is attributable to the lack of self-management skills, including self-regulation and time management. Some researchers have recognized this
need and have proposed the enhancement of these skills in interventions as a potential strategy to prevent weight gain in a college population (Nelson et al., 2008).

Some of the factors perceived to motivate healthy eating and physical activity behaviors are the same for both males and females, while others tend to be more gender-specific. Generally, college students are often motivated by the short-term benefits associated with engaging in healthy behaviors (Greaney et al., 2009). For example, the benefits of athletic performance, attractiveness and the feeling associated with a good workout often motivate college men to eat a healthy diet and stay physically active (Walsh et al., 2009). Further, males are generally less concerned about weight gain than females (LaCaille et al., 2011), while females often fear weight gain (Smith-Jackson & Reel, 2012). As a result, females appear to be motivated to reduce their fat intake and consume nutrient-rich foods to avoid gaining weight (Chung, Hoerr, Levine, & Coleman, 2006). Social support appears to encourage physical activity in both genders, while females find social support to be a positive influence in eating a healthy diet (Greaney et al., 2009).

Understanding the risk factors and motivators associated with the diet and physical activity behaviors of a college population can support the design and development of effective interventions for the promotion of behavioral change. In a college population, this may include introducing strategies to reduce the impact of environmental and psychosocial risk factors known to influence these behaviors, such as cues and stress. It may also involve efforts to increase student awareness of the short-term, gender-specific benefits of consuming a healthy diet and staying physically active.
Finally, interventions that promote improvements in self-regulation and time-management skills may support reducing some of the barriers associated with eating a healthy diet and staying physically active for college students.

DETERMINANTS OF BEHAVIOR AND BEHAVIORAL THEORY

Social science research has effectively identified a variety of psychosocial and environmental risk factors perceived by college students to influence their diet and physical activity behaviors (Greaney et al., 2009; LaCaille et al., 2011; Walsh et al., 2009; Nelson et al., 2009; French et al., 2001). From this qualitative research we can determine the most common risk factors and attempt to modify their impact through interventions in an effort to improve behaviors. Decreasing the influence of these risk factors, however, does not always ensure the adoption of healthier behaviors as these risk factors have a varying degree of influence on individual student behaviors (Greaney et al., 2009). More proximal determinants of behavior, including beliefs, values, and attitude, are thought to mediate these influences (Ajzen & Fishbein, 1980). The nature of these determinants and others, their association with external factors and their impact on human behavior constitute some of the foundations of behavioral theory.

The theory of planned behavior (TPB) is a widely used and accepted theory of human behavior (Armitage & Conner, 2001). It was developed as an extension of the theory of reasoned action, offering a more comprehensive conceptual understanding of why humans behave the way they do (Ajzen, 2002). The TPB posits that an individual’s intention towards engaging in a behavior reflects the likelihood of the individual actually
engaging in the behavior. This intention results from the influence of reasoned thoughts associated with the determinants of a behavior including attitudes, subjective norms and perceived behavioral control (PBC). Further, these determinants are products of an individual’s attitude, subjective norm, and perceived behavioral control beliefs associated with the behavior. Intentions are therefore assumed to have the most direct influence on behavior (Ajzen, 1991). Though our behaviors may change under different circumstances or conditions, our beliefs toward specific behaviors tends to be consistent and compatible with our actions. Thus, understanding the influence of these determinants on behavior can help explain the nature of an individual’s actions (Ajzen, 2005).

Individual determinants of a behavior, including attitudes, subjective norms and PBC, are assumed to mediate external variables or risk factors associated with the behavior. Therefore, risk factors are assumed to be indirect influences of behavior (Ajzen & Fishbein, 1980). This results in the risk factors having different perceived levels of influence between individuals, despite equal levels of exposure. For example, a common external variable or risk factor for eating an unhealthy diet on a college campus is the increased availability of unhealthy food options (LaCaille et al., 2011). The influence of this risk factor may be mediated by the student’s perceived behavioral control toward choosing healthy food options or perhaps their attitudes toward eating a healthy diet. In this manner, the influence of this risk factor may be increased or decreased depending upon the individual’s beliefs associated with the behavior.

An individual’s attitudes, subjective norms, and perceived behavioral control toward engaging in a behavior are thought to be formed predominately from salient
beliefs; the foremost thoughts associated with the behavior (Conner & Armitage, 1998). Salient beliefs are those beliefs that come to mind first and with the least amount of delay when thinking about the behavior. Although we may hold many beliefs about a behavior, the salient beliefs are assumed to play the largest roles in influencing intentions. Moreover, they are often the beliefs perceived to be important or personally relevant to the individual (Ajzen, 2001). Favorable salient beliefs associated with a behavior are assumed to positively influence determinants of behavior, including attitude, subjective norms, and perceived behavioral control. Because these determinants are assumed to influence behavior, beliefs are inherently associated with behavior (Ajzen, 1991).

In the TPB, attitudes are defined as judgments or evaluations of a behavior that are formed from beliefs associated with the behavior (Ajzen, 1991). The development of attitudes from these beliefs can be explained using the expectancy-value model. Here, attitudes are formed from an individual’s beliefs associated with the expected outcomes or attributes of engaging in the behavior. The influence of these beliefs is multiplied by the value that the individual ascribes to the expected outcomes or attributes of the behavior. Therefore, if an individual believes that the outcomes or attributes of engaging in a behavior are favorable or beneficial, the individual’s attitude toward engaging in the behavior is assumed to be more favorable. Further, if the individual perceives these favorable or beneficial outcomes to be important, the influence of this attitude belief is thought to be increased, resulting in a stronger, more favorable attitude toward the behavior. In this manner, attitudes are assumed to be favorably or unfavorably influenced by changes in beliefs associated with the expected outcomes or attributes of
engaging in the behavior and further strengthened or diminished by changes in beliefs in the value the individual ascribes to the behavior.

In the TPB, attitudes associated with a behavior may be categorized as either cognitive or affective in nature (Ajzen, 2001). Cognitive attitudes are formed from thoughts associated with the expected outcomes of engaging in a behavior, while affective attitudes are based on the emotions or feelings associated with engaging in the behavior. For example, a student may choose to consume an apple because they believe that consuming it will result in fewer calories than other sugar-based desserts. This belief is cognitive in nature as it is based on thoughts associated with the behavior. Another student may choose to consume apple crisp instead because they recall the pleasure and comfort associated with consuming this sugary dessert. This belief is affective in nature as it reflects emotions and feelings associated with engaging in the behavior.

Both cognitive and affective attitudes are thought to influence intentions toward engaging in a behavior; the magnitude of which varies across behaviors, populations, and situations (Ajzen & Fishbein, 1980). Stronger attitudes, either cognitive or affective in nature, are very important, as they are not easily changed and exert more influence on behaviors. Thus, stronger, more convincing arguments are necessary to counter and change these existing beliefs. Conversely, ambivalence, holding both positive and negative attitudes towards a behavior, lacks belief strength (Ajzen, 2001). Consequently, these beliefs are more easily swayed and changed.

In the TPB, subjective norms, also known as injunctive norms, are defined as the perceived social pressures towards engaging in a behavior (Ajzen, 1991). These
perceived social pressures are a result of normative beliefs about the opinions of important others regarding the individual’s engagement in a behavior. The degree of importance ascribed to acting consistently with these opinions influences the strength of the subjective norm. Thus, if an individual believes that important others approve of their engaging in a behavior, the influence of the subjective norm would support engaging in the behavior. Moreover, if the individual believes that it is important to behave consistently with these opinions, the strength of this influence would be increased. Favorable subjective norm beliefs toward engaging in behavior are thought to positively influence intentions toward engaging in behavior. Thus, social norm beliefs are inherently associated with behavior.

In the TPB, perceived behavioral control (PBC) is defined as an individual’s perceived confidence or self-efficacy in overcoming barriers toward engaging in a behavior (Ajzen, 2002). This construct also includes the influence of variables associated with behaviors that are essentially out of the individual’s control. If the perceived influence of these variables is valid, they may have a direct affect on an individual’s behavior. For example, a student may feel confident in their ability to overcome the barriers to eating a healthy diet and believe that they possess the necessary skills for selecting healthy food items to create a healthy diet. In this manner, the student’s perceived behavioral control may favorably influence intentions toward eating a healthy diet through self-efficacy. However, the student may be limited in their selection of food items due to the restrictions of their college meal plan. This perceived lack of control over healthy food options may diminish the students’ self-efficacy and/or it may
influence their consumption behaviors directly. Strong self-efficacy or confidence in one’s skills or ability to overcome barriers is assumed to result in a positive influence on intentions toward engaging in a behavior (Ajzen, 2002). Because self-efficacy beliefs and controllability beliefs are thought to influence perceived behavioral control, they are inherently associated with behavior.

Researchers have identified additional determinants of behavior that may influence behaviors directly, or may influence intentions toward engaging in some behaviors (Amitage & Christian, 2006). The influence of these determinants is found to vary based on the situation, population, and behavior. Therefore, the addition of such determinants to the TPB is advocated only if these determinants are thought to influence intentions and consequently increase the predictive power of the TPB (Conner & Armitage, 1998). Otherwise, the addition of these extensions would offer no additional value to the conceptual framework of the TPB.

Proposed extensions to the TPB associated with normative beliefs include moral norms, descriptive norms and self-identity (Conner & Armitage, 1998; Amitage & Christian, 2006). Moral norms are formed from beliefs that engaging in a behavior is right or wrong, based on personal moral or ethical standards (Conner & Armitage, 1998). The use of this determinant may be important if intentions to engage in a behavior are typically based on moral or ethical values. For example, moral norms may have a strong influence on student’s intentions to cheat on a college exam. Descriptive norms are formed from an individual’s beliefs of how others judge engaging in a behavior and the perceived importance of aligning with how others are behaving (Amitage & Christian,
For example, the belief that college peers consume energy drinks may support more favorable descriptive norm beliefs toward consuming energy drinks, particularly if there is a perceived social pressure to “fit in” with peers. Similarly, the determinants of self-identity or self-categorization are established from beliefs as to whether or not engaging in a particular behavior is consistent with the “image” an individual wishes to project to others or with the behaviors of a group with whom they affiliate or wish to affiliate (Conner & Armitage, 1998). For example, students may be influenced to consume more wholesome, locally grown foods if they desire to be perceived as environmentally conscientious or wish to be accepted by groups who embrace a similar ideology.

Past behavior or habit strength is another determinant proposed to influence behaviors or intentions toward some behaviors (Conner & Armitage, 1998). This determinant is essentially the experience of having engaged in the behaviors in the past influencing the continued engagement in the same behaviors. Past behavior or habit strength has been shown to be an additional determinant of some health-related behaviors including exercise and smoking. For example, students may be influenced to consume a healthy diet and stay physically active in college if they consumed a healthy diet during adolescence and childhood and engaged in high school sports in the years prior to attending college.

Social Cognitive Theory (SCT), another widely used theory of behavior, posits that individuals choose to engage in behaviors as a result of interactions that occur reciprocally between personal, behavioral, and environmental factors (Albert Bandura,
Personal factors include outcome expectations, self-efficacy, personal agency and goals. Consistent with the expectancy-value model, the influence of beliefs associated with outcome expectations may be increased by the values or ‘incentives’ ascribed to the expected outcomes. Behavioral factors include behavioral knowledge, skills, and self-regulation. Finally, environmental factors include physical and social factors that influence behavior including modeling. Unlike the unidirectional framework posited by the TPB, SCT explains human behavior as the result of reciprocal influences. The nature of these reciprocal interactions is further influenced by the levels of individual competencies in establishing forethought, self-regulation, self-reflection, self-efficacy, and social support (Albert Bandura, 1989).

The reciprocal influences between behavioral, environmental, and personal factors are not equal in strength. Moreover, the degree of influence of each factor on behavior varies depending upon the behavior, population, and situation (Albert Bandura, 1986). These reciprocal interactions between factors is illustrated in the conception-matching process of behavior (Albert Bandura, 1999). Prior to engaging in a behavior, an individual is thought to possess beliefs associated with the behavior including outcome expectations, goals, and perceived levels of self-efficacy. Further, the individual maintains behavioral knowledge, skills, and standards associated with the behavior. These personal and behavioral factors support forethought, the process of anticipating and planning action. Prior to engaging in the behavior, they also support the formation of conceptions of the behavior that are symbolic in nature. When actively engaging in the behavior, these factors are recruited to guide skilled action and to support adjustments in

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skills to promote improvements in the behavior. Physical, emotional, and cognitive feedback from engaging in the behavior supports the adjustment of conceptions of the behavior including outcome expectations, knowledge, skills, and standards to match the current levels of mastery in the behavior. In this manner, positive experiences in engaging in the behavior can result in positive enhancements in self-efficacy, personal agency, and motivation toward engaging in the behavior (Albert Bandura, 1986).

