DIABETES MELLITUS II EDUCATION: A LOW CARBOHYDRATE GAMING INTERVENTION FOR IMPROVING T2DM DIET

by

Kelly Foster

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As members of the DNP Project Committee, we certify that we have read the DNP project prepared by *Kelly Foster*, titled *Diabetes Mellitus II Education: A Low Carbohydrate Gaming Intervention for Improving T2DM Diet* and recommend that it be accepted as fulfilling the DNP project requirement for the Degree of Doctor of Nursing Practice.

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Final approval and acceptance of this DNP project is contingent upon the candidate's submission of the final copies of the DNP project to the Graduate College.

I hereby certify that I have read this DNP project prepared under my direction and recommend that it be accepted as fulfilling the DNP project requirement.

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ABSTRACT

Background: Diabetes is one of the leading causes of death among adults worldwide, and the number of individuals affected continues to grow. The key to managing diabetes is maintaining an optimal blood glucose level. Controlled blood glucose levels helps to prevent diabetes related complications such as cardiovascular issues, neuropathy, kidney failure, eye deterioration, and death. In order to manage blood glucose, individuals must have an understanding of nutrition, diet, and health.

Objective: The objective of this project is to promote nutritional awareness and encourage low carbohydrate dieting among T2DM patients through interactive game based learning.

Design: A convenience sample of 30 (N=30) was recruited to participate in the project. The quality improvement (QI) project used a pretest/posttest design to compare fundamental knowledge and willingness to improve lifestyle and diet after receiving diabetic nutritional education in the form of interactive gaming.

Setting: The setting for this project was the Diabetes Management Center at P/SL in Denver, Colorado. Participants consisted of established patients at the Diabetes Management Center P/SL.

Participants: A total of 30 participants were recruited as a convenient sample population, only 21 volunteers actually participated. Participants received a flyer from their clinician illustrating the projects requirements and purpose. Participants received detailed information from the PI regarding the project rules, outline, and disclosures. Criteria for inclusion included: (a) type two diabetic, (b) current patient (c) 18 years of age or older, and (d) English speaking regardless of whether it was their first language or a secondary language.

Measurements: A pre and posttest questionnaire were completed via Qualtrics survey software. Participants first completed a pretest, then played the educational game. After gaming they completed a posttest survey. The pre and posttest consisted of the same 10 multiple-choice questions written at a 4th grade level; the questions pertained to low carbohydrate foods and healthy meal options. The posttest also included a 5-point Likert scale, the scale assessed participants likelihood to follow a low carbohydrate diet.

Results: The PI provided 21 T2DM participants with a virtual educational game which illustrated low carbohydrate foods. Prior to gaming participants completed a pretest questionnaire, after gaming they completed a posttest questionnaire. All 21 participants completed the pretest, gaming intervention, and posttest survey for a participation rate of 100%. After participating in the QI project, 86% of participants verbalized an appreciation for the educational game. Of the 21 diabetics who participated, 16 participants (76%) felt more inclined to begin a low carbohydrate diet after participating in the Joslin Carbohydrate Challenge game.

Conclusion: This project provided an overview of an innovative integrated gaming platform which combined technology with sensory motor education. The educational game provided insight into how interactive game based learning can be applied to the design of behavior change technology in health care. The findings from this QI project contribute to current knowledge regarding the development and testing of complex behavior change technologies in healthcare.

INTRODUCTION

Diabetes mellitus (DM) is a condition in which the body does not properly process glucose and turn it into energy. With diabetes the pancreas does not make enough insulin or cannot use its own insulin; in turn cells cannot reuptake the available glucose (Kelly, 2017). Diabetes Mellitus Type 1 (T1DM) occurs when the body does not produce insulin. Whereas, type two diabetes (T2DM) occurs when the body does not make or use insulin well (Kelly, 2017). When the body does not produce insulin or cannot use it effectively, blood sugar levels increase. Hyperglycemia can increase individuals risk for blindness, kidney failure, stroke, and heart disease (Center for Disease Control and Prevention [CDC], 2016).

Background

Diabetes is one of the leading causes of death among adults worldwide, and the number of individuals affected continues to grow (WHO, 2017). The key to managing diabetes is maintaining an optimal blood glucose level. Optimal blood glucose helps to prevent diabetes related complications such as cardiovascular issues, neuropathy, kidney failure, eye deterioration, and death (Brundisini et al., 2015). In order to manage blood glucose, individuals must have an understanding of nutrition, diet, and health. Recent studies have shown a low carbohydrate diet may be the best way for diabetics to control blood glucose levels, meet metabolic goals, and lose weight (ADA, 2018; Saslow et al., 2014). Introducing low carbohydrate foods through interactive educational gaming could have a profound effect on diabetics overall health.

Significance

Currently 30.3 million people have diabetes, which is 9.4% of the US population (CDC, 2016). The number of prediabetics is about three times higher, leaving many Americans at risk for T2DM and other chronic illnesses (CDC, 2016). Diabetes is a chronic, complex condition, which requires patients to be knowledgeable and committed to self-care. Diabetics must understand how to control their glycemic index and commit to managing their diseases through diet, lifestyle, and pharmaceuticals. Evidence based research indicates that appropriate nutritional education can result in long-term blood glucose improvement, ultimately minimizing the risk of diabetes related morbidity and mortality (Nielsen, Gando, Joensson, & Paulsson, 2012).

In the past, many health organizations proposed diabetics learn about their disease, learn how to live with their disease, and get routine health care to manage their disease (National Institutes of Health [NIH], 2016). The results of this approach have been underwhelming considering the number of diabetics continues to rise, increasing morbidity and mortality rates within the United States. In order to reduce diabetes nationwide, individuals at risk and/or living with DM must understand how to manage their disease and reduce their risks for chronic illness. The ADA 2018 guidelines proposed six core elements for optimizing the care of diabetics: (1) health delivery system must be proactive and interactive, (2) self-management support should include skills to support behavior change and maintenance, (3) decision support care must be evidence based and effective, (4) clinical information systems, getting the correct information to patients the best way possible, (5) community resources and policies, identifying or developing resources to support healthy lifestyles, and (6) health systems, create a quality oriented culture

(ADA, 2018). Implementing game based nutritional education may be a means of incorporating all six-core elements to create an effective strategy focused on diabetes prevention, management, and treatment.

The Center for Innovation in Diabetes Education (CIDE) at Joslin Diabetes Center found that interactive games were an effective way to engage patients and improve knowledge and medical outcomes (Weinger, Hebert & Rizzotto, 2012). Evidence based research has shown that active learning increases participation, retention, and improves performance (Freeman et al., 2014). Current DM games typically involve problem-solving and decision-making skills; simulating self-management, food intake, and insulin requirements to keep players blood glucose within normal limits (Klaassen, et al., 2018). These games are successful because they provide practice through rehearsal and show cause and effect, while educating individuals on diabetes self-management (Klaassen et al., 2018). There are many games that teach the relationship between food, exercise, blood glucose levels, and insulin dosing; this project focused solely on carbohydrate nutrition education.

This DNP Project provided T2DM patients with game based education regarding carbohydrate intake in order to increase their nutritional knowledge and improve self-management skills. The quality improvement (QI) project took place at the Diabetes Management Center at Presbyterian/St. Luke's (P/SL) in Denver, Colorado. The principal investigator (PI) provided the diabetic participants with an interactive educational game while they were waiting for their appointments. The quality improvement project aimed for thirty T2DM participants and ended with only surveying 21 (N=21) participants, all of which were current patients at the clinic. The PI collected pre and post-game data to review knowledge

deficit and gain. The results were analyzed using descriptive analysis; the data summarized the improvement via bar graphs (Plichta & Kelvin, 2013). The project illustrated whether or not game based learning is an appropriate model for self-care motivation and goal beliefs (Peters & Templin, 2010).

