TEXT MESSAGING TO ENHANCE PATIENT ENGAGEMENT IN DIABETES SELF-CARE

A DOCTOR OF NURSING PRACTICE PROJECT SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI`I AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF NURSING PRACTICE

MAY 2020

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Acknowledgments

I would like to thank Castle Wellness Center and their patients for graciously allowing this quality improvement project to take place. Thank you to Tracie Ann Tjapkes, director of the Wellness Center, for your diligent feedback and constant engagement in this project. I would also like to acknowledge Amanda McFarland and Anela Tamashiro for their advice and time in supporting this project. Thank you to the entire staff at the Wellness Center for the work you do in improving the health and wellbeing of your patients; thank you for letting me be a part of this process.

Mahalo to my committee members: Dr. Julie Kathman and Dr. Allen Hanberg for your time mentoring me and providing meaningful feedback and encouragement. Thank you for helping me on this journey as I reach for my dreams.

Abstract

Diabetes is a costly chronic condition that can lead to serious complications including kidney disease, cardiovascular disease, and vision problems. The progression of diabetes and the development of complications depends largely on the patient's self-management behaviors. Providers often do not have enough time to teach patients all the necessary skills needed to manage this chronic disease. Diabetes self-management education (DSME) programs have been created to improve self-care activities such as healthy eating, physical activity, glucose monitoring, and medication taking. However, few patients with diabetes engage in DSME programs. Mobile health interventions have emerged as a promising tool for managing chronic conditions. Text messaging can begin to address barriers to DSME participation and engage patients in self-care behaviors in their everyday life. This quality improvement project assessed the impact of text messaging on patient attendance, satisfaction, follow-up rates, and self-management behaviors for adults with type 2 diabetes enrolled in a five week diabetes education program at the Adventist Health Castle Wellness & Lifestyle Medicine Center in Kailua, Hawaii. Attendance rates in 2019 increased compared to 2018 for two group education classes that were offered text messaging. It was not possible to determine the impact of texting on patient satisfaction or self-management behaviors due to lack of participation in post-intervention surveys. However, responses to interactive questions provided insights into the self-management strengths and weaknesses of participants. As mobile health use expands, this project is valuable as it provides a framework for future projects to further explore text messaging in diabetes education and support.

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Automated Text Messaging for Adults Enrolled in a Type 2 Diabetes Education Program

Diabetes is a chronic condition affecting over 30 million adults in the US and approximately 12% of Hawaii's population (American Diabetes Association, 2015). In Hawaii, diabetes accounts for an estimated $1.5 billion in health care costs yearly (American Diabetes Association, 2015). Between 2007 and 2017, the prevalence of diabetes in Hawaii increased 42%, from 7.7% to 10.9% (Johnson, 2019). If not adequately controlled, diabetes leads to irreversible complications including kidney disease, vision problems/blindness, amputations, and cardiovascular disease (Mayo Clinic, 2019). Currently, diabetes is the 7th leading cause of death in America, and the leading cause of new onset blindness and end stage renal failure (Centers for Disease Control and Prevention, 2017).

The management of diabetes is challenging for both health care providers and patients as it requires diligence in several areas including physical activity, healthy eating, glucose monitoring, and adherence to medications. Providers often do not have enough time to equip their patients with the tools needed to manage the disease (Shan, Sarkar, & Martin, 2019). The American Diabetes Association recommends that all patients with diabetes participate in diabetes self-management education (DSME) to gain the necessary knowledge and skills needed to cope with the disease (American Diabetes Association, 2019). Self-management education increases preventive care, improves quality of life for those living with diabetes, and can decrease health care costs associated with complications (Centers for Disease Control and Prevention, 2017). DSME is critical because the choices that patients make in their everyday lives have a direct impact on the progression of diabetes and the prevention of serious complications.

Description of the Problem

While there are many proven benefits of DSME, participation in DSME programs remains limited. In 2016, there were approximately 4,100 DSME programs in the US to serve 30.3 million Americans with diabetes. However, only 1.1 million Americans with diabetes participated in DSME programs in 2016 (Centers for Disease Control and Prevention, 2017). Data has also shown that less than 10% of privately insured patients with type 2 diabetes participated in a DSME program within 12 months of being diagnosed (Powers et al., 2015). Among Medicare patients with diabetes, only 4% received DSME services (Powers et al., 2015). Additionally, an online survey revealed that 2/3 of diabetic patients were not currently or had never been enrolled in a DSME program (Lopez et al., 2016). In 2015, only 58.4% of adults diagnosed with diabetes in Hawaii reported that they had attended a diabetes self-management class (Centers for Disease Control and Prevention, 2017).