Reciprocal interactions can further be illustrated in observational learning, the interactions between personal and environmental factors that can result in the vicarious development of behavioral knowledge and skills (Albert Bandura, 1999). In this interaction, the individual learns skills and knowledge associated with behaviors by observing the successes and the mistakes of others. Observational learning is not simply the mimicking of behavior, however. This type of learning requires the capacity of processes including attention, retention, production, and motivation. To learn vicariously from others, one must first offer attention to the behaviors of others. Further, the individual must transform the observed behaviors into symbolic conceptions in the conception-matching process. The probability of actually engaging in the behaviors is influenced by personal, vicarious, or direct “incentives” (Albert Bandura, 1986). If the behavior offers valued incentives, such as favorable outcomes or benefits that are important to the individual, the individual will be motivated to engage in the behavior. Conversely, negative feedback or non-beneficial outcomes will discourage the individual from taking action.
Self-efficacy, the perceived confidence an individual has in their ability to overcome barriers and engage effectively in a behavior, is thought to be the most influential determinant of behavior (Albert Bandura, 1999). Stronger beliefs of self-efficacy will result in greater motivation to engage in the behavior and persevere when engaging in the behavior is perceived to be difficult. Self-efficacy can also affect an individual’s level of goal-setting by influencing the outcome expectations of engaging in a behavior through symbolic forethought. The overestimation or underestimation of self-efficacy can be problematic, as these beliefs may misguide the individual into setting goals that are too high or too low. Self-efficacy beliefs that are set slightly higher than the individual’s actual abilities can be beneficial, however, as they may motivate the individual to attempt what would otherwise be perceived as a less attainable goal and result in the individual exceeding their previously set internal standards of achievement (Albert Bandura, 1986).

Self-efficacy is thought to play a significant role in influencing a variety of health behaviors. Increasing levels of self-efficacy by enabling individuals with the skills and confidence necessary to adopt and maintain healthier behaviors, may result in the increased motivation to engage in these behaviors (Albert Bandura, 2004). Moreover, increasing an individual’s self-efficacy can play a critical role in establishing healthier behavioral standards and achieving loftier goals.

Individual behaviors are also influenced by competencies in self-regulation and self-reflection (Albert Bandura, 1989). Self-regulation involves the comparison of individual behaviors to internal standards and perceived self-efficacy. Individuals are
motivated to meet or exceed their internal standards for purposes of self-fulfillment, satisfaction, and self-worth. A stronger sense of self-efficacy in meeting or exceeding these standards can result in increased perseverance and the establishment of higher internal standards. Conversely, lower levels of self-efficacy can result in the abandonment of efforts in the face of adversity and a decrease in internal and goal-setting standards. In self-reflection, an individual examines the accuracy of their thoughts to determine if they are congruent with their actions or symbolic predictions. Thoughts are then modified to match perceived capabilities. Central to self-reflection and perceived capabilities are the individual’s thoughts of self-efficacy associated with the behavior.

PREDICTING BEHAVIORS USING THE THEORY OF PLANNED BEHAVIOR

Research has supported the application of the TPB in predicting intentions and behavior for a variety of health-related behaviors. In a large meta-analysis of 185 studies, the correlation of the proposed determinants of behavior in the TPB with intention accounted for an average 39% (r = .63) of the variance (Armitage & Conner, 2001). Further, when accounting for the additional direct influence of PBC on behavior, the multiple correlation with behavior accounted for an average 27% (r = .52) of the variance. These correlations were stronger for self-reported (r = .55) behaviors when compared to observed (r = .44) behaviors. Using Cohen’s guidelines for interpreting social science correlations (product-moment r), the correlation of (r = .55) would indicate a large effect size, while the correlation of (r = .44) would indicate a medium effect size (J. Cohen, 1992). Both offer support for the predictive strength of the TPB in a variety of
behaviors. In this meta-analysis, PBC was shown to play a significant role in influencing intentions toward engaging in a wide range of behaviors (Armitage & Conner, 2001). In some studies, the PBC construct alone was shown to predict behaviors (Ajzen, 2002).

The TPB has also been shown to be effective at predicting healthy eating habits in a young adult population. In a study of 23-26 year olds, determinants of behavior explained 32% of the variance of intentions to adopt healthy eating habits, however, student intentions were weak predictors of behavior (Øygard & Rise, 1996). In this study, student attitude associated with appearance and taste and student PBC associated with ability and regulation were the strongest influences of intentions. In another study of 413 college students, intentions predicted fruit and vegetable consumption, independent of ethnicity and gender (Blanchard et al., 2009). Similar to the previous study, affective attitude, and PBC were the strongest influences on intentions, while normative beliefs had a weaker influence, particularly for males. In a study examining the dietary influences of undergraduate baseball players, attitudes and control beliefs had the strongest influence on consuming a healthy diet (Pawlak, Malinauskas, & Rivera, 2009). Here, the strongest beliefs influencing attitude were those associated with increased mental focus and cognitive benefits associated with consuming a healthful diet. Positive control beliefs were associated with their athletic schedules. Research has also shown that student attitudes have the strongest influence on intentions to adopt a plant-based diet in a college population (Wyker & Davison, 2010). In this study, students with stronger positive attitudes and intentions were also found to have greater readiness for change. Finally, in a population of young adults not attending college, the TPB predicted
healthy eating habits ($r = .72$) with attitude and PBC having the strongest influence on behavior, while subjective norms, role identity and past behavior were found to have a weaker influence (Nordrehaug Astrom & Rise, 2001).

Research has also supported the inclusion of past behaviors and habit strength to the TPB as additional determinants of some behaviors. In a meta-analysis of 11 studies, researchers found the determinant of past behavior to independently influence both intentions and behavior in a variety of health behaviors including smoking, exercise, drinking, and condom use (Conner & Armitage, 1998). In an adult population attending a health clinic, PBC was found to be the strongest influence of intention and predictive of current and future (6 mos.) exercise behaviors (Norman, Conner, & Bell, 2000). In this study, past behavior was found to have a strong influence on current behaviors. Further, individuals having exercised in the past had higher levels of PBC when compared to individuals who had not regularly exercised in the past. Perhaps the past participation in exercise promoted higher levels of skill and proficiency in the exercise behaviors. This may have resulted in increased self-satisfaction, self-confidence, and self-efficacy in the behaviors and consequently an increased intrinsic motivation to continue participating in the behaviors. The influence of habit strength has been found to increase the power of the TPB at predicting fruit consumption behaviors of college students (de Bruijn, 2010). Here, researchers found that both intentions and PBC predicted fruit consumption behaviors and that stronger habit strengths resulted in reduced intentions to engage in the behavior.
Research comparing the effectiveness of the SCT to TPB, found SCT to be more predictive of physical activity behaviors in a college population, with self-efficacy more influential of behavior than PBC (Dzewaltowski, Noble, & Shaw, 1990). Self-efficacy is also a significant determinant of intentions in the TPB, however. When the influence of the sub-components of PBC on behavior were examined in one study, researchers found self-efficacy to have a stronger influence on intentions to participate in regular exercise ($r = .74$) than controllability ($r = .38$) in a college population (Rhodes & Courneya, 2003). The independent influence of self-efficacy on some behaviors suggests that there may be predictive advantages in sub-categorizing this construct. However, it is recommended that researchers first assess the control beliefs of the study populations to determine if self-efficacy and controllability influence behavior independently (Conner & Armitage, 1998). Further, researchers suggest strengthening the item measures in assessments associated self-efficacy and controllability if the determinants are to be examined separately.

The construct of subjective norms in the TPB is generally found to be the weakest determinant of intentions towards engaging in a variety of behaviors (Armitage & Conner, 2001). The weak influence of this construct on intentions to eat a healthy diet and engage in physical activity may be due to a limited number of salient social pressure beliefs in some populations. There may also be a perceived ambivalence or social acceptance for unhealthy behaviors. Or, perhaps, the influence of social norms varies with age. Research has shown that the perceived social pressures from peers has a strong influence on physical activity behaviors of females during adolescence (Trinh, Rhodes, &
Ryan, 2008). This hypothesis is also supported by other research that found the indirect influence of social norms (peers and parents) on attitudes toward eating healthy and being physically active among both male and female adolescents (Baker, Little, & Brownell, 2003).

Extensions to the TPB, including those associated with subjective norms, are also found to influence adolescence behavior. For example, self-identity and descriptive norms, were found to influence adolescent intentions to select healthy food items at lunchtime (Dennison & Shepard, 1995). This finding is supported by a meta-analysis of 18 studies, where the average influence of descriptive norms on intentions toward a variety of behaviors was $r = .44$, explaining an additional 5% of the variance of intentions (Rivis & Sheeran, 2003). Further analysis found descriptive norms to be significantly more influential of intentions in younger populations (< 25 yrs) than in older adults, particularly those intentions to engage in health-risk behaviors. These results suggest that adolescents and young adults observe the actions of others for the purpose of behavioral guidance or, for health-risk behaviors; misguidance. Perhaps an effective approach to promoting desired behaviors in this age group would be the modeling of appropriate behaviors by those with whom they self-identify.

These examples of the effectiveness of the TPB at predicting health behaviors also illustrate a few of the theory’s limitations. First, the TPB is more predictive of behaviors when the assessments of intentions and behaviors are close in timeframe (Ajzen, 2005). This reduces the potential for unforeseen changes in beliefs and consequently, changes in behaviors. The predictability of the TPB is therefore contingent
upon the stability of an individual’s intentions when assessments are not administered close to behaviors. Further, the stability of intentions are thought to be weaker during periods of perceived instability (Ajzen & Fishbein, 1980; Stutton, 1998). This is illustrated in a study, where the TPB was able to predict current intentions to be physically active in a college freshman population, but did not predict physical activity 8 weeks later (Wing Kwan, Bray, & Martin Ginis, 2009). Here, past behavior was found to play a more significant role in predicting behaviors. The transition from high school to college and the adoption of new lifestyles is sometimes perceived as a period of instability (Cluskey & Grobe, 2009). Perhaps, the inherent instability associated with this transition to college affects the stability of intentions to stay physically active during the freshman year. This concept is further illustrated in a study examining the consumption behaviors of a predominately female adult population attending a health-promotion clinic (Conner, Norman, & Bell, 2002). Here the TPB predicted behaviors to consume a healthy diet over a six year timeframe. Intentions were found to be stable over the assessed period of time, suggesting that the predictability of this behavior was supported by the stability of intentions. In this study, the influence of past behavior was found to play a less significant role when the intentions toward the behavior were more stable.

The TPB also assumes that self-assessments of behaviors are accurate and that there are no misconceptions associated with the behavior. Inaccurate self-assessments, although sometimes consistent with determinants of behavior and intentions, can result in ineffective health promotions as they reflect a lack of awareness in a population of the need to change (Brug, Van Assema, Kok, Lenderink, & Glanz, 1994). In a study
examining the determinants of fruit and vegetable consumption in adult women, researchers found stronger positive attitudes, PBC, and intentions for those who overestimated their consumption behaviors when compared to their “realist” counterparts (Rogers, Brug, van Assema, & Dagnelie, 2004). However, when self-assessments and biomarkers of fruit and vegetable consumption were compared, researchers found the TPB to be more successful at explaining the variance in behaviors of those who accurately assessed their consumption behaviors. Similarly, the TPB is found to be more effective at predicting actual behaviors than hypothetical behaviors (Stutton, 1998). Perhaps this is due to the hypothetical behaviors eliciting lower levels of perceived commitment to engage in the behaviors than actual behaviors.

Finally, the TPB may not be effective at predicting all health behaviors, particularly those that are complex or habitual in nature, or those that result from multiple behaviors. For example, some researchers have found health behavior theories to be ineffective at understanding the influences associated with weight loss (Jeffrey, 2004). Moreover, researchers argue that one of the strongest predictors of weight loss, self-weighing, and the most successful treatments for weight loss are unexplained by behavioral theory. Weight loss results from the imbalance in energy balance variables, energy intake and energy expenditure, in favor of energy expenditure. Perhaps, the inability of behavioral theories to predict weight loss is due to the dual nature of the weight loss behavior. Further, although intentions may be high at the onset of a weight loss, the challenges of the weight loss process may negatively impact intentions,
particularly if the level of difficulty is unanticipated or if the outcomes are perceived to be less than favorable.

USE OF BEHAVIORAL THEORY TO PROMOTE BEHAVIORAL CHANGE

Use of behavioral theory can support the development of interventions that promote behavioral change. Using behavioral theory as a guide to understanding human behavior can increase the probability of promoting behavioral change in health programs (Rimer & Glanz, 2005). In nutrition education, behavioral theory is found to provide a framework for understanding the determinants of behavior and support the promotion and evaluation of psychosocial and behavioral change (Contento, 2011). Behavioral theory does not explain a causal process, however. Therefore, to use the theories for the promotion of behavioral change, it must be assumed that the determinants of behavior posited in behavioral theory guide behavior and that sufficient modifications to these determinants will result in behavioral change (Conner & Armitage, 1998). Moreover, the integration of behavioral theory in education and interventions does not guarantee the effectiveness of the program and the adoption of targeted behaviors. Behavioral theory is used merely as a conceptual guide to understanding the influences on human behavior. In using this guide, researchers are better equipped to identify the modifiable variables in a given population that are thought to influence change. Targeting these evidence-based variables increases the probability of success (Lytle, 2005). For example, researchers have proposed that enhancing individual self-efficacy, individual goals, outcome expectations, and control over engaging in behaviors is an effective approach to health
promotion (Albert Bandura, 2004). Further support for the use of behavioral theory is illustrated in interventions that are effective at promoting improvements in determinants of behaviors and also result in behavioral change (Webb & Sheeran, 2006).