Project Question

Will the use of interactive education gaming increase type two diabetics understanding and intent to choose low carbohydrate foods at the Diabetes Management Center P/SL in Denver, Colorado?

Purpose, Aims and Objectives

Purpose

This project explored game based nutritional education at the Diabetes Management Center P/SL in Denver, CO. The purpose was to review the impact active learning could have on diabetic's lifestyle, diet, and overall disease management. Providing T2DM with a virtual educational game illustrating low carbohydrate foods could improve their nutritional knowledge and self-management skills. The gaming interventions targeted nutritional and behavioral changes to promote healthy habits, controlled blood glucose levels (BGLs), and well managed A1Cs < 7% (ADA, 2018). Once the project was completed, participants were able to receive ongoing education and feedback from their healthcare providers in regards to a healthful lifestyle and diet. The project had the potential to improve the patient-practitioner relationship, which ultimately impacts practitioners treatment plans and increases the rate of successful patient outcomes (ADA, 2018). Key stakeholders involved in the project included patients, staff, practitioners, and the Diabetes Management Center at P/SL in Denver Colorado.

Aim

The aim of this project was to educate type two diabetic patients on appropriate diet choices and review the short term outcomes of game based learning with a pre and post gaming questionnaire. The principal investigator (PI) provided patients with a tablet while in their designated rooms; participants completed a pretest questionnaire, then played the educational game, and after gaming took the posttest questionnaire. Clinicians at the Diabetes Management Center P/SL can follow up with the patients in three months to review their BGLs, A1C, and diet. The aim is to improve the overall health and wellbeing of each participant through interactive educational gaming.

Objective

The objective of this project was to promote nutritional awareness and encourage low carbohydrate dieting among T2DM patients through interactive game based learning. Educating T2DM patients about low carbohydrate foods through interactive gaming should improve their BGLs, A1C, and overall health. By offering T2DM participants game based learning activities, diabetics can recognize proper eating habits and appropriate food choices while actively participating and applying themselves. The project also encouraged practitioners to be more involved with their patients, and patients to gain the necessary knowledge and assistance needed for healthy self-care management.

Stakeholders

Stakeholders included project participants, type two diabetics, clinicians, and the Diabetes Management Center. This project aimed to improve the health of type two diabetics through nutritional education and lifestyle modifications. In order to perform the project, current

T2DM patients working with the Diabetes Management Center consented to volunteering as participants. Clinicians at the Diabetes Management Center were willing and available to discuss low carbohydrate dieting with their patients once the project was completed. All stakeholders can benefit from the project if all individuals involved are committed to behavioral and lifestyle modifications. Benefits include increased nutritional awareness, self-care compliance, blood glucose control, improved A1C, weight loss, fewer hospital visits, and reduced risk of morbidity and mortality (ADA, 2018).

THEORETICAL FRAMEWORK AND SYNTHESIS OF EVIDENCE

Theoretical Framework

Quality improvement projects begin with developing a goal, understanding what is an improvement, and developing a change plan that aims to improve healthcare (Institute for Healthcare Improvement [IHI], 2018). Utilizing the Institute for Healthcare Improvement model, the project attempted to improve diabetics overall health through interactive game based education and learning. An improvement would be to increase diabetic's knowledge and intention to choose low carbohydrate foods after playing the educational game. If the data collected reflects an improvement in nutritional understanding and diet choices, the planned intervention (educational gaming) will be implemented within the Diabetes Management Center for further review.

The IHI model uses the Plan-Do-Study-Act (PDSA) framework to test the impact of a project. The PDSA framework guided this project by "developing a plan to test the change (Plan), carrying out the test (Do), observing and learning from the consequences (Study), and determining what modifications could be made to the test (Act)" (IHI, 2018). The PDSA

worksheet and the IHI quality improvement (QI) toolkit was used to organize the project and "test the change" (Figure 1). The toolkit promoted and guided a successful evidence based improvement project (IHI, 2017).

The PDSA framework guided the quality improvement project, while the theory of planned behavior (TPB) and the self-care theory (SCT) measured the attitudes and beliefs of participants. The theory of planned behavior and self-care theory helped assess participants behavioral goals; this determined the ability of goal beliefs to predict engagement and commitment to low carbohydrate dieting (Peter & Templin, 2013). By integrating the conceptual theories of planned behavior and of self-care the quality improvement project was able to motivate participants through interactive gaming to pay attention, learn, and retain positive self-management skills (Mukhtar, Ali, Belaid, & Lee, 2014).