Possible barriers to DSME participation are numerous and may include shortage of programs, lack of physician referrals, misconception regarding DSME effectiveness, psychosocial factors, lack of patient time/motivation to engage, and reimbursement concerns (Adu, Malabu, Malau-Aduli, & Malau Aduli, 2019; Powers et al., 2015; Shan et al., 2019). The lack of participation in DSME programs encourages an exploration of alternative formats for disseminating self-management information. Chronic disease management programs are typically held in a face-to-face, group class setting, however, there is growing evidence to support mobile health interventions (Adu et al., 2019; Hall, Cole-Lewis, & Berhnhardt, 2015; Marcolino et al., 2018; Wang, Xue, Huang, Huang, & Zhang, 2017). Mobile technology, such as text messaging, is promising as it is cost-effective, easy to use, and engages patients in self-management behaviors in their everyday life (Dobson, Whittaker, Pfaeffli Dale, & Maddison, 2017; Hall et al., 2015; Sahin, Courtney, Naylor, & Rhodes, 2019).

Adventist Health Castle Wellness & Lifestyle Medicine Center in Windward O'ahu offers a five-week diabetes self-management education group class led by certified clinical diabetes educators, one of which is a registered dietician and the other a nurse practitioner. Although the prevalence of diabetes in Hawaii continues to increase, attendance rates for this class remain lower than desirable. The purpose of this quality improvement project was to assess if an automated text messaging service improved patient attendance, satisfaction, follow-up rates, and self-management behaviors for individuals enrolled in the diabetes education program at Adventist Health Castle Wellness & Lifestyle Medicine Center.

Literature Review

Literature Search

A literature search of PubMed and CINAHL was performed to find articles pertaining to diabetes and mobile health interventions, with a focus on text messaging. Key terms such as "diabetes", "mobile health", "text messaging", "SMS", and "diabetes education" were combined with Boolean operators to obtain relevant articles. The articles were restricted to English language, free full-text available, and published within the past 5 years. The PubMed search: "diabetes AND (education OR mobile reminders) AND (text messaging OR SMS)" yielded 132 articles. A literature search in CINAHL combining key terms "diabetes" and "text messaging" resulted in 8 articles. After abstract review, 17 articles were included in this literature synthesis.

Literature Synthesis

Mobile health. Mobile health can be defined as "the application of mobile technologies, including phones, tablets, telemonitoring, and tracking devices, to support and enhance the performance of health care and public health practice" (Hall et al., 2015, p. 394). Text messaging, smartphone applications, and wearable devices are types of mobile health interventions (Shan et al., 2019). In 2015, there were over 7 billion worldwide mobile phone subscribers with mobile penetration nearing 100% even in developing countries (Iribarren, Cato, Falzon, & Stone, 2017). As cell-phone use is rapidly growing, there is compelling evidence to support mobile health interventions to improve outcomes for patients with chronic diseases including diabetes, AIDS, asthma, and obesity (Hall et al., 2015). Benefits of mobile health have been extensively described and include their ease of use, cost-effectiveness, interactivity, customizability, and ability to meet patients in their everyday lives (Hall et al., 2015; Nepper, McAtee, Wheeler, & Chai, 2019). Additionally, mobile health interventions have the potential to address provider and resource shortages in underserved areas (Iribarren et al., 2017; Owolabi, Goon, & Ajayi, 2019).

Text messaging and DSME. Nearly all studies evaluating the effectiveness of text messaging have reported positive effects on diabetes outcomes including HbA1c, fasting blood glucose, patient satisfaction, acceptability, self-efficacy, lifestyle & behavior change, and clinic attendance (Arambepola et al., 2016; Dobson et al., 2018; Greenwood, Gee, Fatkin, & Peeples, 2017; Holcomb, 2015; Kannisto, Koivunen, Valimaki, 2014; Marcolino et al., 2018; Nundy et al., 2014; Owolabi et al., 2019; Wang et al., 2017; Russell, Vess, Durham, & Johnson, 2017). Several text messaging programs reported in the literature were customizable, giving participants the opportunity to tailor the content and schedule of text messages to their individual preferences (Capozza et al., 2015; Dobson et al., 2018; Nundy et al., 2014). Some programs were bidirectional, giving patients the chance to respond to text message prompts regarding self-monitored blood glucose levels, exercise, and medication adherence (Capozza et al., 2015;

Nundy et al., 2014; Russell et al., 2017). However, one study investigated the difference in impact between bidirectional and unidirectional text messaging and did not find a significant difference (Arambepola et al., 2016). A wide variety of educational topics can be covered through text messaging including healthy diet, physical exercise, smoking cessation, foot care, blood glucose goals, symptoms of hypo and hyperglycemia, importance of medication adherence, and awareness of development of complications (Capozza et al., 2015; Dobson et al., 2018; Nepper et al., 2019).