Researchers have proposed program planning and intervention mapping to support the effective integration of behavioral theory into health interventions (Johannes Brug, Oenema, & Ferreira, 2005; Lytle & Perry, 2001). Planning and mapping begins with a comprehensive understanding of the needs of a population and the identification of associated behaviors in need of improvement. Risk factors are then identified through focus groups, surveys, or a review of the literature. Use of behavioral theory supports the identification of modifiable determinants of behavior and the mediators of risk factors for the specific population. Intervention objectives are then developed to target the population-specific influences, risk factors, and determinants of behavior for the promotion of positive behavioral change. As most theories of behavior offer only a conceptual framework of the determinants of behavior, researchers must translate these conceptual models and the behavior-specific needs of population into effective strategies for behavioral change (Johannes Brug et al., 2005). Finally, the intervention is implemented in the population, evaluated for effectiveness, and maintained. In the “new health promotion,” some researchers suggest a more comprehensive application of behavioral theory in intervention development to include the assets and participation of the community (Heaney, 1998). This integrated approach increases the influence of social and environmental factors and is thought to result in the increased likelihood of promoting change.
Evaluation of the effectiveness of interventions at improving behaviors or determinants of behavior requires the development of appropriate, valid, and reliable tools to detect change. Appropriate tools are those that evaluate outcome measures that are consistent with intervention objectives, power, and duration (Contento, Randell, & Basch, 1999). For example, assessing changes in consumption behaviors may be an ideal measurement outcome in a semester-long college nutrition course intervention. However, this outcome measure may not be appropriate for interventions that are two weeks in duration. Here, psychosocial determinants of behavior may be more appropriate outcome measures.

When developing an assessment tool to detect psychosocial change using the TPB, the conceptual framework of the theory, the behaviors of the population, and the salient beliefs of the population must be considered. In intervention mapping and health promotion, the current behaviors of the population are compared to the desired behaviors to establish the objectives for behavioral change (Johannes Brug et al., 2005). The behavioral change must be defined with specificity to include the target, action, context and time elements (TACT) (Ajzen, 2006). Research has shown that behavioral interventions are more effective if they target specific behaviors (Fishbein, 1995). Item measures are then developed for each construct using the salient beliefs of the population associated with the specific behavior (Ajzen, 2006). To ensure the reliability and validity of the tool, assessment measures must match the objectives in wording and specificity (Stutton, 1998). Finally, the item measures for each construct should be evaluated for internal consistency to ensure a high correlation between item measures and to support
the power of the tool to detect associations between constructs and behavior (Ajzen, 2006). The creation of an assessment tool with these factors in mind can support the effective evaluation of health interventions.

Use of behavioral theories can play a significant role in the design and development of effective nutrition and physical activity interventions, as they offer a framework for understanding human behavior. Program planning and mapping can also support the effective development of these interventions by guiding the researcher through the necessary steps to ensure effective targeting of specific determinants of behaviors in a given population. Finally, the development of appropriate and valid assessments can support the reliable evaluation of the psychosocial determinants of a population and the evaluation of an intervention’s effectiveness.

BEHAVIORAL STRATEGIES IN NUTRITION INTERVENTIONS

Effective interventions are needed in a college population to promote improvements in behaviors associated with energy balance variables, as students often gain weight during the college years. This assertion is supported by research finding that students often adopt unhealthy diet and physical activity behaviors during the transition to college and college years (Nelson et al., 2008). Interventions designed to promote healthier diet and physical activity behaviors may be effective during this period, as the instability of behaviors, and perhaps ambiguity in beliefs may allow for change with effective persuasion. The impact of these interventions may be increased with the use of behavioral theory as a guide to understanding the motivations and determinants of
behavior and to selecting appropriate evidence-based strategies for the promotion of behavioral change. Numerous strategies have been employed in this population; some of which have resulted in limited behavioral change, while others show great promise. Understanding which of these strategies is successful would support the development of effective interventions for the promotion of healthier diet and physical activity behaviors and perhaps, the prevention of weight gain.

Behavioral theory suggests that the diet and physical activity behaviors of college students may be improved with sufficient improvements in determinants of behavior, including attitudes and outcome expectations. A strategy often used to improve the attitudes of students toward eating a healthy diet is to increase nutrition awareness through point-of-purchase cues. In one study, researchers posted nutrition information for snack items near vending machines on a college campus (Hoerr & Louden, 1993). This nutritional cue was found to be ineffective at promoting increases in sales of more nutrient-dense food items. Greater success was shown in an intervention promoting the selection of healthier food items by identifying them as more “healthful” in a campus convenience store (Freedman & Connors, 2010). The limited success of these interventions may be attributable to the nature of the sales and the values of the individuals frequenting these venues. Snack machines and convenience stores are designed to provide their patrons with convenience and speed in food purchases. Perhaps the students who frequented these venues valued convenience regardless of the nutritional content.
The use of food labels is another strategy often used to increase point-of-purchase nutrition awareness in a college setting. College students are generally amenable to the display and use of nutrition labels, (Kolodinsky, Green, Michahelles, & Harvey-berino, 2006) particularly those students with a strong positive attitude toward labels or those having received some form of nutrition education (Misra, 2007). Research has shown that the use of point-of-purchase nutrition labels is effective at influencing the food choices of some students at least some of the time (Driskell, Schake, & Detter, 2008). Other researchers have found that students who tend to use nutrition food labels are often successful at selecting a healthy diet (Graham & Laska, 2012). Although the diets of both male and female students are often in need of improvement, (American College Health Association, 2011) significantly more females than males report using nutrition labels in a dining hall setting to guide their eating choices (Driskell et al., 2008; Li et al., 2012). Some have hypothesized that the general discrepancy of male-to-female use of nutrition labels may be due to a higher “involvement” of females in food-related decisions and the desire of males to not participate in what they perceived as “female activities” (A. Levi, Chan, & Pence, 2003). Despite the limited success of these point-of-purchase interventions, the strategy of increasing nutrition awareness through food labels appears to be effective at motivating some students to select a healthier diet.

Interventions that employ motivational strategies can also be effective at improving attitudes and promoting healthier diet and physical activity behaviors. In a predominately female college setting, the use of cafeteria table tents encouraging the addition of fruits and vegetables to student meals was found to increase fruit and
vegetable consumption behaviors (Niland, Goldman, & Edelstein, 2011). Other forms of motivation, including the use of posters to promote stair use instead of elevators on a college campus, are shown to effectively increase physical activity behaviors of students and faculty (Ford & Torok, 2008). Perhaps in addition to motivating the students, the tents and posters improved attitudes through increased awareness and cued the students to engage in healthier behaviors.

Motivation to engage in behaviors may also be increased through motivational interviewing, a counseling technique grounded in behavioral theory (Holli, O’Sullivan Maillet, Beto, & Calabrese, 2009). This technique is often used in nutrition counseling where clients are guided to examine and actively resolve their own nutrition-related issues. This client-centered approach supports improvements in self-efficacy and problem solving, and promotes self-regulation for the maintenance of healthy behaviors.

In an intervention promoting weight loss among overweight and obese students, motivational interviews were found to significantly increase motivation to lose weight in pre-to-post interview comparisons (Buscemi, Yurasek, Dennhardt, Martens, & Murphy, 2012). At three months, the interview and follow-up phone call were not found to promote significant changes in student weight-related behaviors or weight, however. In another intervention designed to promote fruit and vegetable consumption through tailored nutrition education newsletters (4), a motivational interview, subsequent emails (2) and the availability of a web nutrition resource, a significant increase fruit and vegetable consumption behaviors was observed when compared to controls (Richards, Kattelmann, & Ren, 2006). The results of these studies suggests that motivational
interviewing, although effective in the short-term at increasing motivation, may be limited in its capacity to sustain behavioral change in a college population without sufficient support from additional strategies or sources of reinforcement.

Attitudes may also be improved by increasing nutrition knowledge and awareness of the benefits associated with consuming a healthy diet. Although increases in nutrition knowledge alone are often marginally effective at promoting dietary change, nutrition knowledge is thought to play a fundamental role in influencing dietary behaviors (Worsley, 2002). The strength of this influence is mediated by personal factors including past experiences and knowledge. Thus, the influence of nutrition knowledge on behaviors is thought to be dependent upon the unique perspective of the individual.

Nutrition education may play a small, but critical role in changing dietary behaviors by correcting misconceptions and promoting the acquisition of new nutrition knowledge. Improving nutrition knowledge and beliefs may promote improved attitudes and outcome expectations toward healthier dietary behaviors. This could result in increased motivation to engage in these behaviors. This presumption is supported by research in an adult population, where higher levels of nutrition knowledge were shown to be associated with higher intakes of fruits and vegetables, independent of occupation or education (Wardle, Parmenter, & Waller, 2000). In a college population, greater knowledge of the dietary guidelines appears to promote dietary intake levels that are more consistent with recommendations (Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007).
The use of peer educators may increase the effectiveness of interventions at promoting nutrition knowledge. In one study, peer dietetic students met with female athletes to share and promote nutrition knowledge through multiple one-on-one nutrition education sessions (Kunkel, Bell, & Luccia, 2001). Researchers observed significant increases in the general and sports nutrition knowledge of athletes participating in the program. In another similar program, most students reported that they were more motivated to learn when receiving instruction from peer instructors (Khan, Nasti, Evans, & Chapman-Novakofski, 2009). Finally, in the “Right Bite” program, researchers promoted increases in fruit, fruit juice, and vegetable consumption while reducing fat consumption in a college population through peer nutrition education, awareness, and increases in the availability of healthy food items (Evans & Sawyer-Morse, 2002).

Preliminary results of this peer intervention were found to be promising. In these three studies, students may have found the peer educators to be less intimidating than traditional instructors. Or perhaps students identified with their peer educators and were motivated to learn from the inherent observational learning or modeling that occurs in the peer education process.

In social cognitive theory, observational learning is thought to be an effective method of increasing knowledge, skills, and self-efficacy in behaviors (Albert Bandura, 1989). In interventions, observational learning may occur through peer modeling of healthy eating behaviors in videos, interactive technology, or television viewing. In a dental hygiene nutrition education study, researchers found videos to be an effective tool at preparing dental hygienists for patient nutrition counseling sessions (Gilboy & Grady,
Using SCT and other theoretical models of behavior, researchers have developed “serious” video games designed to promote healthy behaviors in youth (Thompson et al., 2010). Characters in these games are thought to model targeted behaviors, promote skills in goal-setting, and build self-efficacy. Although this venue for learning may appeal to younger audiences, research evaluating the effectiveness of these games at increasing learning and enhancing skills is currently inconclusive (Girard, Ecalle, & Magnan, 2013). Peer modeling through television programs has also shown promise in teaching skills and behaviors through observational learning. Researchers found that a series of cooking shows with professionals and peers, developed from a framework of SCT and designed to increase nutrition knowledge and promote healthy cooking behaviors can be an effective tool at increasing nutrition knowledge (Clifford, Anderson, Auld, & Champ, 2009).

Increasing the personal relevance of nutrition information may support a greater understanding of nutrition knowledge and promote improved nutrition behaviors. The expectancy-value model of behavioral theory suggests that the perceived influence of outcome expectations associated with consuming a healthy diet on behavior may also be increased with increases in the value ascribed to these outcomes. Increasing awareness of the personal relevance of nutrition knowledge and outcomes in the lives of students may therefore foster increases in their perceived value and promote improved attitudes.

In nutrition education and interventions, one strategy often used to increase dietary awareness and the personal relevance of nutrition in the lives of students is to evaluate the students’ dietary intake through food recalls and dietary analyses. Through these programs, student diets are captured and evaluated for nutritional quality against
current nutrient recommendations. In one nutrition study, students reported believing that the use of a personalized diet analysis program would be effective at motivating changes in fat intake behaviors, independent of a student’s perceived readiness to change (Morris & Merrill, 2004). In a meta-analysis, researchers reviewed studies where participants received dietary feedback in the form of personal letters, newsletters, or printouts (J Brug, Campbell, & van Assema, 1999). The researchers suggest that interventions offering individualized dietary feedback may be more effective at motivating change than those that do not, as the participants in these interventions often find the feedback to be personally-relevant.

The increase in motivation to change dietary behaviors may also be attributable to an increase in awareness of the need to change. Contento said of personalized self-assessments in nutrition interventions:

“Accurate self-assessment is key: people are often not aware of their own dietary intake status and do not perceive a need to change. Knowing about their actual behaviors can help them become more interested in deliberation of issues and more motivated. Such personalized feedback may also counteract the tendency to be optimistically biased and encourage individuals to consider changes in their dietary behaviors based on their true risk.” (Contento, 2011)

This assertion is supported by research showing that intentions and determinants of behavior are significantly more correlated with self-assessments of behavior than actual behaviors, particularly if the self-assessments are highly unrealistic (Johannes Brug et al., 2005). For example, if an individual overestimates their level of engagement in a desired behavior, they may hold stronger positive beliefs, attitudes, and PBC toward engaging in that behavior. An intervention designed to increase the individual’s level of
engagement in this behavior would probably be ineffective, as the participant may believe that their level of engagement is adequate. Thus, increasing awareness of the need to change is a critical component of health interventions to effectively promote behavioral change (Johannes Brug et al., 2005).