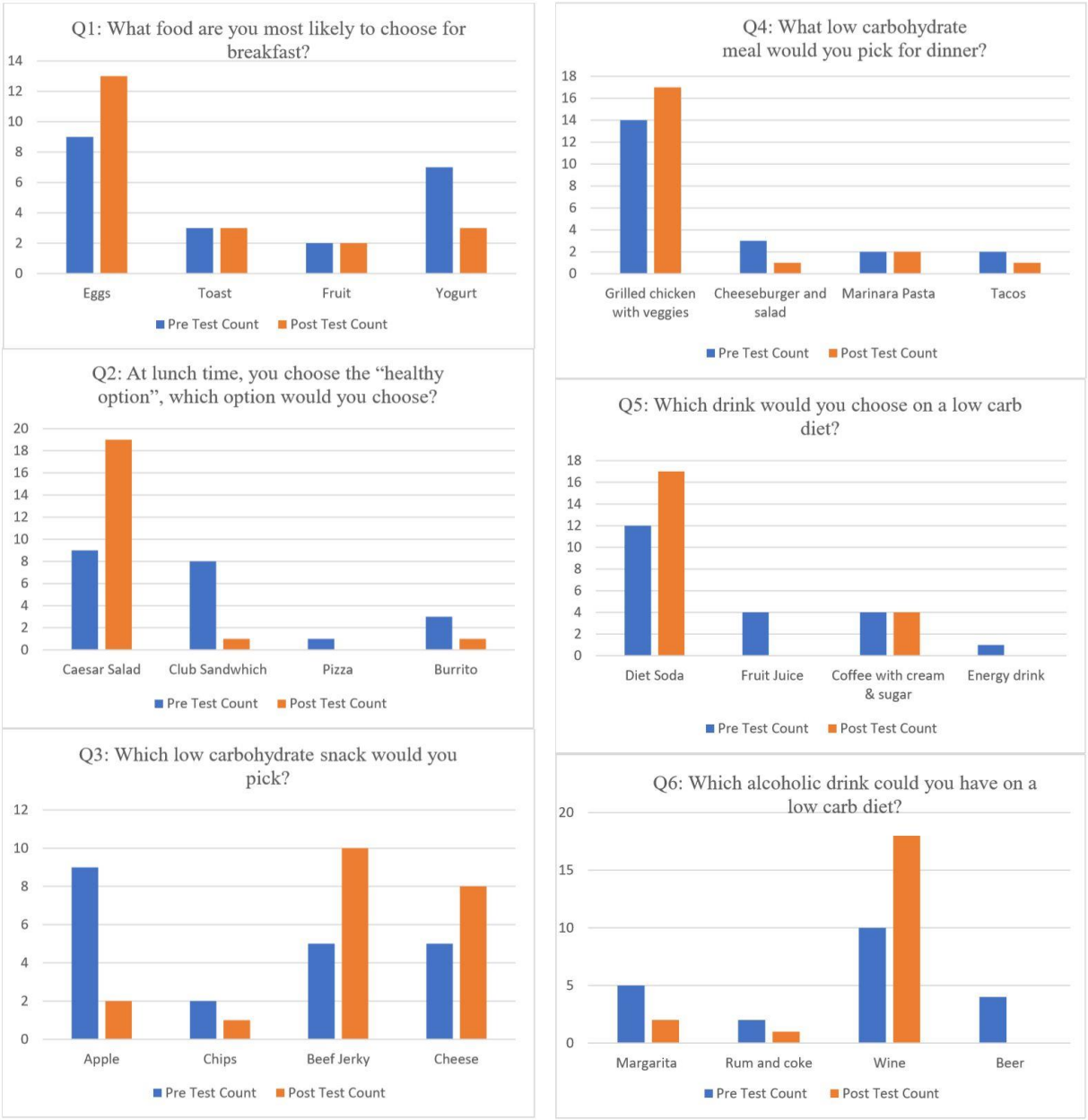
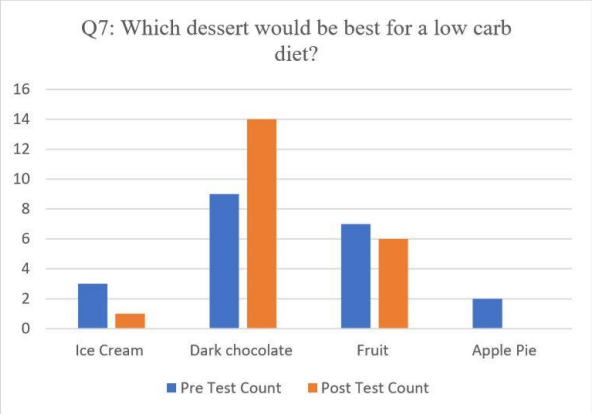
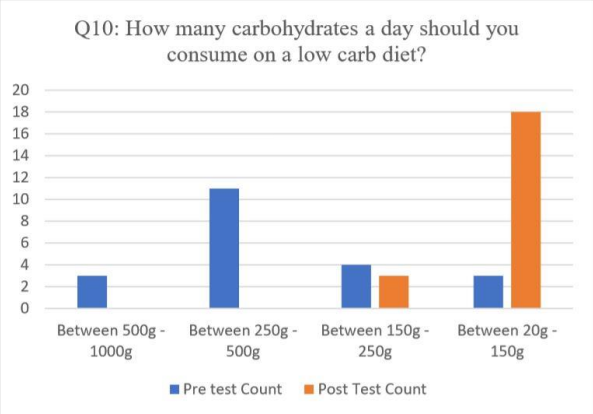
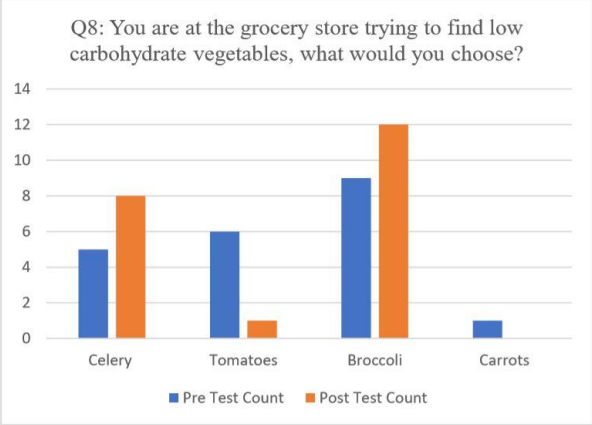


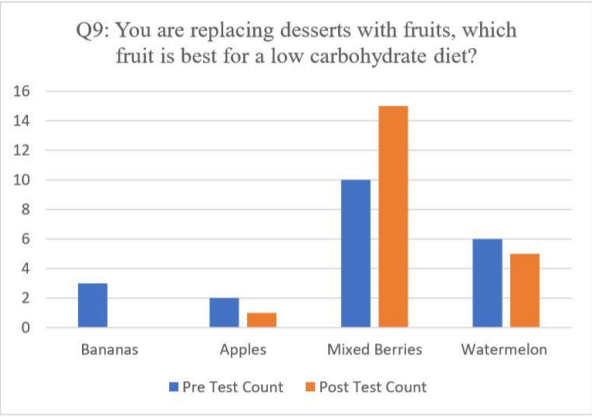
FIGURE 1. Pre/posttest questionnaire data.

FIGURE 1. - Continued









Concepts

Dr. Icek Ajzen's theory of planned behavior suggests that attitude, subjective norms, and perceived behavioral control predicts individuals intention; intention along with perceived behavioral control predicts actual behavior (Peter & Templin, 2013). The TPB is based on an expectancy-value model, the model suggests that the development of attitude, subjective norm, and perceived behavioral control involves an interaction between beliefs combined with the subjective value or relevance the person attributes to those beliefs (Figure 2) (Peter & Templin, 2013). The project introduced the relevance and significance of a low carbohydrate diet to the sample population with the intention of improving participants current diet and lifestyle. The use of interactive gaming, nutritional education and practitioner support should enhance participants understanding and therefore increased their desire to self-regulate their disease through lifestyle modifications (Peter & Templin, 2013).

Integrating the theory of planned behavior with the self-care theory provides a theoretical link between intended behaviors with actual outcomes (Peter & Templin, 2013). The Orem model describes self-care as "a human regulatory function, deliberately engaged in by a person in order to attain structural integrity and human functioning for the purpose of maintaining life, health, and well-being" (Orem, 2001, p. 45). There are three components which guide behaviors to transpire into outcomes; (1) knowledge of the required action, as well as knowledge of the effectiveness and desirability of those actions, (2) options to decide from; individuals desire choice within their self-care, and (3) resources to make the necessary changes, whether it be physical, psychological, emotional, or material (Peter & Templin, 2013). The rationale for interactive educational gaming is to encourage purposeful self-care, goal forming actions and

result-seeking behaviors among type two diabetics. If healthy dieting behaviors are solidified, participants diabetes will be well-controlled and their overall health should improve.

Synthesis of Evidence

There are many studies which address the use of technology and education among individuals with chronic disease. The majority of these studies found that incorporating psychological and behavioral theories into gaming built confidence, increased social support, and improved self-efficacy among their participants; ultimately enhancing their ability to manage their health conditions (DeShazo, Harris, & Pratt, 2010; Lazem et al., 2016; Mukhtar, Ali, Belaid, & Lee, 2014). The literature reviews covered multiple dimensions; target age, diabetes type, game goal, game play, technology type, theoretical framework used, evaluation methodology (if used), and results (if any) (Lazem et al., 2016; Mukhtar, Ali, Belaid, & Lee, 2014). They found that the majority of games focused on self-management; checking blood glucose levels, estimating carbohydrate count, and balancing food (Lazem et al., 2016; Mukhtar, Ali, Belaid, & Lee, 2014).