Impact on glycemic control. Mobile health interventions have the potential to impact HbA1c levels. Many studies have reported a significant decrease in HbA1c levels through the use of a text messaging program (Dobson et al., 2018; Greenwood et al., 2017; Holcomb, 2015; Marcolino et al., 2018; Wang et al., 2017;). Differences in HbA1c from baseline to study completion range from 0.53% to approximately 1% reduction (Arambepola et al., 2016; Holcomb, 2015; Wang et al., 2018). In light of the fact that the majority of adults utilize texting services in everyday life, it is reasonable to believe that a text message program can improve glycemic control.

Impact on behavioral outcomes & patient satisfaction. Self-care behaviors such as checking and managing blood sugar, maintaining healthy weight, engaging in physical activity, performing foot care, and adhering to medication regimens have been improved with text messaging interventions (Arambepola et al., 2016; Dobson et al., 2017; Wang et al., 2017). Additionally, mobile health interventions can improve self-efficacy and overall attitude towards diabetes (Nundy et al., 2014). High satisfaction levels have been reported by users enrolled in text messaging programs for diabetes education (Arambepola et al., 2016; Capozza et al., 2015; Dobson et al., 2018; Dobson et al., 2017; Kannisto et al., 2014; Owolabi et al., 2019).

Impact on clinic attendance. Text message reminder services can reduce the rates of no-show appointments (Marcolino et al., 2018). A systematic review evaluating the use of text message reminders in health care reported that attendance rates improved in 46 out of 60 studies (77%) (Kannisto et al., 2014). Text message reminders are equally efficacious as phone calls. They are also more cost-effective as they can be automated and thus reduce personnel time (Kannisto et al., 2014; Marcolino et al., 2018).

Grading the Evidence

The American Family Physician's Strength of Recommendation Taxonomy (SORT) System was used to grade the level of evidence for each article (Appendix A). Level 1 evidence includes systematic reviews, meta analyses of high-quality studies, and high-quality randomized controlled trials. Level 2 evidence include systematic reviews or meta analyses of lower quality studies, cohort studies, and retrospective studies. Level 3 evidence include consensus guidelines, opinion, and case series (Ebell et al., 2004). According to the SORT tool, eleven of the seventeen studies included in this synthesis provided level 1 evidence (Appendix B).

The literature provided high-quality evidence to support mobile health interventions in diabetes care. The majority of articles included in the literature synthesis supply the highest level of evidence, providing strong recommendations for clinical practice (Ebell et al., 2004). Eight systematic reviews were included, representing a large amount of smaller studies that have been completed in diverse populations and widespread locations.

Weaknesses & Limitations

While most studies evaluated the impact of text messaging on glycemic control, there are fewer studies that report its impact on self-management behaviors. Each study is unique in its design, timing, content, and frequency of text messages, making it difficult to determine which styles lead to the greatest impact on diabetes outcomes. Most studies took place in primary care settings. The impact of adding a text messaging service to an established diabetes group education program is unknown. It is difficult to estimate the finances required to support long-term implementation of a text messaging intervention as most published studies do not include a detailed cost/benefit analysis (Iribarren et al., 2017). The effectiveness of mobile health technology on diabetes patients in diverse populations similar to Hawaii has not been studied, therefore, this project has the potential to fill a gap in the current literature.

Interventions

The evidence-based intervention used in this quality improvement project was automated text messaging, provided through the company, Simple Texting. This was an additional service offered to patients that were enrolled in the diabetes education program at Adventist Health Castle Wellness & Lifestyle Medicine Center. The text messages included reminders to attend diabetes classes, self-management education with links to online resources, and diabetes-related interactive questions (Appendix C). The content and schedule of text messages were designed by the DNP student in coordination with the Wellness Center staff. This intervention was chosen as several high-quality studies have demonstrated that text messaging has a significant effect on patient attendance, satisfaction, glycemic control, and self-care behaviors (Arambepola et al., 2016; Capozza et al., 2015; Dobson et al., 2018; Marcolino et al., 2018; Wang et al., 2017; Greenwood et al., 2017; Holcomb, 2015; Dobson et al., 2017; Kannisto et al., 2014; Nundy et al., 2014; Russell et al., 2017).