Behavioral theory also suggests that increasing self-efficacy in eating a healthy diet and staying physically active through interventions can result in increased motivation to engage in these behaviors. Further, self-efficacy may be increased through self-regulation and the attainment of diet and physical activity goals. Incorporating opportunities for self-regulation into interventions, including goal-setting and self-monitoring, may, therefore, support increases in self-efficacy and motivation to engage in targeted behaviors. In an 8-week, email-based intervention, researchers used education, social support, and self-regulation including goal-setting, self-monitoring, and incentives to promote increases in student dairy consumption (Poddar, Hosig, Anderson-Bill, Nickols-Richardson, & Duncan, 2012). As a result of participating in the intervention, self-regulation skills and self-efficacy levels increased when compared to controls, but no significant differences in dairy consumption levels were observed between intervention and controls. Studies have also used self-regulation as a strategy to prevent weight gain in first-semester college freshman (Dennis, Potter, Estabrooks, & Davy, 2012). Here, researchers compared two, semester-long interventions promoting weight maintenance through education, social support, and goal-setting with and without self-regulation training. Neither intervention was found to be successful at promoting weight maintenance. As noted earlier, the perceived instability during the transition from high
school to college may make interventions promoting behavioral change difficult during the first semester of college. Further, the outcome measure in this study lacked specificity. The broad scope of the measure (weight maintenance) may not have allowed for the detection of smaller changes in more specific diet and physical activity behaviors that may have occurred.

The strategy of goal-setting has also been found to be successful at promoting increases in physical activity behaviors in a college population. In a 6-week intervention, researchers compared the effectiveness of a motivational action plan brochure and a physical activity guidelines brochure at promoting physical activity behaviors in first-semester college freshman (Bray et al., 2011). All groups exhibited declines in physical activity, but researchers observed significantly more moderate-to-vigorous physical activity in students who received a motivational action plan brochure when compared to the guideline brochure. Researchers have also used pedometers and goal-setting in a college population to support increases in physical activity though walking (Jackson & Howton, 2008). Here researchers offered strategies, tools, and skills in goal-setting and self-monitoring to increase the amount of walking throughout the semester of a required health class. Significant increases were observed from baseline to the end of the semester, with the largest increased observed in students of normal weight.

The strategy of goal-setting is often proposed as a multi-step process, where each component of the process is encouraged to achieve optimum effectiveness. In a review of goal-setting interventions, 4 steps were identified; recognizing a need for change, establishing a goal, monitoring goal-related activity, and self-reward for goal attainment.
(Cullen, Baranowski, & Smith, 2001). In this review, researchers supported the use of goal-setting in the promotion of dietary changes, finding that at a minimum, the steps of establishing a goal and monitoring goal-related activity promoted positive change. In another review of 13 studies using goal-setting as a strategy, researchers found goal-setting to be an effective strategy at promoting improved diet and physical activity behaviors in an adult population, particularly if all the proposed components of the goal-setting process and theory are supported (Shilts, Horowitz, & Townsend, 2004).

As exhibited in some of these studies, interventions are often designed and developed using multiple strategies to promote behavioral change. As there are multiple influences on behavior, incorporating multiple strategies in a health-promotion intervention may increase the likelihood of promoting change. In a study targeting improved self-efficacy and dietary behaviors in female athletes, researchers incorporated a diet analysis, interactive activities, and problem-solving into 8 one-hour educational sessions (Abood, Black, & Birnbaum, 2004). A significant increase in self-efficacy, knowledge, and dietary behaviors was observed in the athletes when compared to controls. In an internet-based nutrition and physical activity intervention, researchers evaluated the effectiveness of a combination of strategies, including nutrition and fitness education, interactive activities, and goal-setting with or without a booster session at improving consumption and exercise behaviors in a student population (Franko et al., 2008). Researchers observed increases in nutrition knowledge, fruit, and vegetable consumption behaviors and improvements in motivation and readiness to change in both experimental groups when compared to controls. However, changes in fruit and
vegetable consumption behaviors were not maintained in follow-ups. The limited success of this intervention may have been due to the short, two-week duration of the program, although participants in the booster group who were offered additional access to the program did not exhibit improved outcomes.

In a review of 14 health interventions targeting dietary improvements in a college population, researchers found the overall effectiveness of the interventions mixed (Kelly, Mazzeo, & Bean, 2013). Further, inconsistencies in methods and outcome measures made comparisons and conclusions difficult. Many of the interventions showed limited to modest improvements in student behaviors with researchers finding the most promise in interventions that used self-regulation as a strategy to promote sustained change in dietary behaviors. In another meta-analysis, researchers found encouraging results from nutrition interventions in a college population, particularly those that included nutrition education (Lua & Wan Putri Elena, 2012). However, the fourteen studies in the review included predominately female students, had small sample sizes, and were identified as having some design limitations.

Although the behavioral changes resulting from some nutrition interventions may seem small, if sustained, they could have a significant impact on the long-term health of the participants as well as the general health of this population. A review of the literature to determine the strategies found to be most effective in a college population may play a critical role in the design and development of interventions with the greatest likelihood of success. Further, combining these strategies with nutrition education in interventions
may prove to be the most effective approach in promoting behavioral change, as it would also promote nutrition knowledge.

NUTRITION EDUCATION COURSE INTERVENTIONS

Designing an effective nutrition and physical activity intervention for college students that results in long-term behavioral change can be challenging. Empirical evidence suggests that the use of behavioral theory may support the design of interventions, guide the selection of evidence-based strategies and methodologies, and increase the probability of promoting behavioral change. Moreover, the use of multiple strategies and longer durations in interventions may increase the long-term impact of interventions in promoting change. Finally, promoting nutrition and physical activity knowledge and the personal relevance of these concepts in the lives of students could result in more intrinsic motivation to improve health behaviors. As college nutrition and health education courses promote education, allow for strategies, and are longer in duration, they may be ideal settings for nutrition interventions that promote behavioral change.

A traditional nutrition education course offers face-to-face instruction in a conventional classroom setting. Participation in this type of nutrition course may promote increases in nutrition knowledge and improvements in student attitudes and behaviors toward eating a healthy diet. In one study, researchers observed significant increases in student nutrition knowledge and self-efficacy towards eating a healthy diet as
a result of participating in a traditional high school nutrition course (Watson, Kwon, Nichols, & Rew, 2009). Researchers also observed significant increases in milk consumption and the frequency of breakfast consumption in students participating in the course, when compared to controls. Similarly, as a result of participating in a traditional undergraduate nutrition course, researchers observed improvements in student attitudes toward consuming a healthier diet (Pawlak, Cerutti, & Quinton, 2009). Researchers also observed improvements in the intake of select nutrients essential for a healthy diet.

College-level nutrition courses may also be effective at preventing weight gain in a college population during the transition to college. Students attending a series of interactive nutrition and physical activity seminars during the first two years of college were found to have higher levels of weight maintenance as a result of participating in the intervention, when compared to controls (Hivert, Langlois, Bérard, Cuerrier, & Carpentier, 2007). No significant changes were observed in energy balance variables between groups; however biomarkers indicated improvements of lipid profiles in the intervention group. This outcome suggests that students in the intervention group may have selected healthier, more nutrient-dense food items as a result of the intervention. The results of the study also highlight the potential health benefits associated with subtle changes to dietary intake behaviors as a result of education-based interventions. In another study, researchers used a science-based nutrition curriculum to promote energy balance and weight maintenance in female freshmen (Matvienko, Lewis, & Schafer, 2001). Here students received instruction in some scientific concepts in nutrition, including energy balance, the physiological and metabolic impact of diet and physical
activity behaviors, and the potential role of genetics in health. Researchers observed improvements in dietary behaviors and greater success at maintaining weight among participants with higher BMIs (>24) when compared to controls. At a 16-month follow-up, differences in dietary behaviors were no longer significant, however students were found to have retained more science-based knowledge than general nutrition knowledge. Perhaps science-based knowledge promoted a deeper understanding of the physiological impact of consumption behaviors and the metabolic outcomes of energy balance variables in the lives of students. This may have supported an increase in the perceived value of the information and promoted greater retention.

Behavioral theory suggests that subjective norms toward consuming a healthy diet may be influenced by moral and ethical issues associated with the behavior. If the issues are perceived to be important to the student, these ideological beliefs could change subjective norms and influence behaviors. Introducing social and environmental issues associated with consuming a healthy diet into a college nutrition education curriculum may support improvements in healthy dietary behaviors. In a college food and society course, students were presented with ethical and social issues associated with food (Hekler, Gardner, & Robinson, 2010). Students were also encouraged to become activists in food-related issues during the semester. Researcher compared pre to post self-reported diets of students participating in the food and society course to peer controls in other health courses. They found significant improvements in select dietary behaviors in students participating in the food and society course. In this study, students may have also been motivated to consume a healthy diet as a result of their affiliation with “like-
minded” peers. Consistent with behavioral theory, self-identifying with other students in the course may have motivated them to behave in a manner consistent with the ideology of the group.

Behavioral theory also suggests that the effectiveness of nutrition education course interventions at improving and maintaining healthy dietary behaviors may be improved with the use of self-regulation. Self-regulation is a behavioral strategy that includes both goal-setting and self-monitoring. In an undergraduate health course and intervention promoting fiber consumption, students were randomly assigned to four different intervention strategies including goal-setting, self-monitoring, goal-setting with self-monitoring, or no skill development (controls) (Schnoll & Zimmerman, 2001). Significant increases were observed in self-efficacy and fiber consumption for those students who set fiber-consumption goals when compared to controls. The largest increases in self-efficacy and fiber consumption were seen in students who used both goal-setting and self-monitoring to increase fiber consumption. Further analysis revealed that goal-setting had a strong direct influence on dietary fiber consumption and an indirect influence on fiber consumption through self-efficacy. In a shorter nutrition intervention, improvements in strategies including self-regulation were found to play a pivotal role in the motivation of behaviors (Poddar et al., 2012). These results suggest that students are more successful at improving behaviors if they set achievable goals. Moreover, if they also self-monitor their behaviors the probability of achieving these goals is increased. However, self-monitoring, independent of setting goals, is sometimes less effective at motivating behaviors (Schnoll & Zimmerman, 2001).
College health courses appear to be an effective venue for promoting long-term improvements in health behaviors through interventions in a college setting. Incorporating interventions into these natural learning environments can support the enhancement of nutrition knowledge; a fundamental component of nutrition interventions. Further, they allow for the incorporation of evidence-based strategies and opportunities to foster increased awareness of the personal relevance of health knowledge and behaviors. Finally, the duration of a semester-long course allows for sustained use of strategies and the development of skills for the promotion of self-efficacy and motivation to engage in healthy behaviors.

NUTRITION EDUCATION COURSE DEVELOPMENT AND PEDAGOGY

Effective courses are designed and developed to promote meaningful learning and understanding for students (Wiggins & McTighe, 2005). These understandings then become the foundations of knowledge from which all further education and experiences extend. For learning to be meaningful, it must be perceived as relevant in the lives of the students. A well-designed course offers opportunities for students to recognize the personal relevance of the information and concepts presented. Further, effective courses offer opportunities for students to transfer and apply new understandings to other experiences. Thus, for a course to be effective, it must both foster meaningful learning experiences and promote the application of understandings to future growth and learning.

The development of effective courses begins with the establishment of the desired outcomes or objectives. Determining the desired outcomes first is pivotal, as it sets the
stage for creating meaningful experiences in the learning process and supports the establishment of appropriate tools for assessing outcome achievements (Wiggins & McTighe, 2005). The desired outcomes or objectives answer the question; what do we want the students to understand as a result of participating in the course? Core objectives reflect the understanding of fundamental concepts in the course from which secondary objectives may be established. In college-level nutrition education, the establishment of these objectives may be guided by the national health education standards (Joint Committee on National Health Education Standards, 2013). These standards are designed to support a universal set of objectives and expectations in nutrition education. Although these standards were established for K-12 curriculums, they offer a framework from which higher-level objectives may be developed. Further use of national health guidelines such as the Dietary Guidelines for Americans, 2010 (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010) and the 2008 Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2008) may support the development of age-appropriate objectives and expectations for a college population.

When developing a course, it is important to have congruency in the levels of difficulty between the course objectives, lesson processes, and outcome assessments. Use of Bloom’s Taxonomy (Bloom, Engelhart, Furst, & Hill, 1956) can support this goal, as it offers a hierarchy of educational objectives within the cognitive domain. This hierarchy includes the categories of knowledge, comprehension, application, analysis, synthesis, and evaluation that range from simple to complex in learning difficulty. In
Bloom’s Taxonomy, these levels of difficulty are defined with a standard language from which objectives may be established. Developing course objectives and corresponding lessons and assessments from the same level of difficulty within Bloom’s Taxonomy promotes congruency within the course.

With a firm understanding of the course objectives, assessments may be developed to determine if the desired outcomes are achieved and/or if the core understandings are readily applied to other experiences (Wiggins & McTighe, 2005). These assessments may be traditional in nature, including quizzes, tests and exams, or drawn from collective evidence in activities and applications of understanding. All assessment should be evaluated for content validity and reliability to ensure that they accurately and consistently measure achievement (Kitao & Kitao, 1999). Content validity may be determined by soliciting the opinions of experts in the field regarding the capacity of the tool to accurately assess achievement of the objectives or desired outcomes. For traditional tests, reliability may be determined through a variety of techniques including inter-item consistency testing, test/retest reliability testing, or split-half consistency testing. In traditional assessments, the use of a table of specifications can also support the development of valid assessments (Notar, Zuelke, Wilson, & Yunker, 2004). A table of specifications is designed to support balance and congruency between the instruction content and the assessment tool. Finally, an item analysis, including facility value and discrimination index testing, can ensure that each item in the assessment evaluates the students at an appropriate level of difficulty and is able to
discriminate between those that understand the content and those who do not (Kitao & Kitao, 1999).