Multiple randomized controlled trials (RCTs) assessed the benefits of educational gaming among diabetics. The majority of the RCTs found technology and gaming to be helpful tools for improving self-care and disease management (Lieberman, 2012; Klaassen et al., 2018; ADA, 2018). Klaassen et al. (2018) found that an integration of pervasive coaching and gamification could greatly improve young diabetics lives. Pervasive coaching is defined as “a shared plan, a leadership approach, and a set of methods aligned to achieve commonly-held objectives” (Klaassen et al., 2018, p. 2). The web-based design aimed at supporting the patient in becoming responsible in their self-care; they provided interactive online coaching as a means of support

and motivation to make well-informed decisions (Klaassen et al., 2018). The American Diabetes Association (2015) RCT also demonstrated the benefit of innovative interactive diabetes education. Their study found interactive Conversation Maps helped reinforce healthy self-care and lifestyle behaviors, thus helping patients achieve and maintain their glycemic targets (Ghafoor, Riaz, Eichorst, Fawwad, & Basit, 2015). The study also found interactive gaming provided clinicians with pertinent patient information and led to meaningful referrals (Ghafoor et al., 2015).

The Saslow et al. (2014) study revealed that a low carbohydrate diet equal to or less than 50g per day (not including fiber) reduced participants A1C by 0.5% or greater. Individuals participating in a low carbohydrate diet were able to discontinue one or more oral diabetes medications after maintaining a low carbohydrate diet for three months (Saslow et al., 2014). Individuals in the low carbohydrate group experienced significant weight loss, with an average of 2.6kg and 2.8% of their body weight (Saslow et al., 2014). Participants experienced less heartburn and decreased aches and pain (Saslow et al., 2014). The Saslow et al. (2014) study reported multiple health benefits associated with a low carbohydrate diet; including psychological benefits, a significant decrease in diabetes distress, negative mood between meals, and perceived disconnection between psychological and physical states. These results are consistent with several other studies which also found substantial improvements in glycemic control with low carbohydrate dieting (Saslow et al., 2014; Accurso et al,. 2008).

Appraisal Limitations, Weaknesses, Gaps and Strengths

"In the field of education, computer games have been suggested as a medium to deliver effective pedagogy" (Lazem et al., 2016, p.487). Gaming education targets certain individuals

and exploits their interests and experiences, thus leading to better learning. Educational games aim to encourage persistence, risk taking, attention to detail, and problem solving skills (Lazem et al., 2016). Research has shown that well designed educational games can enable players to actively construct understanding at their own pace (Lazem et al., 2016). Unfortunately, the majority of game based studies have limited evidence to support their theories due to a lack of reported evaluation methodologies.

Many of the articles reviewed had unsatisfactory and or limited scope; lacking appropriate details mak it impossible to compare games effectively, draw general conclusions about their efficacy, or establish a relationship between the design features and the game outcomes (Lazem et al., 2016). The Lieberman (2012) literature review discussed how an evidence-based foundation of behavioral health principles should be integrated into the design of future games for more successful engagement and player motivation. Increasing the number of evidence based studies would demonstrate the benefits of educational gaming by indicating improvements among participants food choices, diet, self-management, and health outcomes (Lieberman, 2012).

The most successful studies used the behaviorist gamification approach, meaning "the use of game design elements in non-game contexts" (Lazem et al., 2016). The behaviorist gamification approach uses concepts of experiential learning and stresses the importance of direct experience and reflective observation (Lazem et al., 2016). Behavioral theory designs and games effectively motivate the user, encourage learning, and change behaviors by tailoring the participant's opportunities; including observational learning, skills or decision-making practice, social support, and rewards systems (Swartwout, El-Zein, Deyol, Sweenie, & Streisand, 2016).

The literature reviews revealed educational gaming produces positive outcomes in knowledge, disease management, adherence, and clinical outcomes (DeShazo, Harris, & Pratt, 2010; Lazem et al., 2016; Mukhtar, Ali, Belaid, & Lee, 2014; Swartwout et al., 2016).

METHODS

Project Question

Will the use of interactive nutritional education gaming increase type two diabetics understanding and intent to choose low carbohydrate foods at the Diabetes Management Center P/SL in Denver, Colorado?

Project Purpose

The quality improvement project explored game based nutritional education at the Diabetes Management Center P/SL in Denver, CO. The purpose was to review the impact active learning can have on diabetic's lifestyle, diet, and overall disease management. Providing T2DM with a virtual educational game illustrating low carbohydrate foods could improve their nutritional knowledge and self-management skills. The gaming interventions targeted nutritional and behavioral changes to promote healthy habits, controlled blood glucose levels (BGLs), and well managed A1Cs < 7% (ADA, 2018). Once the project was completed, patients could receive ongoing education and feedback from their practitioners in regards to a healthful lifestyle and diet. This should improve the patient-practitioner relationship, which ultimately impacts practitioners treatment plans and increases the rate of successful patient outcomes (ADA, 2018). Key stakeholders involved in this project included patients, staff, practitioners, and the Diabetes Management Center.

Planning the Study

Project Design

For the purpose of this project, a convenience sample of 30 was recruited to participate in the project; though only 21(N=21) individuals surveyed. The quality improvement project used a pretest/posttest design to compare fundamental knowledge and willingness to improve lifestyle and diet after receiving diabetic nutritional education in the form of interactive gaming. By using a pretest/posttest design, the PI compared participants answers from the pretest to the posttest and assessed if the game impacted participants nutritional knowledge, meal choices, or willingness to change their diet. The pre and posttest questionnaire was an appropriate design for assessing how educational gaming can influence patient's knowledge, behaviors and perceptions. Furthermore, the design allowed the PI to obtain baseline data (Polit & Beck, 2012).

Before commencement of the QI project, approval from the Diabetes Management Center P/SL (Appendix G and H) and the University of Arizona Institutional Review Board (IRB) was obtained to ensure all the necessary steps and measures were taken to protect participants, minimize risk, and safeguard privacy (Polit & Beck, 2012). Prior to participation, each volunteer received a disclosure agreement (Appendix D) stating their participation is voluntary, refusal to participate will not involve penalty or loss of benefits to which they are otherwise entitled, and they may withdraw at any time from the project. By reviewing the disclosure agreement (Appendix D) and completing the survey (Appendix A and B) participants gave informed consent

The project included an in office survey and game that participants completed individually while in exam rooms waiting to be seen for their visit (see Appendix C for game).

The PI was available to assist participants with any language barriers, technological issues, or gaming concerns. This strategy reduced user error, technological deficits, and or access limitations. Prior to gaming, participants received a short questionnaire (Appendix A) from the PI which evaluated their understanding of low carbohydrate foods. After gaming, each participant completed a posttest questionnaire (Appendix B) which assessed any changes in diet knowledge or perspective. The results evaluated any increase in knowledge and willingness to choose low carbohydrate food options. Once the participant had played the game and taken both pre and posttests, they were seen by the provider for their routine visit. During their visit, the patient and provider were able to discuss nutritional and dietary needs.

Methods of Evaluation

Setting

The setting for this project was the Diabetes Management Center at P/SL in Denver, Colorado. Participants consisted of established patients at the Diabetes Management Center P/SL. Participants were not required to do any extracurricular activities, other than attend their regular diabetes follow up appointment. The surface tablet was provided by the PI. The PI was present throughout the gaming process to assist participants with any questions or concerns. The PI used a script designed to help participants better understand the survey, the game, and the purpose of the project (Appendix E).

Offering educational gaming to established outpatients provided relevant data pertaining to nutritional knowledge, behavioral perceptions, and willingness for improvement. Once the project was completed, patients were able to receive ongoing education and feedback from their practitioner in regards to a healthful lifestyle and diet. Key stakeholders involved in this project

included patients, staff, providers, and the Diabetes Management Center at P/SL. Project resources included the Carbohydrate Challenge game developed by the Joslin Diabetes Center at Harvard University (Appendix C) (2018), the Surface tablet, and Excel.