Conceptual Framework

The Advancing Research and Clinical Practice Through Close Collaboration (ARCC) model developed by Bernadette Melnyk (2011) was used as a framework for this DNP project

(Appendix D). The ARCC model has been successfully used to improve care in many hospitals and health care systems nationally. (Schaffer, Sandau, & Diedrick, 2012). This model was chosen because it emphasizes assessing organizational readiness for evidence-based practice (EBP) and identifying possible barriers to EBP (Melnyk, Fineout-Overholt, Gallagher-Ford, & Stillwell, 2011). Consistent with the ARCC model, the team at Adventist Health Castle Wellness & Lifestyle Medicine Center was very supportive of EBP and included many experienced mentors that were integral to implementing this practice change.

PICO Question

Does an automated text messaging program for reminders and diabetes self-management education increase patient attendance, satisfaction, follow-up rates, and self-management behaviors for individuals enrolled in a five week diabetes self-management education program at Adventist Health Castle Wellness & Lifestyle Medicine Center?

Methods & Procedures

Purpose Statement & Project Objectives

The purpose of this evidence-based quality improvement project was to increase attendance, patient satisfaction, follow-up rates, and self-management behaviors of individuals enrolled in the diabetes education program at Adventist Health Castle Wellness & Lifestyle Medicine Center by implementing an automated text messaging service. Project objectives include: (1) between August and September 2019, enroll at least 75% of group class participants in the text messaging service; (2) between August 2019 to September 2019, increase group class attendance rates compared to 2018 attendance rates; (3) by January 2020, 50% of August and September group class graduates will return to the Adventist Health Castle Wellness & Lifestyle Medicine Center for a follow-up within 3 months of group class completion; (4) by January

2020, self-management behaviors on the post-intervention survey will be improved when compared to the pre-intervention survey (Appendix E); (5) by January 2020, 75% of participants will rate their satisfaction with the text messaging service as “satisfied” or “very satisfied.”

Project Design

This project was implemented at Adventist Health Castle Wellness & Lifestyle Medicine Center located next to the Adventist Health Castle hospital in Kailua, O’ahu. The organization focuses on making lasting impacts in their patient’s lives through lifestyle changes that include healthy eating, health education, behavior modification, and exercise. The fitness classes, educational programs, support groups, activities, and cooking demonstrations are available to the entire community with most clients residing on the Windward side of O’ahu. Patients in the diabetes education program are primarily recruited through primary care doctor’s offices but can also be self-referred. The program is covered by HMSA, Medicare, and other insurance plans (Adventist Health Castle, 2019).

The target population for this project were patients diagnosed with type 2 diabetes mellitus receiving health care services on the Windward side of O’ahu. The accessible population were patients with type 2 diabetes that were referred to the diabetes education program by their primary care provider. Inclusion criteria for eligible patients were: must have a diagnosis of type 2 diabetes, be enrolled in a diabetes group class in August or September 2019 and have a cell phone with text messaging capability. The text messaging intervention was offered to a total of three group classes, two in August and one in September. The number of participants was 18 patients (15 from August classes, 3 from September class).

Procedures

Human subjects' consideration. The author has completed the Collaborative Institutional Training Initiative (CITI) Training for research ethics and compliance, and Health Insurance Portability and Accountability Act (HIPAA) Training on patient privacy protections. This DNP project involves making judgments about a program to improve or further develop program effectiveness and inform decisions about future programming within an organization (University of Hawaii Human Studies program, personal communication, August 2, 2018). All these tasks are related to quality improvement and will not produce generalizable knowledge. Thus, this project will not require IRB application and review.

Patients that chose to enroll in the text messaging service signed a consent form as outlined in the data collection procedures. Participant surveys were kept anonymous in order to protect patient privacy. For data analysis of the pre and post-intervention surveys, only aggregate data was analyzed, and patients' identities were not known.