After establishing the learning outcomes and associated assessments tools, the stage is set for creating effective learning environments. As noted previously, effective learning environments offer opportunities for students to recognize the relevance of information and concepts in their own lives. This fosters deeper, more meaningful understandings that form the foundations of future learning. One method of fostering personal relevance is to engage students in experiential learning. Through active engagement in the learning process, the learner transforms experiences into more meaningful understandings (Joplin, 2008).

Experiential Learning Theory (ELT) defines experiential learning as a “holistic process” in which a person transforms experiences into knowledge. The experiential learning process is further posited as a cycle that integrates two dimensions of learning; the grasping and the transforming of experiences (D. A. Kolb, 1984). Through active engagement, the student becomes holistically involved in the experience through physical, emotional, sensory, and cognitive interactions with the environment. In the ELT model, this is referred to as the “Concrete Experience.” Through “Reflective Observation” the student then thinks about the experience, noting any inconsistencies with previous knowledge or conflicts with existing understandings. Any realized conflicts or inconsistencies must be resolved by using resources and previous knowledge to transform the experience into new “Abstract Conceptualizations.” These new conceptualizations may foster further reflective observation to be sure that no further
conflict in understandings exists. They may also be applied to new experiences through “Active Experimentation”; the last stage in the experimental learning model. Thus, by actively engaging students in the learning process, students transform experiences into new, more meaningful understandings and knowledge from the foundations of personal experience.

Use of ELT in higher education requires the creation of “learning spaces” that support understanding through experiences (A. Y. Kolb & Kolb, 2005). These spaces consider the learning styles of the student and offer respect for the learner and for their current level of knowledge in the subject matter. They also facilitate student dialog in a non-threatening environment. This supports reflection and promotes the development of understandings. Finally, these learning spaces should enable students to take responsibility for their own learning and promote skills in lifelong inquiry and growth.

Similar to ELT, constructivism is a theory of learning that recognizes the value of student engagement in the learning process. In this theory, new understandings are constructed through “reflective abstractions” in response to conflicts in thoughts and understandings resulting from the new experiences (Fosnot & Perry, 2005). In constructivism, the instructor’s role is to facilitate and support student self-directed learning while mediating the learning process (Brooks & Brooks, 2001). To do this, the instructor must first create opportunities for students to construct new understandings from experiences that challenge previous knowledge. The instructor must further support student exploration and encourage connections to student-relevant experiences or other aspects of the student’s life. This should all occur in an environment that is amenable to
inquiry, dialog, and sharing. Essentially, the instructor must relinquish some of the responsibility for learning to the student and enable them to autonomously engage in the learning process. By engaging in the learning process, the student experiences learning that either expands on existing knowledge or creates conflict with previous knowledge. To resolve these conflicts, the students must either integrate the new information into previous knowledge or construct new understandings to accommodate the new learning. The active engagement in the learning process internalizes student learning and results in a more personally meaningful understanding of information and concepts that can be applied to other aspects of the student’s life.

Constructivism or ELT may be most appropriate in adolescence, late adolescence, or in adult education where increased independence would support the acceptance of a self-directed course. Further, adolescents, late adolescents, and adults are distinctly different from children in their learning styles and goals. From empirical evidence, assumptions have been proposed to help understand the adult learning process (Knowles, 1973). First, adults tend to be independent learners with the capacity to engage in self-directed learning, independent of the instructor. Further, they offer a rich resource of experiences that can support understandings, particularly if the learning is made relevant to their needs. Adults also prefer problem-centered approaches to learning as it supports the translation of understandings to adult-relevant action. Finally, adults are often motivated to seek learning opportunities by internal influences such as the desire to increase self-esteem, recognition, or to promote mobility in the workforce. Experiential learning may be ideal for college students transitioning to a life of increased
independence and autonomy, as it offers opportunities to engage in self-directed inquiry and may result in more meaningful understandings that can be readily incorporated into student lives.

In college-level nutrition education course, offering opportunities for experiential learning may motivate improvements in dietary behaviors. One method of incorporating experiential learning into a traditional classroom would be to actively engage students in interactive nutrition activities that are relevant to their lives. In a recent study, researchers used SCT to guide the development of interactive nutrition activities for the promotion of improved dietary behaviors and the prevention of chronic disease. These activities included skill-building in reading labels, selecting healthy foods, goal-setting, and self-monitoring. Significant improvements in student fruit and vegetable consumption (Ha & Caine-Bish, 2009), whole grain consumption (Ha & Caine-Bish, 2011), and healthier beverage consumption behaviors (Ha, Caine-Bish, Holloman, & Lowry-Gordon, 2009) were observed as a result of participating in the course.

Use of experiential learning in a college nutrition course setting may be ideal, as it may promote the recognition of the personal-relevance of nutrition in the lives of students and result in deeper understanding of nutrition. Actively engaging students in the learning process may also support enhancements in self-efficacy through skill-building and mastery learning and may result in an increased motivation to engage in healthier dietary behaviors. Finally, experiential learning may offer college students the increased freedom and independence they desire through participation in self-directed learning.
ONLINE NUTRITION EDUCATION COURSE DEVELOPMENT

Self-directed learning and the active engagement of students in the learning process can also be achieved through computer technology. In the late 1990’s researchers evaluated the effectiveness of a nutrition education course with or without the addition of computer assisted instruction (CAI) (Carew, Chamberlain, & Alster, 1997). This early “hybrid” course offered students a method of reinforcing concepts presented in the traditional classroom through computer-based lessons that paralleled the course. Significant increases in nutrition knowledge were observed in students participating in the “hybrid” course when compared to students not participating in the intervention. This study was one of the first to illustrate the potential benefits of computer-based support in nutrition education.

Currently, computers and the use of the World Wide Web play a significant role in the education of most college students. Web-based distance learning is a now commonplace, offering opportunity for students to participate in distance learning that is both flexible and convenient. Online courses are also often well received by students. In focus groups, students who participated in an online nutrition education program reported finding the student-centered course convenient, accessible, and motivating (Mazurak, Whybrow, Varnhagen, & Field, 2005). They further reported that the lack of distractions and flexibility was a welcome change from traditional classrooms. Similarly, in another nutrition education study, students expressed an appreciation for the flexibility and convenience of an online format (Rochester & Pradel, 2008). However, some of these
students reported having difficulty understanding the concepts presented in the course; many preferring a hybrid course over the pure online format.

Online nutrition education courses may be effective at increasing nutrition knowledge and motivating students to consume a healthy diet. In a research study to determine if of an online nutrition education intervention was feasible in a college setting, researchers found the intervention feasible (Tarra M. Cousineau, Franko, Ciccazzo, Goldstein, & Rosenthal, 2006). Moreover, the researchers believed that if the intervention provided personal dietary feedback and targeted the specific needs of the student population, it may also be an effective tool at increasing nutrition knowledge and promoting improved dietary behaviors. Other researchers have compared the effectiveness of a traditional, online and hybrid nutrition course at increasing the nutrition knowledge of nursing students (Buckley, 2003). In this study the online course was found to be as effective as the traditional classroom course at increasing nutrition knowledge, however, nurses reported the strongest support for the hybrid format.

Online formats may also be effective in promoting motivation to be physically active in a college setting. Researchers compared student motivation to engage in physical activity behaviors between participants in an online, hybrid, and traditional course designed to promote increased physical activity (Sidman, Fiala, & D’Abundo, 2011). Although, one might expect that the students selecting to participate in the online course would be less motivated to stay physically active, online participants were found to be equally motivated and often chose the online course to fit into their busy lifestyles. These results are supported by a meta-analysis of online learning where the evidence
suggests that hybrid courses offer greater benefit to older learners than pure online or traditional classrooms (Means, Toyama, Murphy, Bakia, & Jones, 2009). The hybrid format was not found to be superior, however, as the benefits may have been associated with the increased flexibility, opportunities for collaboration, increased time on task or the pedagogy associated with a hybrid format.

The development of an effective online course requires an understanding of the essential components of web-based design. When designing a course, it is important to establish a learning environment that is easy to navigate, offers feedback, and does not overwhelm the student (Smith, 2009). To achieve this, a learner-centered environment should be developed that supports repetition and unlimited access. The content should also be clear, unambiguous, and free of typographical errors. Further, the content should be “chunked” into smaller segments to support increased retention, ease of repetition, and allow for reflection. Finally, the course should offer opportunities for student feedback to reflect their levels of understanding and to guide the student in the self-directed learning process.

Effective online course design may also benefit from the collaboration between researchers, professionals, and students. Researchers in one study used focus groups to solicit the features of an online program thought to be most important to students and to professionals working with the students (Tara M Cousineau, Goldstein, & Franko, 2004). Concept maps were used to prioritize the specific features thought to be important to each group. This proposed method of design and development is thought to ensure content relevance in the lives of students while addressing their most pressing needs. Similarly,
researchers assembled college freshman focus groups to determine the effective components of a seventy-five minute hybrid nutrition intervention (Kicklighter, Koonce, Rosenbloom, & Commander, 2011). Components that addressed the specific needs of students were found to be most effective, motivating some students to make behavioral changes. Students also found the peer instructors to be “believable messengers” that motivated healthier behaviors. Ineffective components included the use of interactive computer games. Although the students found the games to be entertaining, they were not thought to enhance learning. These studies suggest that determining the specific needs of an undergraduate population when developing a nutrition education course can support more effective targeting of interventions and promote personally-relevant changes in dietary behaviors.

CONCLUSIONS

Changes in energy balance variables and weight gain that often occurs during late adolescents and the transition to college is well recognized. Moreover, the adoption of less-than-optimal dietary habits and physical activity behaviors of students during the college years is also well recognized. To better understand the nature of these lifestyle changes, empirical research has identified the social and environmental risk factors thought to influence these energy balance behaviors. Further, behavioral theories have contributed to a better understanding of these influences and have guided the selection of strategies thought to be most effective in this population. Understanding the nature of these influences and the strategies found to be successful in a college population can
support the effective development of interventions targeting improvements in energy balance behaviors.

Incorporating these interventions into a college level nutrition course can be an effective approach at increasing energy balance knowledge and improving diet and physical activity behaviors. For young adults, an online format and the use of experiential learning are ideal as they facilitate self-directed learning to accommodate an emerging independent lifestyle. Moreover, experiential learning can support awareness of the personal relevance of nutrition and physical activity behaviors in the lives of the students and promote a deeper understanding of energy balance.

With these factors in mind, we examined the efficacy of an online, interactive energy balance course developed from a framework of behavioral theories at increasing energy balance knowledge and improving determinants of diet and physical activity behaviors. We also examined to what extent applications of behavioral theory were perceived to have supported concepts presented in the course and/or increased student motivation/ability to eat a healthy diet and meet physical activity recommendations.
INTRODUCTION

For many Americans, few events will impact their lives as significantly as the transition from high school to college. During this transition, young adults characteristically experience an increase in independence, responsibility, and freedom of choice that often results in significant and sometimes unfavorable lifestyle changes (Nelson et al., 2008). For many, these changes include a reduction in physical activity levels or the adoption of unhealthy dietary behaviors. These adverse changes to energy balance variables can result in significant energy imbalances and weight gain (Levitsky, Halbmaier, & Mrdjenovic, 2004; Wengreen & Moncur, 2009). Preparing students with the tools, skills and support necessary to cope with these unanticipated challenges may promote the adoption of healthier lifestyles and foster sustained healthier diet and physical activity choices throughout the college years (Strong et al., 2008).

Improving nutrition and physical activity behaviors through college-level nutrition and health education programs is a strategy used in some interventions. Increasing physical activity awareness through participation in an introductory fitness course using pedometers has been shown to result in increased physical activity among college students (Jackson & Howton, 2008). Similarly, participation in a traditional nutrition education course can result in improved dietary behaviors (Pawlak, Cerutti, et al., 2009), presumably due to an increase in nutrition knowledge, as a higher level of nutrition knowledge is often associated with consuming a healthier diet (Wardle et al.,
Determinants of behavior (self-efficacy and self-regulatory skills) associated with dairy consumption, have also been shown to improve as a result of participating in an online nutrition course emphasizing increased dairy consumption (Poddar, Hosig, Anderson, Nickols-Richardson, & Duncan, 2010).

Learning environments that offer opportunities for transactions between the individual and their environment can promote a deeper understanding of concepts through experiential learning (D. A. Kolb, 1984). By actively participating in the learning process, individuals transform experiences into more comprehensive understandings through their adaptations to these experiences. In nutrition education, participation in an online interactive learning environment designed to promote healthy diet and physical activity behaviors has been shown to promote nutrition knowledge, healthy dietary behaviors and reduce perceived barriers to physical activity when compared to controls (Franko et al., 2008).