Participants

The quality improvement project aimed for thirty T2DM participants and ended with only 21 (N=21) participants; all participants were established patients recruited from the Diabetes Management Center P/SL (Polit & Beck, 2012). Patients at the Diabetes Management Center P/SL received a flyer (Appendix F) from their clinician illustrating the project requirements and purpose. Patients willing to volunteer as participants received detailed information from the PI regarding the project rules, outline, and disclosures (Appendix D and E). Criteria for inclusion in the project included: (a) type two diabetic, (b) current patient (c) 18 years of age or older, and (d) English speaking regardless of whether it was their first language or a secondary language. Exclusion criteria included: (a) type one diabetics, (b) participants younger than 18 years of age, and (c) non-English speaking. These criteria were chosen due to the immense impact lifestyle and diet can have on adolescent and adult diabetics. The anticipated outcome was more probable with participants 18 years or older whom are willing and able to manage their disease through behavioral modifications. In order to participate in the project, participants received a disclosure form consenting to be part of the project. The disclosure discussed the provisions of the project and the projects purpose. No personal identifiable information was collected during the project. Participants were given an anonymous number through Qualtrics; the number served as their identifier. The data was collected and stored using Qualtrics survey software. All data collected was analyzed and published without personal identifiers. There was zero to minimal risk for all

participants. Minimal risks included an increase in knowledge and awareness; participants have the ability to change their diet based on the education received.

Data Collection

Upon receiving informed consent (Appendix D), a pretest and posttest questionnaire was completed via Qualtrics survey software. Participants completed a pretest (Appendix A) and posttest (Appendix B), which was administered immediately before and after the education game (Appendix C). The pretest (Appendix A) and posttest (Appendix B) consisted of the same 10 multiple-choice questions written at a 4th grade level; the questions pertained to low carbohydrate foods and healthy meal options. The posttest (Appendix B) also included a 5-point Likert scale, the scale assessed participants likelihood to follow a low carbohydrate diet. Once the data was collected, participants were able to meet with their clinicians to review and discuss their diets. No practitioner-patient discussions, treatment plans, or interventions will be collected for the purpose of this project. No further information will be obtained from stakeholders after the posttest. All three components of the project, the pretest, game intervention, and posttest was completed on-site during the established outpatient visit.

Data Analysis

Descriptive analysis compared responses on the pretest and posttest. Descriptive analysis characterizes the world or a phenomenon by identifying the who, what, where, when, and to what extent (Loeb, Dynarski, McFarland, Morris, Reardon, & Reber, 2017). It is an appropriate form of analysis when reviewing methods, practices, and populations relevant to a specific project, research study, or policy question (Loeb et al., 2017). Descriptive analysis can stand on its own when used to identify a phenomena or patterns in data (Loeb et al., 2017). For the

purpose of this project, descriptive analysis assessed the collected data and the PI transferred the data into bar graphs.

Based on the data gathered, the PI could make appropriate modifications, adopt new methodologies, abandoned processes, or reconfigure participants for future projects if necessary (IHI, 2017). The PI used the PDSA cycle, TPB and SCT to test the impact of the project on a small scale. The data was carefully reviewed to ensure any problems faced, unexpected outcomes, or observations were accounted for and discussed in the limitations section.

Ethical Considerations

Ethical aspects of implementing the project were reviewed to include protection of all human subjects and meet IRB requirements. Participants were volunteers looking for ways to improve their diet and ultimately their lifestyle. The participant had nothing to gain other than the exception of an increase in knowledge of nutritional requirements. Volunteers were allowed to stop participation at any time with no adverse action. The practitioners of the clinic did not change patient care based on the participant being willing or not willing to participate. No practitioner-patient discussions, treatment plans, or interventions were used for the purpose of this study. No further information was obtained from stakeholders after the posttest. All three components of the project, the pretest, intervention, and posttest were completed on-site during the established outpatient visit. There was zero to minimal risk for all participants. Minimal risks included an increase in knowledge and awareness; participants have the ability to change their diet based on the education received.

RESULTS

Data Analysis and Outcomes

The pre and posttest questionnaires completed by 21 patients at the Diabetes Management Center at P/SL. Of those distributed, all 21 participants completed the pretest, gaming intervention, and posttest survey for a participation rate of 100%. Age and gender was not accounted for throughout this project. All participants were self-determined to meet the participation criteria as type two diabetics, current patients at the Diabetes Management Center at P/SL, 18 years of age or older, and English speaking regardless of whether it was their first language or a secondary language.

Relationship of Results

This quality improvement project explored game based nutritional education at the Diabetes Management Center P/SL in Denver, CO. The purpose was to review the impact active learning could have on diabetic's lifestyle, diet, and overall disease management. The PI provided T2DM with a virtual educational game which illustrated low carbohydrate foods. The gaming intervention targeted nutritional and behavioral changes to promote healthy habits, controlled blood glucose levels (BGLs), and well managed A1Cs < 7%. The outcomes illustrated in Figure 1 suggest that the gaming intervention influenced participants intended dietary choices and increased their willingness to change their diet.

The pretest and posttest questionnaires were compared using bar graphs (Figure 1) to calculate the difference in participants responses after gaming. For question 1 listed in Appendix A and B, a total of four participants (19%) changed their dietary choice to a low carbohydrate option after playing the educational game (see Figure 1). A total of ten individuals (47.6%)

changed their answer for question 2 (Appendix A & B) as shown in Figure 1. A total of eight participants (38%) changed their snack option to a low carbohydrate option after gaming (Figure 1, Question 3). When asked about choosing a low carbohydrate meal for dinner in question 4, three participants (14.2%) changed their original choice to a low carbohydrate option after gaming. A total of five participants (23.8%) changed their beverage choice on question 5 after playing the educational game. For question number 6, eight participants (38%) changed their alcoholic beverage choice to the low carbohydrate option. Five individuals (23.8%) changed their dessert preference after gaming (Figure 1, Question 7). Question number 8 asked individuals to choose a low carbohydrate vegetable; six participants (28.5%) changed their original choice to a low carbohydrate option after gaming. When choosing to replace dessert with fruits, nine participants (42.8%) changed their original choice to a low carbohydrate option (Figure 1, Question 9). Question 10 asked how many carbohydrates one should consume in a day; fifteen participants (71.4%) changed their answer to the correct amount after completing the educational game (Figure 1).

DISCUSSION

Impacts of Results on Practice

A key finding of this quality improvement (QI) project was that once educated on the benefits of a low carbohydrate diet, type two diabetics at the Diabetes Management Center P/SL were more likely to choose healthier food options after playing the educational game. A total of four participants (19%) stated they were extremely likely to change their diet after gaming (Figure 1, Question 11). Twelve participants (57%) were somewhat likely to change their diet, two (10%) participants were neither likely nor unlikely to change their diet, one individual (5%)

stated they were somewhat unlikely to change their diet, and two participants (10%) marked they were extremely unlikely to change their diet (Figure 1, Question 11). Of the 21 diabetics who participated in this QI project, 76% felt more inclined to begin a low carbohydrate diet after participating in the Joslin Carbohydrate Challenge game. The findings of this project suggest a possible benefit of a low carbohydrate diet intervention that warrants further investigation. Though the project positively impacted the patients at the Diabetes Management Center at P/SL, it was unclear if the educational intervention would be a sustainable practice.