Measurements. Outcomes for this quality improvement project were patient attendance, satisfaction, follow-up rates, and self-management behaviors. For the August cohort, the pre-intervention survey was completed via paper form during the second group class. A link to the post-intervention survey was sent via text message during the final month of implementation. For the September cohort, both pre and post-intervention surveys were sent via text message (Appendix E). Self-management behaviors were measured using the Diabetes Self-Management Questionnaire (DSMQ), a validated tool used to assess self-care activities related to glycemic control (Schmitt et al., 2013). The pre-intervention survey consisted of the DSMQ only, while the post-intervention survey consisted of the DSMQ plus additional questions relating to patient satisfaction and feedback towards the text messaging service.

Data collection procedures. Project implementation occurred between Aug 6, 2019 and January 17, 2020. The text messaging service was offered to all patients enrolled in diabetes education group classes during August and September 2019. The DNP student or diabetes educator introduced the purpose of the quality improvement project to patients at their first group class. Patients that chose to enroll in text messaging signed a consent form providing permission to send text messages to their personal phones and agreeing to pay standard fees, if applicable (Appendix F).

During the five-week group class, participants received four text messages per week: a reminder to attend the weekly group class, a link to an educational resource that reinforced concepts taught in class, and an interactive self-management question with a follow-up response. After completion of the five-week group class, participants continued to receive one text message every two weeks for three months. A link to the post-intervention survey was sent through text message during the final month of implementation. Participants were able to opt out of receiving text messages at any point.

Data analysis. The total number of patients enrolled, percentage of patients that attended all five group classes, and no-show rates for August and September 2019 were compared to 2018 attendance data. After completion of the group classes, the percentage of patients that returned to the Adventist Health Castle Wellness & Lifestyle Medicine Center for a follow-up within 3 months was calculated. Aggregate scores on the DSMQ surveys were compared to determine if there was an increase in self-management behaviors from baseline. Although performing a statistical analysis could lead to more robust results, it was not feasible given the small sample size, lack of control group, and short study duration.

Results

Attendance Rates

For the August 2019 group classes, 15 out of a total of 27 enrolled patients, or 55%, participated in the text messaging program. For the September 2019 class, 3 out of a total of 6 enrolled patients, or 50%, participated in the text messaging program. As shown in Table 1 and Figure 1, 59% of the August 2019 participants attended all 5 diabetes classes, compared to just 39% that attended all 5 classes in August 2018. 40% of the September 2019 class participants attended all 5 classes compared to 25% in September 2018. A patient was considered a no-show if they enrolled for the class but did not attend any of the five classes. There were 2 no-shows for August 2019 compared to 6 no-shows for August 2018. For September 2019, there were zero no-shows, compared to 4 no-shows for September 2018 (Figure 2).

Table 1

Attendance Data for Diabetes Classes in 2018 and 2019

	Aug 2018	**Sept 2018**	**Aug 2019** (2 classes)	**Sept 2019** (1 class)
Total Enrolled	23	20	**27**	**6**
% that attended all 5 classes	39%	25%	**59%**	**40%**
# of no-shows (Enrolled in program but did not attend any classes)	6	4	**2**	**0**

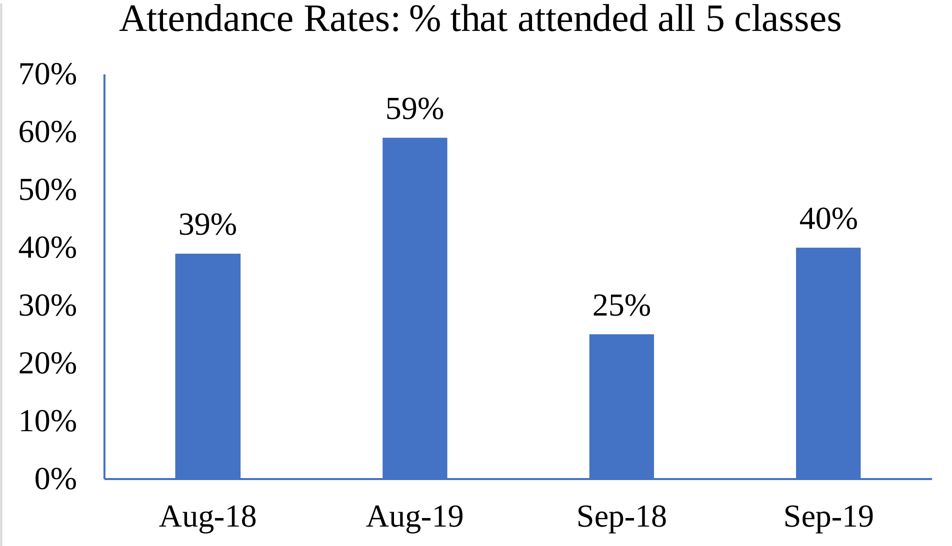

Figure 1. Percentage of patients that attended all 5 classes in August and September 2019 vs. 2018.