Use of behavioral theory as a framework for understanding the behaviors of populations can support the design and development of effective interventions for the promotion of behavioral change (Rimer & Glanz, 2005). In nutrition education, behavioral theory can offer a deeper understanding of the determinants of behavior, promote the selection of appropriate, evidence-based strategies, and support the development of tools for the evaluation of psychosocial change (Contento, 2011). The theory of planned behavior (TPB), a commonly used theory in behavioral research, posits that our beliefs associated with a behavior help to form our attitudes, subjective norms and perceived behavioral control (self-efficacy and controllability) towards engaging in
the behavior (Ajzen, 1991). These determinants further influence our intentions to engage in the behavior. In young adults, perceived behavioral control has been shown to have the strongest influence over intentions to eat a healthy diet (Nordrehaug Astrom & Rise, 2001), while self-efficacy has been shown to have the strongest influence over intentions to engage in regular exercise (Rhodes & Courneya, 2003).

Social cognitive theory (SCT), another commonly used theory in behavioral research, posits that our behavioral choices result from reciprocal influences that occur naturally between personal factors, including outcome expectations, self-efficacy, and goal-setting, behavioral factors, including knowledge and skills, and environmental factors (Albert Bandura, 1986). Through modeling or actively engaging in a behavior, individuals formulate more accurate conceptions of the behavior that result in adjustments to personal and behavioral factors associated with the behavior (Albert Bandura, 1999). Changes in these factors can influence motivation to engage in behaviors. Of the personal determinants, self-efficacy is thought to play the most critical role in motivating behavior (A Bandura, 1989). In health promotion, self-efficacy can play a central role in motivating and sustaining action toward engaging in healthy behaviors (Albert Bandura, 2004).

Consistent with behavioral theory and the process of experiential learning, a science-based, interactive online energy balance course was designed and developed to improve energy balance knowledge and determinants of behavior towards eating a healthy diet and engaging in the recommended amount of physical activity. The purpose of this study was (1) to determine the effectiveness of this course and intervention at
increasing energy balance knowledge and improving determinants of behavior towards eating a healthy diet and engaging in the recommended amount of physical activity and (2) to assess to what extent the applications of behavioral theory were perceived by students to influence student knowledge and motivation/ability to eat a healthy diet and meet physical activity recommendations.

METHODS

A two-week, online, science-based, interactive, energy balance course was designed using the TPB and SCT as guides in the development of the course content and the selection of applications of behavioral theory (Table 1). Scientific concepts introduced in the curriculum included; basic processes of energy transformation, metabolism and functions of select nutrients, and environmental and biological influences associated with energy balance. Required assignments included 3-day diet and physical activity recalls, diet and energy balance analysis, and the preparation of an action plan.

A knowledge assessment, consisting of 25 multiple-choice questions, was developed from the curriculum to assess energy balance knowledge. Use of Blooms Taxonomy (Bloom et al., 1956) and a table of specifications (Notar et al., 2004) supported congruency between the curriculum and assessment questions and alignment with learning objectives. The assessment was reviewed by a panel of peers for content validity. One question was replaced due to ambiguity. Further analyses included split-
half internal consistency testing (r = 0.69) for reliability and item analyses including facility value and discrimination index testing (Kitao & Kitao, 1999).

A self-perception survey, developed from a framework of the TPB (Ajzen, 2006), was used to assess intentions, attitude, subjective norms, and perceived behavioral control (PBC) toward eating a healthy diet and engaging in the recommended amount of physical activity (Table 2). The survey was evaluated for reliability and modified prior to beginning the research. An internal consistency value could not be calculated for the diet intentions measure, as the pre- and post-intervention responses to one item of the two-item measure were identical in reliability tests. A two-item measure assessed physical activity intention (Cronbach’s α = .85). Diet and physical activity attitudes were assessed using three single item measures, as each was found to measure independent attitude judgments towards eating a healthy diet and engaging in the recommended amount of physical activity. Diet subjective norms were assessed using a three-item measure (Cronbach’s α = .73). An internal consistency value could not be calculated for the physical activity subjective norms measure, as one of the items in the two-item measure was eliminated due to a typographical error. Finally, a four-item measure assessed diet and physical activity PBC (Diet Cronbach’s α = .87, Physical activity Cronbach’s α = .81).

A course evaluation was developed to solicit student feedback of the online course and to assess to what extent the applications of behavioral theory supported concepts presented in the curriculum and/or increased student motivation/ability to eat a healthy diet and meet physical activity recommendations. The course evaluation, a
demographics survey, and identical pre- and post-intervention energy balance knowledge assessments and self-perception surveys were completed by students as course requirements.

In the fall of 2012, University of Vermont (UVM) students were recruited, though on-campus posters, to participate in the study as members of the comparison group. The Committee on Human Research in the Behavioral Sciences at the University of Vermont approved the research protocol in an expedited review of the study. Implied consent was obtained from students with the completion of initial assessments. Eligible students were 18-25 years of age and had not enrolled a nutrition course prior to the study. Participants received a $20.00 gift certificate to the University Bookstore after successfully completing an online demographics survey and two identical energy balance knowledge assessments and self-perception surveys administered two weeks apart.

During the 2013 UVM winter session, the online, energy balance course was offered for one credit through UVM’s Department of Nutrition and Food Sciences. Registration was open to all university students as well as the general public through the University’s Division of Continuing Education. Enrolled students were invited to participate in the study associated with the course, without benefit, but could elect to not participate, without penalty. Eligible students were 18-25 years of age and had not completed a nutrition course prior to the study.

All data, including survey and reliability testing, were analyzed using IBM SPSS Statistics for Windows, Version 22.0, (IBM Corp., Armonk, NY). All data were collected in databases through online surveys and programs. Identifiable data were
replaced with randomly-generated identifiers prior to analysis. The BMI for each student was calculated using self-reported data for height and weight. Two-tailed, independent samples t-tests and Chi-square tests were conducted to determine if demographic data differed significantly between course participants and the comparison group. Responses to the pre-intervention and initial self-perception surveys from course participants and students in the comparison groups were compared using two-tailed independent samples t-tests to determine if there were statistical differences in determinants of behavior at baseline. Two-tailed, paired samples t-tests were conducted to compare pre- and post-intervention responses to knowledge assessments and self-perception surveys from course participant group and to compare responses to the same assessments and surveys taken two weeks apart from the students in the comparison group. Cross tabulation analyses were conducted to determine the nature of the changes in responses to self-perception survey items in both groups. Differences were considered significant at P < .05. Subsequent two-tailed, independent samples t-tests were conducted to compare the mean changes in responses to knowledge assessments and self-perception surveys between the course participants and the students of the comparison group. A Bonferroni correction was applied to significance values to adjust for multiple tests on the same data set. Differences were considered significant at P < .004 (.05/13). Course evaluation responses were reviewed to determine the perceived influence of applications of behavioral theory on knowledge and motivation/ability to engage in targeted behaviors.

RESULTS
A total of 49 students completed the online, energy balance course during the 2013 winter session. Fifteen of these students were ineligible for the study, as they had previously completed a nutrition course (14) or exceeded the age limit (1). One student chose not to participate in the study. During the 2012 fall semester, 26 students participated in the study as members of the comparison group. No statistical differences in demographics, health majors, and college year were found between the course participants and the comparison group (Table 3).

Significant differences in baseline self-perception survey responses were found between the course participants and the comparison group (Table 4). A more favorable attitude associated with the adjective pairs “Very Unpleasant” to “Very Pleasant” was observed in the course participants toward eating a healthy diet (P = .04) and engaging in the recommended amount of physical activity (P = .04). Moreover, course participants were found to have greater PBC (P = .02) toward engaging in the recommended amount of physical activity.

Significant differences were observed between the course participants and the comparison group in pre- to post- mean changes in responses to knowledge assessments and self-perception surveys (Table 4). A significant increase in energy balance knowledge was observed in course participants when compared to the comparison group (P < .001). A significant difference was also observed between the course participants and the comparison group in PBC (P = .004) toward consuming a healthy diet. The changes associated with this outcome included improvements in 28% of the responses to
the PBC item measure in course participants and a decline in PBC for 25% of the responses in the comparison group to the PBC item measure. (Cross tabulation data not shown).

In course evaluations, over ninety-six percent of the students believed that the curriculum had increased their general nutrition knowledge from a moderate to great extent. Approximately eighty-two percent of the students reported that the lesson activities supported the concepts in the lesson from a moderate to great extent. Students also reported that several applications of behavioral theory were perceived to influence their motivation/ability to eat a healthy diet and meet physical activity recommendations from a moderate to a great extent (Figure). The applications of behavioral theory that were perceived to be most influential in motivating behavior included the diet recalls, physical activity recalls, and the diet and energy balance analysis. Although perceived to be less influential, the remaining applications of behavioral theory, including the action plan, interactive activities, and peer and professional interviews, were perceived to influence motivation/ability to engage in targeted behaviors from a moderate to a great extent for more than 68% of the students.

**DISCUSSION**

The online, interactive, energy balance course was effective at increasing energy balance knowledge in a college population. This outcome is consistent with other studies, where an increase in nutrition knowledge was observed as a result of student
participation in an online, college-level nutrition course (N. L. Cohen, Carbone, & Beffa-Negrini, 2011). Moreover, the use of an online format in nutrition education has been shown to be as effective at increasing nutrition knowledge as a traditional lecture format (Buckley, 2003) and is accepted among students and health experts alike, particularly when the content is designed to address the issues and needs of the student population (Tarra M. Cousineau et al., 2006).

The effectiveness of this intervention at significantly increasing energy balance knowledge may be partially attributable to the science-based design of the curriculum, as it may have fostered a deeper understanding of energy balance and the physiological and metabolic impact of diet and physical activity behaviors. The interactive design of the program may also have supported the significant increase in energy balance knowledge through active learning. Research comparing the effectiveness of online active learning to expository learning in the promotion of knowledge is mixed (Means et al., 2009). However, in this study, 4 out of 5 students reported that the interactive lesson activities supported the concepts in the lesson from a moderate to great extent. Finally, the course grading structure may have incentivized a greater understanding of energy balance knowledge, as the post-intervention knowledge assessment scores were used to calculate the students’ final grade in the course. Although this may have resulted in higher scores than if the same intervention were implemented outside of a college setting, the greater increases in knowledge may offer support for the integration of health interventions in college courses.
The intervention was also found to be effective at improving determinates of behavior associated with eating a healthy diet and less effective at improving determinants of behavior associated with engaging in the recommended amount of physical activity. This result may be attributable to the course content, as it focused more on improving dietary behaviors than physical activity behaviors. The smaller gains associated with physical activity in our study may have also been a consequence of setting the standard too high; students may have perceived “engaging in the recommended amount of physical activity” as too daunting a task. However, in baseline self-perception comparisons, students who elected to participate in the course intervention reported stronger attitudes and PBC toward engaging in the recommended amount of physical activity than students in the comparison group. This may have resulted in an underestimation of the effectiveness of the intervention at improving determinants of behavior associated with physical activity in a general college population.

The effectiveness of the intervention at increasing PBC towards consuming a healthy diet may be attributable to the curriculum design, increased dietary awareness, and skills resulting from the use of applications of behavioral theory. The science-based design may have promoted increased awareness of the personal relevance of nutrient and physical activity recommendations. This presumption is supported by previous research where a science-based college nutrition course was effective at promoting energy balance among female freshman with a BMI > 24 when compared to controls (Matvienko et al., 2001). Diet and physical activity recalls and energy balance and diet analysis
assignments may have increased awareness of the need to change and developed skills in selecting healthier food items and physical activity behaviors. Support for activities that promote increased dietary awareness is seen in recent research where most students in a traditional nutrition course believed an online dietary analysis program would be effective at motivating peers to improve their dietary behaviors (Morris & Merrill, 2004). Further, student skills and self-efficacy in goal-setting may have also been increased as a result of developing an individualized action plan. Additional support for the use of these applications of behavioral theory in nutrition interventions is seen in this study where the majority of students perceived the interactive activities, diet, and physical activity recalls, diet and energy balance analysis assignment and the preparation of an action plan to have influenced their motivation/ability to eat a healthy diet and meet physical activity recommendations from a moderate to great extent.

Although intentions and determinants of behavior are not direct measures of behavioral change, intentions and PBC have been shown to be predictive of some health behaviors. In a meta-analysis, researchers found the TPB to be predictive of a variety of health behaviors with an average multiple correlation between intention and PBC with behavior of $r = .52$ (Armitage & Conner, 2001). In other research, intentions have been shown to predict fruit and vegetable consumption (Blanchard et al., 2009) and participation in physical activity (Dzewaltowski et al., 1990) in a college population. While sufficient improvements in intentions towards engaging in a behavior have been shown to promote behavioral change (Webb & Sheeran, 2006), future studies are necessary to determine if the observed improvements in determinants of behavior found
in this study would result in improvements of actual behaviors as well as promote long-term behavioral change.

There are several limitations in this study worth noting. First, the participants in the study were self-selected, which may have resulted in a bias toward students with stronger interests in energy balance and perhaps a greater readiness for change in diet and physical activity behaviors. Moreover, for those students with strong intentions or very positive attitudes at baseline, the study may have failed to capture improvements in intentions and attitude due to the limitations of the self-perception instrument. Time may have been a confounding factor in our study, as the students in the experimental and control groups completed pre and post assessments during different academic periods. Consequently, students in each group may have been subject to different environmental influences of behavioral change. Finally, the relatively short duration of the course may have limited the influence of the applications of behavioral theories in promoting change in determinants of behavior.