Study Strengths and Limitations

Strengths

The aim of this project was to educate type two diabetic patients on appropriate diet choices and review the short term outcomes of game based learning with a pre and post gaming questionnaire. The pretest/posttest design was an appropriate way to measure participants fundamental knowledge and willingness to improve their lifestyle and diet after receiving diabetic nutritional education in the form of interactive gaming. By using a pretest/posttest design, the PI was able to compare participants answers from the pretest to the posttest and assess if the game impacted participants nutritional knowledge, meal choices, and willingness to change their diet. The majority (86%) of participants verbalized an appreciation for the game and low carbohydrate nutritional education. Multiple participants stated “If I had this type of educational gaming when I was first diagnosed, I would have been more likely to follow dietary recommendations”. Participants felt the interactive nature of the surveys and game made them feel more involved in their care. The results of this project contribute to and further the literature regarding the positive effects of diabetic educational gaming.

Limitations

Specific limitations for this project included time constraints, population size, personal preferences, and the presence of the PI. The project took place over a three-month period; this limited the number of participants, amount of data gathered, and reduced the quantity and quality of information collected. The project size of twenty one (N=21) is small and not generalizable. The information gained from the project may not be received well or utilized by the general public because of the studies sample size, participants, or economic bias. The project took place in a small urban neighborhood comprised mainly of middle class citizens. Though there were no technological difficulties or impairments faced, participants often stated they could not relate to certain questions asked in the surveys because they did not consume or partake in some of the options provided. For example, seven participants (33.3%) stated they did not drink alcohol, which ultimately created a bias for question number 6 (Figure 1). Another bias faced was personal taste; three participants (14.2%) stated they would generally choose a salad for lunch, but they would never eat a Caesar salad (Figure 1, Question 2). The presence of the PI possibly impacted participants answers and honesty. Having someone present while completing a surveying or playing a game can impact the outcome. Despite these limitations, the data obtained demonstrates the positive impact educational gaming had on nutritional knowledge, behavioral perceptions, and willingness to change ones diet for these patients.

Recommendations for Practice

Dissemination and Implementation for Practice

Several studies have indicated that a low carbohydrate diet is more effective than a standard, moderate carbohydrate diet at reducing HbA1c (Saslow et al., 2014). Multiple studies

found substantial improvements in glycemic control with low carbohydrate diets. After finalizing this project, reviewing multiple RCT, and reading many article reviews it is apparent that more research is needed to develop and test gaming models that can have an impact on diabetes management; especially those that illustrate long-term benefits. This includes studies with larger sample sizes, longer follow-up periods which address long-term feasibility of a low carbohydrate diet for T2DM, and establish long-term outcomes and possible adverse effects based on theory and evaluation of both medical and psychosocial outcomes (Saslow et al., 2014; Swartwout, El-Zein, Deyo, Sweenie, Streisand, 2016; Klaassen et al., 2018). Though there is a clear need to further study the mechanism by which games can have positive impacts on behavior change or clinical outcomes, this project supports previous studies in regards to the benefits of interactive educational gaming (Saslow et al., 2014; Swartwout et al., 2016; Klaassen et al., 2018).

Conclusion

This project provided an overview of an innovative integrated gaming platform, which combined technology with sensory motor education. The educational game provided insight into how interactive game based learning can be applied to the design of behavior change technology in health care. Providing T2DM with virtual gaming education increased participants nutritional knowledge and self-management skills. The QI project found active learning to be a beneficial means of improving participants diet choices, which ultimately impacts their lifestyle and disease management.

APPENDIX A:

PRETEST QUESTIONNAIRE

1. What food are you most likely to choose for breakfast?
   A. Eggs
   B. Toast
   C. Fruit
   D. Yogurt

2. At lunch time, you choose the "healthy option", which option would you choose?
   A. Caesar salad
   B. Club sandwich
   C. Pizza
   D. Burrito

3. Which low carbohydrate snack would you pick?
   A. Apple
   B. Chips
   C. Beef jerky
   D. Cheese

4. What low carbohydrate meal would you pick for dinner?
   A. Grilled chicken with veggies
   B. Cheeseburger and salad
   C. Marinara pasta
   D. Tacos

5. Which drink would you choose on a low carbohydrate diet?
   A. Diet soda
   B. Fruit juice
   C. Coffee with cream & sugar
   D. Energy drink

6. Which alcoholic drink could you have on a low carbohydrate diet?
   A. Margarita
   B. Rum and coke
   C. Wine
   D. Beer

7. Which dessert would be best for a low carbohydrate diet?
   A. Ice cream
   B. Dark chocolate
   C. Fruit
   D. Apple pie

8. You are at the grocery store trying to find low carbohydrate vegetables, what would you choose?
   A. Celery
   B. Tomatoes
   C. Broccoli
   D. Carrots

9. You are replacing desserts with fruits, which fruit is best for a low carbohydrate diet?
   A. Bananas
   B. Apples
   C. Mixed berries
   D. Watermelon

10. How many carbohydrates a day should you consume on a low carb diet?
    A. Between 500g – 1000g
    B. Between 250g – 500g
    C. Between 150g – 250g
    D. Between 20g – 150g

APPENDIX B:

POSTTEST QUESTIONNAIRE

1. What food are you most likely to choose for breakfast?
   A. Eggs
   B. Toast
   C. Fruit
   D. Yogurt

2. At lunch time, you choose the "healthy option", which option would you choose?
   A. Caesar salad
   B. Club sandwich
   C. Pizza
   D. Burrito

3. Which low carbohydrate snack would you pick?
   A. Apple
   B. Chips
   C. Beef jerky
   D. Cheese

4. What low carbohydrate meal would you pick for dinner?
   A. Grilled chicken with veggies
   B. Cheeseburger and salad
   C. Marinara pasta
   D. Tacos

5. Which drink would you choose on a low carbohydrate diet?
   A. Diet soda
   B. Fruit juice
   C. Coffee with cream & sugar
   D. Energy drink

6. Which alcoholic drink could you have on a low carbohydrate diet?
   A. Margarita
   B. Rum and coke
   C. Wine
   D. Beer

7. Which dessert would be best for a low carbohydrate diet?
   A. Ice cream
   B. Dark chocolate
   C. Fruit
   D. Apple pie

8. You are at the grocery store trying to find low carbohydrate vegetables, what would you choose?
   A. Celery
   B. Tomatoes
   C. Broccoli
   D. Carrots

9. You are replacing desserts with fruits, which fruit is best for a low carbohydrate diet?
   A. Bananas
   B. Apples
   C. Mixed berries
   D. Watermelon

10. How many carbohydrates a day should you consume on a low carb diet?
    A. Between 500g – 1000g
    B. Between 250g – 500g
    C. Between 150g – 250g
    D. Between 20g – 150g

11. How likely are you to change your diet after taking these questionnaires and playing the game?

NOT AT ALL NOT LIKELY UNSURE LIKELY VERY LIKELY

APPENDIX C:

JOSLIN CARBOHYDRATE CHALLENGE GAME


How To Play
So you think you know your carbs? Well, let's put it to the test.
As quickly as you can, decide if the food in each picture has
No or Very Low Carb
or
More Carb
You have to beat the clock to win!
If you must, you can get a HINT but that will slow you down.
Need more information about carbs?
Carb Rules
Play Game
© 2008-2012 Center for Innovation in Diabetes Education, Joslin Clinic, Joslin Diabetes Center

Carb Rules

Here are a few facts about carbs to help you play the game.