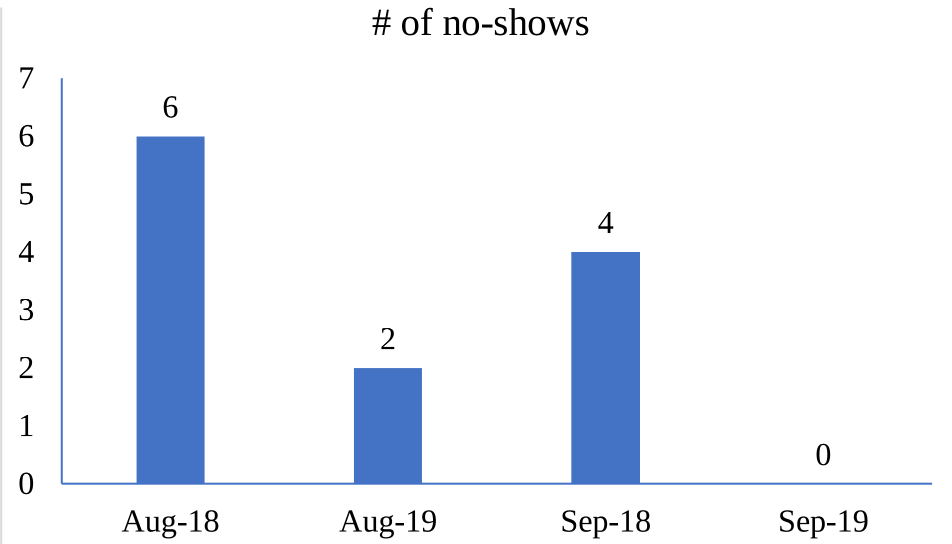

Figure 2. Number of no-shows in August and September 2019 vs. 2018.

Follow-up Rates & Self-Management Behaviors

None of the August or September 2019 group class graduates returned for a follow-up within 3 months of completing the class. No patients answered the post-intervention survey that was sent through text message link in the final month of implementation. The pre-intervention survey (DSMQ) was completed by 22 patients. Five of these surveys were incompletely filled out and discarded. The DSMQ asked participants about their self-care during the previous 8 weeks. Self-care in the following five areas were assessed: glucose management, dietary control, physical activity, and health care use. The maximum score for each of these self-care areas is 10. As shown in Figure 3, participants scored on average the lowest for dietary control (5.7), followed by physical activity (5.9), then glucose management (6.7). Participants scored the highest for health-care use (8.5).