Effective interventions are needed in a college population to promote healthy diet and physical activity behaviors and support weight maintenance. A college-level, energy balance course, designed and developed from a framework of behavioral theory, can be an effective tool in promoting increases in energy balance knowledge and improvements in PBC toward eating a healthy diet in a college population. This study suggests that the use of a science-based curriculum and engaging students in experiential learning through interactive activities can support a deeper understanding of energy balance concepts and promote improvements in energy balance knowledge. This study also suggests that the
use of select applications of behavioral theory including peer and professional interviews, interactive activities, diet and physical activity recalls, diet and energy balance analysis, and goal-setting activities can support improvements in PBC towards eating a healthy diet. Further, these applications of behavioral theory are perceived by most students to effectively influence their motivation/ability to eat a healthy diet and/or meet physical activity recommendations. These novel findings could play an important role in the future design and development of effective interventions in a college population for the promotion of behavioral change in energy balance behaviors.
Table 1  Application of the Theory of Planned Behavior (TPB) and Social Cognitive Theory (SCT) in the "Science of Energy Balance" Course.

<table>
<thead>
<tr>
<th>TPB &amp; SCT Construct / Mediator</th>
<th>Application of Behavioral Theory</th>
</tr>
</thead>
</table>
| Attitude/ Outcome Expectations | **Curriculum:** to improve knowledge, attitude, and outcome expectations toward healthy diet and physical activity behaviors through positive messages and correcting misconceptions.  
**Professional Interviews:** to reinforce positive messages and offer professional support for healthy diet and physical activity behaviors.  
**Diet & Physical Activity Recalls:** to support positive self-evaluation of diet and physical activity behaviors. |
| Subjective Norms/ Social Outcome Expectations | **Peer Interviews and Images:** to model social support for healthy diet and physical activity behaviors and promote positive social outcome expectations. |
| Perceived Behavioral Control/ Self-Efficacy | **Diet & Energy Balance Analysis:** to increase skills in diet and physical activity analysis for the promotion of self-efficacy.  
**Interactive Activities:** to promote skills, confidence and mastery experiences in choosing a healthy diet and improving physical activity behaviors for the promotion of self-efficacy. |
| Perceived Behavioral Control/ Controllability | **Curriculum:** to promote problem solving skills and increase awareness of common barriers to healthy diet and physical activity behaviors for stimulus control and relapse prevention. |
| Self-Regulation | **Diet & Energy Balance Analysis:** to support skills in self-regulation and establish goals for the promotion of healthy diet and physical activity behaviors.  
**Action Plan:** to support skills in goal setting and motivate action. |
Table 2. Diet & Physical Activity Self-Perception Surveys on a 1-5 Likert Scale.

**Diet Survey Preface:** "...a Healthy Diet is defined as a daily eating pattern that includes multiple servings of fruit and vegetables, fiber and whole grains, while limited in saturated fats, added sugars, and salt."

**Physical Activity Survey Preface:** "...for adults, at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity physical activity is recommended."

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Item</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intention</td>
<td>&quot;In the future, I intend to...&quot;&lt;sup&gt;a, b&lt;/sup&gt;</td>
<td>&quot;Very Unlikely&quot; to &quot;Very Likely&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;In the future, I want to...&quot;&lt;sup&gt;a, b&lt;/sup&gt;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
<tr>
<td>Attitude</td>
<td>&quot;My...&lt;sup&gt;a, b&lt;/sup&gt; in the future would be/is...&quot;</td>
<td>&quot;Very Unnecessary&quot; to &quot;Very Necessary&quot;&lt;sup&gt;c&lt;/sup&gt; &quot;Very Pleasant&quot; to &quot;Very Unpleasant&quot; &quot;Very Good&quot; to &quot;Very Bad&quot; &quot;Very Unenjoyable&quot; to &quot;Very Enjoyable&quot;&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Subjective</td>
<td>&quot;Most people who are important to me think that I should...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future.&quot;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
<tr>
<td>Norm</td>
<td>&quot;It is expected of me to...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future.&quot;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;People in my life, whose opinions I value, think that I should...&quot;&lt;sup&gt;a&lt;/sup&gt; in the future.&quot;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
<tr>
<td>Perceived</td>
<td>&quot;For me to...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future would be...&quot;</td>
<td>&quot;Very Difficult&quot; to &quot;Very Easy&quot;</td>
</tr>
<tr>
<td>Behavioral</td>
<td>&quot;If I wanted to, I could...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future.&quot;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
<tr>
<td>Control</td>
<td>&quot;How much control do you believe you have over...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future?</td>
<td>&quot;No Control to &quot;Complete Control&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;I am sure /confident&lt;sup&gt;d&lt;/sup&gt; that I can...&quot;&lt;sup&gt;a, b&lt;/sup&gt; in the future.&quot;</td>
<td>&quot;Strongly Disagree&quot; to &quot;Strongly Agree&quot;</td>
</tr>
</tbody>
</table>

<sup>a</sup> eat/eating a healthy diet, <sup>b</sup> engage/engaging in the recommended amount of physical activity, <sup>c</sup> Diet survey only, <sup>d</sup> Physical activity survey only
Table 3. Demographic Characteristics of Course Participants and Comparison Group.

<table>
<thead>
<tr>
<th></th>
<th>Participant n = 33</th>
<th>Comparison n = 26</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Mean (SD)</strong></td>
<td>20.1 (1.6)</td>
<td>19.5 (1.6)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (%)</td>
<td>7 (21)</td>
<td>4 (15)</td>
</tr>
<tr>
<td>Female (%)</td>
<td>26 (79)</td>
<td>22 (85)</td>
</tr>
<tr>
<td><strong>BMI Mean (SD)</strong></td>
<td>23.3 (4.7)</td>
<td>21.7 (3.6)</td>
</tr>
<tr>
<td>Male Mean (SD)</td>
<td>26.1 (7.4)</td>
<td>24.4 (2.5)</td>
</tr>
<tr>
<td>Female Mean (SD)</td>
<td>22.5 (3.5)</td>
<td>21.3 (3.7)</td>
</tr>
<tr>
<td><strong>College Major</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health (%)</td>
<td>1 (3)</td>
<td>2 (8)</td>
</tr>
<tr>
<td>Non-Health (%)</td>
<td>32 (97)</td>
<td>24 (92)</td>
</tr>
<tr>
<td><strong>College Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman (%)</td>
<td>11 (33)</td>
<td>9 (35)</td>
</tr>
<tr>
<td>Sophomore (%)</td>
<td>3 (9)</td>
<td>8 (31)</td>
</tr>
<tr>
<td>Junior (%)</td>
<td>5 (15)</td>
<td>3 (12)</td>
</tr>
<tr>
<td>Senior (%)</td>
<td>14 (42)</td>
<td>6 (23)</td>
</tr>
<tr>
<td><strong>Ethnicity/Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (%)</td>
<td>24 (73)</td>
<td>23 (88)</td>
</tr>
<tr>
<td>Non-Caucasian (%)</td>
<td>9 (27)</td>
<td>3 (12)</td>
</tr>
</tbody>
</table>

*No significant differences between the groups at p < 05, a Two-tailed independent samples t-tests and b Chi-square tests to determine if there is a statistical difference between the course participants and the comparison group, c Health Majors included: Nutrition, Nursing (3)
Table 4. Comparison of Mean Changes in Knowledge and Determinants of Behavior Between Course Participants and Comparison Group.

<table>
<thead>
<tr>
<th></th>
<th>Course Participants n = 33</th>
<th>Comparison Group n = 26</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test mean (SD)</td>
<td>Post-Test mean (SD)</td>
<td>Mean Change</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intentions (2 items)</td>
<td>4.7 (.53)</td>
<td>4.8 (.51)</td>
<td>0.1 (.24)</td>
</tr>
<tr>
<td>Attitude (3 single items)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Very Necessary to Very Unnecessary&quot;</td>
<td>4.4 (.83)</td>
<td>4.5 (.67)</td>
<td>0.1 (.61)</td>
</tr>
<tr>
<td>&quot;Very Pleasant to Very Unpleasant&quot;</td>
<td>4.4 (1.1)</td>
<td>4.6 (.75)</td>
<td>0.2 (.74)</td>
</tr>
<tr>
<td>&quot;Very Good to Very Bad&quot;</td>
<td>4.8 (.49)</td>
<td>4.9 (.42)</td>
<td>0.1 (.38)</td>
</tr>
<tr>
<td>Subjective Norms (3 items)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PBC (4 items)</td>
<td>4.0 (.93)</td>
<td>4.3 (.71)</td>
<td>0.3 (.72)</td>
</tr>
<tr>
<td>Physical Activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intentions (2 items)</td>
<td>4.7 (.59)</td>
<td>4.9 (.28)</td>
<td>0.2 (.55)</td>
</tr>
<tr>
<td>Attitude (3 single items)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Very Pleasant to Very Unpleasant&quot;</td>
<td>4.3 (.88)</td>
<td>4.3 (.78)</td>
<td>0.0 (.85)</td>
</tr>
<tr>
<td>&quot;Very Good to Very Bad&quot;</td>
<td>4.9 (.44)</td>
<td>4.9 (.44)</td>
<td>0.0 (.61)</td>
</tr>
<tr>
<td>&quot;Very Enjoyable to Very Unenjoyable&quot;</td>
<td>3.7 (1.4)</td>
<td>3.9 (1.4)</td>
<td>0.2 (1.9)</td>
</tr>
<tr>
<td>Subjective Norms (1 item)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PBC (4 items)</td>
<td>4.1 (.98)</td>
<td>4.3 (.77)</td>
<td>0.2 (.78)</td>
</tr>
</tbody>
</table>
| PBC = Perceived Behavioral Control. a Two-tailed, independent samples t-tests comparing mean changes between course participants and comparison group. b, c, d Significantly different determinants of behavior at baseline between the course participants and comparison group at P < .05.
Figure

Perceived Influence of Applications of Behavioral Theory on Student Motivation/Ability to Eat a Healthy Diet and/or Meet Physical Activity Recommendations. (n = 33)

Question: To what extent did the _______ influence your motivation/ability to eat a healthy diet and/or meet physical activity recommendations?

Interviews *
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

Activities *
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

Diet Recall
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

PA Recall
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

Diet & EB Analysis
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

Action Plan
- Great Extent
- Large Extent
- Moderate Extent
- Small Extent
- Not at all

PA = Physical Activity, EB = Energy Balance, * Five students responded "Not sure"
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APPENDICES

A. Cross Tabulation Analysis of Responses to Self-Perception Survey Items Associated with Diet Attitude and Diet Perceived Behavioral Control for Which Significant Differences were Observed in Pre to Post Mean Changes Between the Course Participants and the Comparison Group………………………………………………………………………… page 94

B. Demographics Survey……………………………………………………………page 95

C. Nutrition Knowledge Assessment .......................................................... page 96
APPENDIX A

Cross Tabulation Analysis of Responses to Self-Perception Survey Items Associated with Diet Attitude and Diet Perceived Behavioral Control for Which Significant Differences were Observed in Pre to Post Mean Changes Between the Course Participants and the Comparison Group.

<table>
<thead>
<tr>
<th>Change</th>
<th>Question #1</th>
<th>Question #2</th>
<th>Question #3</th>
<th>Question #4</th>
<th>Question #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 → 5</td>
<td>82%</td>
<td>65%</td>
<td>21%</td>
<td>8%</td>
<td>52%</td>
</tr>
<tr>
<td>5 → 4</td>
<td>-</td>
<td>19%</td>
<td>9%</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>5 → 3</td>
<td>-</td>
<td>8%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 → 5</td>
<td>9%</td>
<td>4%</td>
<td>9%</td>
<td>4%</td>
<td>12%</td>
</tr>
<tr>
<td>4 → 4</td>
<td>3%</td>
<td>4%</td>
<td>21%</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>4 → 3</td>
<td>3%</td>
<td>-</td>
<td>-</td>
<td>8%</td>
<td>-</td>
</tr>
<tr>
<td>4 → 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4%</td>
</tr>
<tr>
<td>3 → 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12%</td>
<td>-</td>
</tr>
<tr>
<td>3 → 4</td>
<td>3%</td>
<td>-</td>
<td>-</td>
<td>12%</td>
<td>-</td>
</tr>
<tr>
<td>3 → 3</td>
<td>-</td>
<td>-</td>
<td>9%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>3 → 2</td>
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<td>-</td>
<td>3%</td>
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</tr>
<tr>
<td>2 → 5</td>
<td>-</td>
<td>-</td>
<td>3%</td>
<td>-</td>
<td>3%</td>
</tr>
<tr>
<td>2 → 4</td>
<td>-</td>
<td>-</td>
<td>6%</td>
<td>8%</td>
<td>-</td>
</tr>
<tr>
<td>2 → 3</td>
<td>-</td>
<td>-</td>
<td>6%</td>
<td>8%</td>
<td>-</td>
</tr>
<tr>
<td>2 → 2</td>
<td>-</td>
<td>-</td>
<td>12%</td>
<td>15%</td>
<td>-</td>
</tr>
<tr>
<td>2 → 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>1 → 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4%</td>
<td>-</td>
</tr>
</tbody>
</table>

PAR = Course Participants (n=33),
COM = Comparison Group (n=26)

a "My eating a healthy diet in the future would be/is..." - "Very Bad" to "Very Good"
b "For me to eat a healthy diet in the future would be..." - "Very Difficult" to "Very Easy"
c "If I wanted to, I could eat a healthy diet in the future." - "Strongly Disagree" to "Strongly Agree"
d "I am sure that I can eat a healthy diet in the future." - "Strongly Disagree" to "Strongly Agree"
e "How much control do you believe you have over eating a healthy diet in the future" - "No Control" to "Complete Control"
APPENDIX B
Demographics Survey

1. What is your age (years)?
2. What is your gender?
   a. Female
   b. Male
3. What is your weight in pounds?
4. What is your height in inches?
5. What is your academic major?
6. What year are you?
   a. First Year
   b. Sophomore
   c. Junior
   d. Senior
   e. Non-degree
7. Select the nutrition courses you have taken at UVM. (check all that apply)
   a. NFS 043 Fundamentals of Nutrition
   b. NFS 053 Basic Concepts of Food
   c. NFS 063 Obesity, Weight Control and Fitness
   d. NFS 143 Nutrition in the Life Cycle
   e. NFS 153 Principles of Food Technology
   f. NFS 163 Sports Nutrition
   g. NFS 203 Food Microbiology
   h. NFS 205 Functional Foods
   i. NFS 223 Nutrition Educ. & Counseling
   j. NFS 243 Advanced Nutrition
   k. NFS 244 Nutrition in Health and Disease Prevention
   l. NFS 260 Diet and Disease
   m. NFS 262 Community Nutrition
   n. None
8. How would you describe yourself?
   a. American Indian or Native American
   b. Black or African American
   c. Asian or Asian American
   d. Hispanic or Latino
   e. White or Caucasian
   f. Other
APPENDIX C

Nutrition Knowledge Assessment

1. What is the major role of plants in an ecosystem?
   A. The production of carbon dioxide for use by other living things.
   B. The conversion of chemical energy to biological energy, mainly in the form of ATP.
   C. The conversion of light energy to chemical energy in organic compounds.
   D. The production of protein, fat, and cholesterol.