What is a carb?

A "carb" (carbohydrate) is a part of food that your body uses for energy. Carbs have the biggest effect on blood glucose. Eat too few and your blood glucose levels go down; eat too many and your blood glucose levels go up. Remember, some foods with carbs, such as some fruits, vegetables, and whole grains, are nutrient-rich healthy choices.

For this game, food that has 5 grams of carb or less for a usual serving is considered "no or very low carb".

Which foods contain carbs?

Anything that grows in theground, plus milk and yogurt.

- Fruit and fruit juices
- Beans
- Starchy and root vegetables: carrots, potatoes, beets, corn
- Grains: rice, wheat, barley
- Foods made with flour or sugar: cereal, pasta, bread, and desserts

But every rule has an exception!

Although they grow from the ground…

- Some vegetables, such as green leafy vegetables, have so few carbs that we don't count them.
- Nuts and oils are fats, not carbs.

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http://carbchallenge.joslin.harvard.edu/

APPENDIX D:

DISCLOSURE AGREEMENT

Diabetes Mellitus II Education: A Low Carbohydrate Gaming Intervention for Improving T2DM Diet

Kelly Foster

This project will explore game based nutritional education. The purpose of the project is to review the impact active learning can have on diabetic's lifestyle, dieting, and overall disease management. The gaming interventions will target nutritional and behavioral changes to promote healthy habits, controlled blood glucose levels (BGLs), and well managed A1Cs < 7%.

If you choose to take part in this project, you will be asked to perform a pre and post-test questionnaire and play a short educational game. It will take approximately 15 minutes to complete the questionnaires and play the game. There are no foreseeable risks associated with participating in this project and you will receive no immediate benefit from your participation. Survey responses are anonymous.

If you choose to participate in the project, participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw at any time from the project. In addition, you may skip any question that you choose not to answer. By participating, you do not give up any personal legal rights you may have as a participant in this project. **By completing the survey, you have given informed consent.**

For questions, concerns, or complaints about the project, you may call Kelly Foster, BSN, RN, DNP-FNP UA student at 303.489.9645 or email her at fosterkm88@email.arizona.edu. You may also contact S. Renee Gregg, DNP, FNP-C at reneegregg@email.arizona.edu.

Thank you for your willingness to participate in this project.

APPENDIX E:

PRINCIPAL INVESTIGATOR PARTICIPANT SCRIPT

Principal Investigator Participant Script

Hello, my name is Kelly Foster.

Thank you for your willingness to participate in this project. The purpose of this project is to educate T2DM patients on low carbohydrate foods. You will complete a pre and post-test questionnaire which will evaluate your understanding and knowledge of low carbohydrate foods. Your project investigator (PI) will set you up on a tablet where you will first complete the pre-test questionnaire. Once you have completed the pre-test, your PI will open the Carbohydrate Challenge game on the tablet so you can play. The game should be a helpful learning tool that illustrates low carbohydrate and high carbohydrate foods. Once you are finished gaming, the PI will pull up the post-test questionnaire for you to complete. The principal investigator (PI) will assist you during the project by answering questions you may have regarding the pre/post-test questionnaire and the Carbohydrate Challenge game. The PI will help you navigate Qualtrics survey software and the Carbohydrate Challenge game. The PI will assist you with any language barriers, technological issues, or gaming concerns. All nutritional education will be obtained from the Joslin Carbohydrate Challenge game. The PI will not provide any additional low carbohydrate education. Clinicians on site will be able to review your results and discuss healthful eating habits with you.

APPENDIX F:

PARTICIPANT RECRUITMENT FLYER

GAME BASED DIABETES NUTRITIONAL EDUCATION

by

KELLY FOSTER, BSN, DNP-FNP STUDENT

UNIVERSITY OF ARIZONA

The purpose of this project is to educate patients on low carbohydrate foods

All participant will receive a pre and post questionnaire prior to playing the educational game

The questionnaire and game should take no more than 10 minutes to finish

No patient information will be collected for this project

THANK YOU TO ALL PARTICIPANTS

APPENDIX G:

DIABETES MANAGEMENT CENTER P/SL SITE APPROVAL

Health ONE Presbyterian/St. Luke's
Medical Center
Diabetes Management

Diabetes Management
1719 East 19th Avenue
Denver, Colorado 80218
303.839.6891 Phone

Date June 7, 2018

University of Arizona Institutional Review Board
c/o Office of Human Subjects
1618 E Helen St
Tucson, AZ 85721

Please note that Ms. Kelly Foster, UA Doctor of Nursing Practice student, has permission from the Diabetes Management Center to conduct a quality improvement project at our facility for her project, "Game Based Diabetes Nutritional Education."

Ms. Foster will conduct an educational game followed by a questionnaire with current patients of the Diabetes Management Center. She will recruit patients through the center. Patients will be provided with a description of the project, what they will be asked to do, the time involved, and access to the questionnaire and game. Ms. Foster's activities will be completed by October 15, 2018.

Ms. Foster has agreed to provide our office with a copy of the University of Arizona Determination before she recruits participants. She will also present aggregate results to the Diabetes Management Center once the project is completed and the data has been analyzed.

If there are any questions, please contact my office.

Lillian Mancinelli RN, CDE
Certified Diabetes Educator
Diabetes Management Center
Presbyterian/St. Luke's Medical Center
Denver, CO

303-839-6891
Lillian.Mancinelli@Healthonecares.com

APPENDIX H:

DIABETES MANAGEMENT CENTER P/SL IRB APPROVAL

HealthONE
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HealthONECares.com

CLINICAL QUALITY IMPROVEMENT CHECKLIST		
Date: 6/15/18		
Division: Diabetes Management Center at P/SL in Denver, CO		
Project Leader: Kelly Foster		
Instructions: Answer **YES** or **NO** to each of the following statements about QI projects.	**YES**	**NO**
The aim(s) of the project is to improve the process or delivery of care with established /accepted quality standards, or to implement change according to mandates of the hospital's Clinical Quality Improvement programs. There is no intention of using the data for research purposes.	☒	☐
The specific aim is to improve performance on a specific service or program in the hospital and **is part of usual care.** All participants will receive standard of care.	☒	☐
The project is **NOT** designed to answer a research question or test a hypothesis and is **NOT** intended to develop or contribute to generalizable knowledge.	☒	☐
The project does **NOT** follow a research design (e.g., hypothesis testing or group comparison (randomization, control groups, prospective comparison groups, cross-sectional, case-control)). The project does **NOT** follow a protocol that over-rides clinical decision-making.	☒	☐
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does **NOT** develop paradigms or untested methods or new untested standards.	☒	☐
The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does **NOT** seek to test an intervention that is beyond current science and experience.	☒	☐
The project is conducted by staff where the project will take place, and involves staff who are working at, or patients who are seen at the facility.	☒	☐
The project has **NO** funding from federal agencies or research-focused organizations, and is not receiving funding for implementation research.	☒	☐
The clinical practice unit (hospital, clinic, division, or care group) agrees that this is a QI project that will be implemented to improve the process or delivery of care (i.e., not a personal research project that is dependent upon the voluntary participation of your colleagues, students and/or patients).	☒	☐
If there is an intent to, or possibility of publishing your work, you and your Department/QI Oversight group are comfortable with the following statement in your methods section: *"This project was undertaken as a Quality Improvement Initiative at X hospital or clinic, and as such was not formally supervised by the Institutional Review Board per their policies." ***	☒	☐
ANSWER KEY: If the answer to **ALL** of these questions is **YES**, the activity can be considered a Clinical Quality Improvement/Measurement activity that does not meet the definition of research and **IRB review is not required. Keep a dated copy of this checklist in your files.** If the answer to **ANY** of these questions is **NO**, the project must be submitted to the IRB for review.		