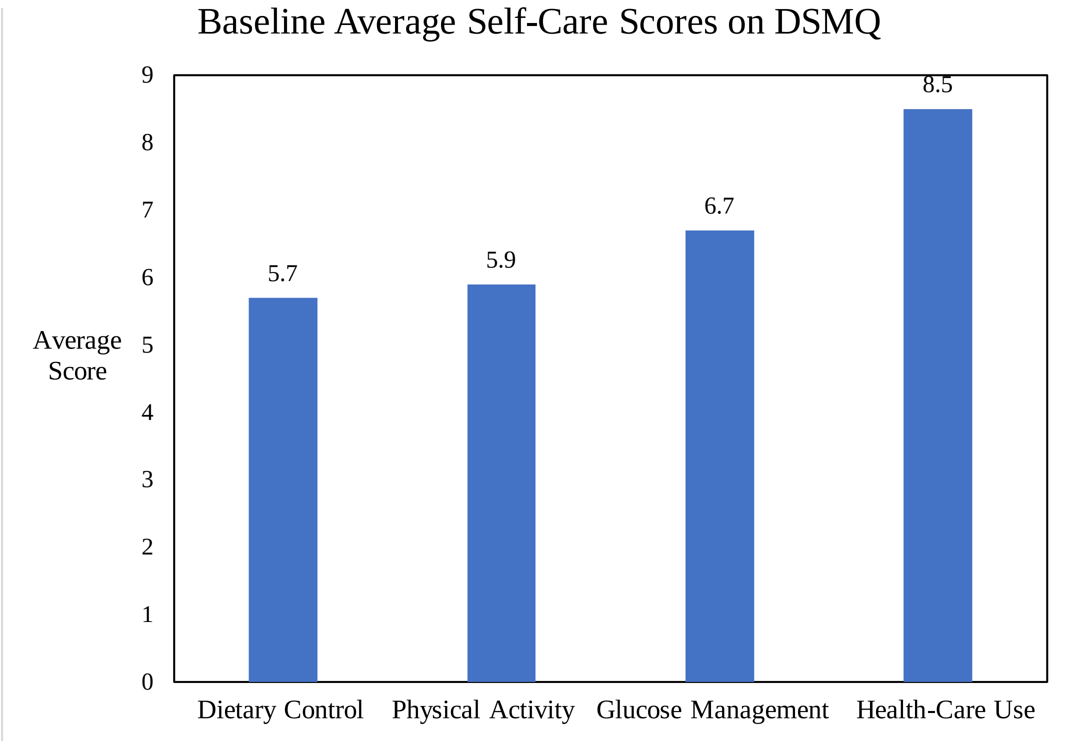

Figure 3. Baseline average DSMQ scores for five self-care categories.

The maximum possible score for the DSMQ is 48 and the average score was 31.8. The final question asks patients about their overall self-care. As shown in figure 4, the majority (53%) of patients responded that the statement: “my diabetes self-care is poor” applies to them to “a considerable degree.”

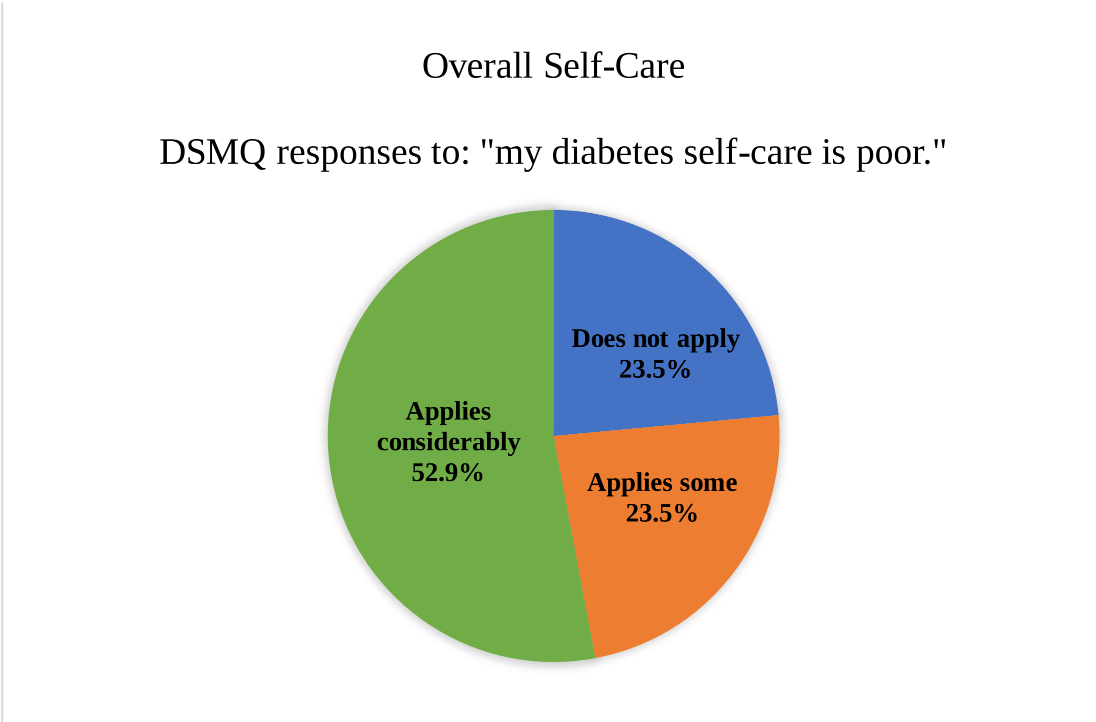

Figure 4. Baseline average DSMQ response to overall self-care question.

Engagement with Text Messages

One participant unsubscribed during the study period. There were minimal clicks on weekly educational links that were sent through text messaging. Figure 5 shows the total number of participants in the texting program compared to the number that unsubscribed during the study period. Table 2 shows the total number of clicks on each educational link.