2. In the process of food metabolism, the cells of the body may ______________.
   A. Capture the energy in food in chloroplasts and convert it to heat.
   B. Convert the chemical bond energy in food to glucose for storage.
   C. Capture the energy in food in chloroplasts and convert it to fat for storage.
   D. Convert the chemical bond energy in food to biological energy.

3. Geoffrey’s estimated resting energy expenditure is 2300 Kcal per day. His total energy expenditure is 3100 Kcal per day. Today, he has consumed 840 Kcal for breakfast and 790 Kcal for lunch. He consumed 350 Kcal for snack and 910 Kcal for dinner. How would you describe his energy status?
   A. Geoffrey has a positive 210 Kcal energy balance and is losing weight.
   B. Geoffrey is in energy balance and is maintaining weight.
   C. Geoffrey has a positive 590 Kcal energy balance and is gaining weight.
   D. Geoffrey has a negative 210 Kcal energy balance and is losing weight.

4. Over a 24 hour period of time, a healthy adult consumes more energy than they expend. How will some of the cells of the body store the extra energy?
   A. They convert excess energy to glucose and fat.
   B. They convert excess energy to glycogen and fat.
   C. They convert excess energy to glycogen and begin breaking down fat.
   D. They convert excess energy to glucose and glycogen.

5. Hannah and Julie are the same age, height and weight. Hannah stays physically active, while Julie is inactive. To stay in energy balance, who will need to consume more energy?
   A. Julie will need to consume more energy.
   B. Hannah will need to consume more energy.
   C. Julie and Hanna will consume the same amount of energy, because their resting energy expenditure is the same.
   D. Julie and Hanna will consume the same amount of energy because they are the same age, height and weight.
6. Both Geoffrey and David weigh 180 pounds. David will swim at 20 yd/min (0.032 kcal/lb/min) for 30 minutes. Geoffrey will swim at 50 yd/min (0.07 kcal/lb/min) for 20 minutes. Who will expend more energy?
   A. Geoffrey will expend approximately 79 more kcal than David.
   B. David will expend approximately 51 more kcal than Geoffrey.
   C. Both expend the same amount of energy because they are the same weight.
   D. Geoffrey will expend approximately 51 more kcal than David.

7. Which of the following statements is correct?
   A. More water is lost in sweat during moderate physical activity than in vigorous physical activity.
   B. Dehydration can suppress muscle performance and initiate fatigue.
   C. Water is a non-essential macronutrient.
   D. Fat tissue contains more water than active muscle.

8. A healthy adult male, who skips both breakfast and lunch, is now feeling sluggish. Which statement could best explain his body’s energy state?
   A. His blood glucose level is low, and his liver is breaking down glycogen to supply the brain with energy.
   B. His blood glucose level is high, and his liver is making glycogen.
   C. His blood glucose level is low and his stomach is breaking down glycogen to supply the brain with energy.
   D. His blood glucose level is high and his metabolism has increased slightly.

9. A healthy adult male consumes a diet containing 15% saturated fat. Would you recommend a change in his diet?
   A. No. He consumes the recommended amount of saturated fat. Saturated fat is an essential part of a healthy diet.
   B. Yes. He consumes more than the recommended amount of saturated fat. This diet may increase his chances of developing some diseases, such as heart disease.

10. The food label on a food item indicates that it contains zero grams of trans fats per serving size. However, the food item may still contain some trans fats. Why?
    A. The definition of trans fats changes based on the food item.
    B. The amount of trans fats in a food item changes as it ages.
    C. A serving of the food item contains less than 0.5 grams per serving, so it can be labeled as containing zero grams of trans fat.
    D. Mislabeling of food items is common.
11. Why are complete proteins or complimentary proteins an important part of a healthy diet?
   A. They contain all the essential building blocks for glycogen synthesis.
   B. They are an essential source of energy for the brain.
   C. Fatty acids from proteins are stored in adipose tissue for use in between meals as an energy source.
   D. They contain all the essential amino acids for protein synthesis.

12. Why is the chronic consumption of alcoholic beverages not good for your health?
   A. It may cause inflammation of the intestinal tract resulting in a higher absorption of nutrients.
   B. It may result in fatty liver disease.
   C. It may result in weight loss as alcohol is not a source of energy in the diet.
   D. It may speed the metabolism of other energy sources and decrease the synthesis of fat.

13. How might a high salt diet affect blood pressure?
   A. There is no association between a high salt intake and blood pressure levels.
   B. A high salt diet increases body perspiration and fluid loss. This can result in decreased blood pressure.
   C. A high salt diet may promote fluid retention in the body. This can result in increased blood pressure.
   D. A low salt diet increases thirst. This increases bodily fluid volumes which can decrease blood pressure.

14. Your body will quickly show signs of illness if it is low in any essential vitamin or mineral.
   A. True
   B. False

15. What are phytochemicals and where do we find them?
   A. Chemical preservatives found in processed foods that extend shelf life.
   B. Chemicals found naturally in plants that may provide health-promoting properties.
   C. Chemicals added to food to enhance flavor.
   D. Essential macronutrients found in a healthy diet.

16. How does vitamin D promote stronger bones?
   A. It interacts with intestinal cells to increase calcium absorption from the diet.
   B. It increases the amount of potassium stored in cells.
   C. It interacts with kidney cells to increase the amount of calcium lost in the urine.
   D. It promotes bone resorption when blood levels of calcium are low.
17. Which of the following foods contains the least amount of saturated fat?

<table>
<thead>
<tr>
<th>Commercial Blueberry Muffin</th>
<th>Cheerios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition Facts</td>
<td>Nutrition Facts</td>
</tr>
<tr>
<td>Serving Size</td>
<td>Serving Size</td>
</tr>
<tr>
<td>1 muffin</td>
<td>1 cup</td>
</tr>
<tr>
<td>Servings per container</td>
<td>Servings per container</td>
</tr>
<tr>
<td>4 muffins</td>
<td>16</td>
</tr>
<tr>
<td>Amount per Serving</td>
<td>Amount per Serving</td>
</tr>
<tr>
<td>Calories 313 Kcal</td>
<td>Calories 100Kcal</td>
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<tr>
<td>% of Daily Value</td>
<td>% of Daily Value</td>
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<tr>
<td>Total Fat 7.3g</td>
<td>Total Fat 1.8g</td>
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<tr>
<td>11%</td>
<td>3%</td>
</tr>
<tr>
<td>Saturated Fat 1.6 g</td>
<td>Saturated Fat .36 g</td>
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<tr>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Trans Fat 0 g</td>
<td>Trans Fat 0 g</td>
</tr>
<tr>
<td>Cholesterol 34 mg</td>
<td>Cholesterol 0 mg</td>
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<tr>
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<td>1%</td>
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<tr>
<td>Sodium 505 mg</td>
<td>Sodium 190 mg</td>
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<tr>
<td>21%</td>
<td>8%</td>
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<tr>
<td>Total Carbohydrate 54.2 g</td>
<td>Total Carbohydrate 22.2 g</td>
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<tr>
<td>18%</td>
<td>8%</td>
</tr>
<tr>
<td>Dietary fiber 2.9 g</td>
<td>Dietary fiber 2.7 g</td>
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<tr>
<td>12%</td>
<td>11%</td>
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<tr>
<td>Sugars 22.3 g</td>
<td>Sugars 1.2 g</td>
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<tr>
<td>Protein 6.2 g</td>
<td>Protein 3.3 g</td>
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<tr>
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<td>0%</td>
</tr>
<tr>
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<tr>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Calcium</td>
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<tr>
<td>4%</td>
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</tr>
<tr>
<td>Iron</td>
<td>Iron</td>
</tr>
<tr>
<td>1%</td>
<td>1%</td>
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</table>
**Granola**

**Nutrition Facts**

<table>
<thead>
<tr>
<th>Serving Size</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Servings per container</td>
<td>16</td>
</tr>
</tbody>
</table>

**Amount per Serving**

<table>
<thead>
<tr>
<th>Calories 210Kcal</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>% of Daily Value</th>
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</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Total Fat 6g</td>
</tr>
<tr>
<td>Saturated Fat 3.5 g</td>
</tr>
<tr>
<td>Trans Fat 0 g</td>
</tr>
<tr>
<td>Cholesterol 1 mg</td>
</tr>
<tr>
<td>Sodium 24 mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
</tr>
<tr>
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</tr>
<tr>
<td>Sugars 13.4 g</td>
</tr>
<tr>
<td>Protein 5.4 g</td>
</tr>
<tr>
<td>Vitamin A</td>
</tr>
<tr>
<td>Vitamin C</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Iron</td>
</tr>
</tbody>
</table>

A. Granola  
B. Cheerios  
C. Muffin  

18. Food items packaged in the US must display warnings if they contain or may contain even trace amounts of the 8 most common food allergens.  
A. True  
B. False  

19. What does the serving size on a food label reflect?  
A. The recommended maximum intake of the food item in a 24 hour period.  
B. The recommended intake of the food item at one eating occasion.  
C. The amount of the food item customarily consumed at one eating occasion.  
D. The minimum intake of the food item to meet nutritional guidelines.
20. Which of the following statements explains why it may be difficult for some adults to lose weight?
   A. The body adapts to changes in food intake and exercise through adaptive thermogenesis.
   B. The process of storing energy in the body has evolved to be highly efficient.
   C. Changes in gene expression may affect the processing and use of energy in the body.
   D. All of the above

21. Janet is a healthy adult who has consumed an excess amount of energy. Which of the following statements would best describe the effect of her diet on ghrelin and leptin levels?
   A. Both ghrelin and leptin levels will decrease with increased fat stores.
   B. Ghrelin levels will decrease and leptin levels will increase with increased fat stores.
   C. Both ghrelin levels and leptin levels will increase with increased glycogen stores.
   D. Ghrelin levels will increase and leptin levels will decrease with increased fat stores.

22. Daniel is a healthy overweight adult weighing 320 pounds. Which of the following weight loss plans would promote healthy fat loss?
   A. An increase in physical activity and a decrease in energy intake resulting in a loss of 0.5 to 2 lbs per week. Goal – lose 32 pounds in 6 months.
   B. An increase in physical activity and a no-carbohydrate diet resulting in a loss of 3-5 lbs per week. Goal – lose 80 pounds in 6 months.
   C. An increase physical activity and a non-fat diet to result in a loss of 1-2 lbs per week. Goal – lose 48 pounds in 6 months.
   D. An increase in physical activity and a diet of energy-dense foods to result in a loss of 0.5 to 2 lbs per week. Goal – lose 48 pounds in 6 months.

23. Carrie is currently underweight but believes she is still in need of weight loss. She has experienced amenorrhea for the past 3 months. Carrie appears to suffer from what eating disorder?
   A. Bulimia nervosa
   B. Purging disorder
   C. Pica
   D. Anorexia nervosa
24. High levels of television viewing or computer use may promote a positive energy balance. How?  
   A. High levels of sedentary activity can promote an increase in metabolism.  
   B. High levels of sedentary activity may stimulate hunger.  
   C. High levels of both activities may result in a decrease in physical activity.  
   D. Both activities may promote meal-skipping which results in an energy deficit.

25. The website www.weightloss4u.com sells weight loss dietary supplement pills. The author of the website is a doctor who claims that anyone can lose 15 pounds of fat in only 3 days as a result of taking the pills. Which of the following statements is valid regarding the credibility of this website?  
   A. The FDA monitors health-related websites for accuracy and credibility.  
   B. Loss of 15 lbs of fat in 3 days is realistic weight loss goal.  
   C. The author of the website is a doctor, therefore an authority on weight loss.  
   D. The author may stand to gain from the sale of the item and may therefore be biased.