REFERENCES

American Diabetes Association [ADA]. (2015). Foundations of care: Education, nutrition, physical activity, smoking cessation, psychosocial care, and immunization. *American Diabetes Association.* doi:10.2337/dc15-S007

American Diabetes Association [ADA]. (2018). *ADA 2018 standards of medical care in diabetes: Notable new recommendations for people with cardiovascular disease and diabetes*. Retrieved from https://www.prnewswire.com/news-releases/english-releases/american-diabetes-association-releases-2018-standards-of-medical-care-in-diabetes-with-notable-new-recommendations-for-people-with-cardiovascular-disease-and-diabetes-300569091.html

Ajzen, I. (1991). The theory of planned behavior. Organizational behavior and human decision processes. *University of Massachusetts at Amherst*, *50*(2), 179-211. doi:0749-5978/91

Brundisini, F., Vanstone, M., Hulan, D., DeJean, D., & Giacomini, M. (2015). Type 2 diabetic patients' and providers' differing perspectives on medication nonadherence: A qualitative meta-synthesis. *BMC Health Services Research, 15*(516), 1-23. doi:10.1186/s12913-015-1174-1178

Center for Disease Control and Prevention [CDC]. (2016). At a glance: 2016 Diabetes working to reverse the US epidemic. *National Center for Chronic Disease Prevention and Health Promotion; Division of Diabetes*. Retrieved from https://www.cdc.gov/chronicdisease/resources/publications/aag/pdf/2016/diabetes-aag.pdf

Freeman, S., Eddy, S., McDonough, M., Smith, M., Okoroafor, N., Jordt, H., & Wenderoth, M. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of American.* doi:10.1073/pnas.1319030111

Ghafoor, E., Riaz, M., Eichorst, B., Fawwad, A., & Basit, A. (2015). Evaluation of diabetes conversation map education tools for diabetes self-management education. *American Diabetes Association 28*(4), 230-235. https://doi.org/10.2337/diaspect.28.4.230.

Grol, B., Hulscher, E., & Wensing, M. (2017). Planning and studying improvement in patient care: The use of theoretical perspective. *Millbank Quarterly, 85*(1), 93-138.

Institute for Healthcare Improvement [IHI]. (2017). QI Essentials Toolkit: PDSA Worksheet. *Associates in Process Improvement*. Retrieved from file:///C:/Users/Kelly%20Foster/OneDrive/Doctorate%20NP%20Program/DNP%20Final%20Project%20922/DNP%20Project%20Articles/PDSA%20Worksheet.pdf

Institute for Healthcare Improvement [IHI]. (2018). How to improve. *Associates in Process Improvement.* Retrieved from http://www.ihi.org/resources/Pages/HowtoImprove/default.aspx

Kelly, J. (2017). *Diabetes*. Center for Disease Control and Prevention. Retrieved from https://www.cdc.gov/media/presskits/aahd/diabetes.pdf

Kennedy, M., Bedrich, M., Gray, L., Kroon, L., Demetsky, M. (2018). Understanding carbohydrates quiz: Diabetes education online. *Diabetes Teaching Center at the University of California, San Francisco.* Retrieved from https://dtc.ucsf.edu/learning-library/quizzes/carbohydrates/

Klaassen, R., Bul, K., Akker, R., Van der Burg, G., Kato, P., & Bitonto, P. (2018). Design and evaluation of a pervasive coaching and gamification platform for young diabetes patients. *MDPI Journals 402*(18). doi:10.3390/s1802040

Lazem, S., Webster, M., Holmes, W., & Wolf, M. (2016). Games and diabetes: A review investigating theoretical frameworks, evaluation methodologies, and opportunities for design grounded in learning theories. *Journal of Diabetes Science and Technology 10*(2), 447-452. doi:10.1177/1932296815604634

Lieberman, D. (2012). Video games for diabetes self-management: Examples and design strategies. *Journal of Diabetes Science and Technology 6*(4). Retrieved from file:///C:/Users/Kelly%20Foster/OneDrive/Doctorate%20NP%20Program/DNP%20Final%20Project%20922/DNP%20Project%20Articles/Video%20games%20for%20diabtes%20self%20management%20by%20Liberman.pdf

Loeb, S., Dynarski, S., McFarland, D., Morris, P., Reardon, S., Reber, S. (2017). Descriptive analysis in education: A guide for researchers. *The National Center for Education Evaluation and Regional Assistance.* Retrieved from https://ies.ed.gov/ncee/pubs/20174023/pdf/20174023.pdf

Nation Institutes of Health [NIH]. (2016). Four steps to manage your diabetes for life. *The National Institute of Diabetes and Digestive and Kidney Diseases.* Retrieved from https://www.niddk.nih.gov/health-information/diabetes/overview/managing-diabetes/4-steps

Nielsen, J. V., Gando, C., Joensson, E., & Paulsson, C. (2012). Low carbohydrate diet in type 1 diabetes, long-term improvement and adherence: A clinical audit. *Diabetology and Metabolic Syndrome, 4*(23), 1-5. http://www.dmsjournal.com/content/4/1/23

Orem, D. (2001). *Nursing concepts of practice*. 6th ed. St. Louis, MO: Mosby.

Plichta, S. B. & Kelvin, E. A. (2013). Munro's statistical methods for health care research (6th ed.). Philadelphia, PA: Wolters Kluwer Health | Lippincott Williams & Wilkins.

Riddle, M. (2018). Standards of medical care in diabetes. *American Diabetes Association 1*(41). ISSN 1935-5548.

Rollo, M., Aguiar, E., Williams, R., Wynne, K., Kriss, M., Callister, R., & Collins, C. (2016). eHealth technologies to support nutrition and physical activity behaviors in diabetes self-management. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* (9), 381-390. http://dx.doi.org/10.2147/DMSO.S95247

Saslow, L., Kim, S., Daubenmier, J., Moskowitz, J., Phinney, S., Goldman, V., Murphy, E., Cox, R., Moran, P., & Hecht, F. (2014) A randomized pilot trial of a moderate carbohydrate diet compared to a very low carbohydrate diet in overweight or obese individuals with type 2 diabetes mellitus or prediabetes. *PLOS ONE 9*(4) e91027. doi:10.1371/journal.pone.0091027

Swartwout, E., El-Zein, A., Deyo, P., Sweenie, R., & Streisand, R. (2016). Use of gaming in self-management of diabetes in teens. *Current Diabetes Reports Journal 16*(59). doi:10.1007/s11892-016-0754-2.

The World Health Organization. (2017). Diabetes fact sheet. *The World Health Media Center*. Retrieved from http://www.who.int/mediacentre/factsheets/fs312/en/

Villarruel, A. M., Bishop, T. L., Simpson, E. M., Jemmott, L. S., & Fawcett, J. (2001). Borrowed theories, shared theories, and the advancement of nursing knowledge. *Nursing Science Quarterly 14*(2), 158-163.

Weinger, K., Hebert, N., & Rizzotto, J. (2012). Center for Innovation in Diabetes Education. Joslin Diabetes Center: *Harvard Medical School*. Retrieved from https://www.joslin.org/care/center_for_innovation_in_diabetes_education.html