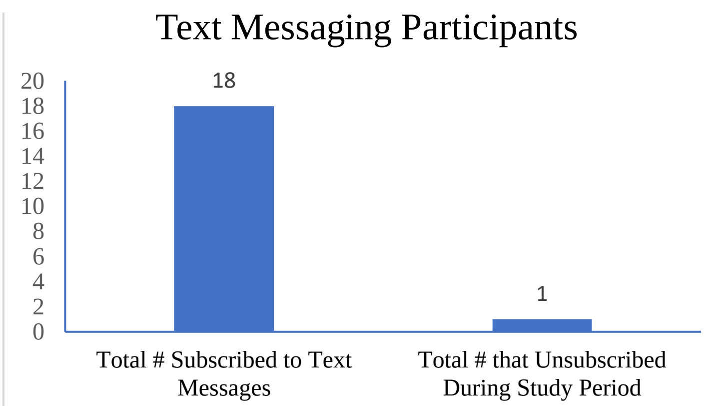

Figure 5. Total number of participants subscribed vs. number that unsubscribed.

Table 2

Number of Clicks on Educational Links Sent Through Text Messaging

Week #	Educational Link	Total # of Clicks
1	Video: Checking Blood Sugar	2
2	Managing Hypoglycemia	2
3	Healthy Recipes	4
4	Diabetes & Heart Disease	5
5	Video: Foot Care	2
8	Video: Nutritious Foods	3
10	Managing Stress	0
12	Tips for Checking Blood Sugar	2

Each week for the first five weeks, an interactive question with a follow-up response was texted to participants. Table 3 shows responses to each of the weekly questions.

Table 3

Answers to Weekly Interactive Questions

Week #	Interactive Question	Answer Choices	# of Responses
1	Did you meet your short-term health goal this week?	A. Yes	5
		B. No	0
2	On average, how many minutes have you exercised every day this week?	A. 30+ min	4
		B. 20-29 min	2
		C. 10-20 min	0
		D. Less than 10 min	0
3	Hope you have been eating healthy this week. Which snack contains 15 grams of carbs?	A. Manapua	1
		C. Small apple	5
		D. Doughnut	1
		E. 1 cup fried rice	0
4	The HbA1c goal for most patients with diabetes is <7%. Do you feel confident in reaching this goal?	A. Yes	6
		B. No	1
5	It is important to see your eye doctor yearly and get your teeth cleaned twice a year. Have you been able to do this in the past year?	A. Yes	7
		B. No	0

Discussion

Most settings described in the literature that used mobile health interventions were primary care offices or diabetes specialty clinics (Capozza et al., 2015; Dobson et al., 2018; Nepper et al., 2019; Nundy et al., 2014; Owolabi et al., 2019). To our knowledge, this is the first project that combines text messaging with a group education program. Measurement tools used in previous studies included the summary of diabetes self-care activities questionnaire (SDSCA), two-item diabetes distress scale (DDS2), the brief illness perception questionnaire (BIPQ), and the diabetes self-efficacy scale (DES) (Dobson et al., 2018; Nepper et al., 2019; Nundy et al., 2014). This may have been the first project to utilize the DSMQ to assess the impact of a mobile health intervention on self-care behavior.

Attendance rates for August and September 2019 group classes increased compared to 2018 data. There was a higher percentage of patients that attended all 5 group classes in August and September 2019 when compared to 2018. There were no patients that returned for a follow-up in the three months after completion of the group classes. Because there were no responses to the post-intervention survey, it was not possible to assess if self-care behaviors or patient satisfaction improved from baseline. However, analyzing the pre-intervention DSMQ scores reveal that there was significant room for improvement in self-care. More than 50% of participants indicated on the baseline survey that their diabetes self-care was poor. At baseline, participants scored the lowest for dietary control, indicating that there may be a lack of knowledge or skills in this area.

Although only one participant unsubscribed during the study period, there were minimal clicks on weekly links sent through text messaging. However, participants were engaged with the interactive questions, with an average response rate of 35%. Analyzing the responses to the weekly questions provides insights into the confidence level and self-management skills of participants. It appears that participants may need more guidance in carb counting, as two out of seven respondents were not able to choose the appropriate snack containing 15 grams. Most respondents felt confident in reaching their short-term health goals and in achieving HbA1c < 7%. 100% of respondents indicated that they were keeping up to date with health maintenance by visiting their optometrist annually and their dentist biannually. All of the respondents reported that they were engaging in some form of daily physical activity. While not all participants answered the interactive questions, the responses provide valuable feedback that can be used to tailor information for areas needing improvement. Overall, this project provides a framework for future studies evaluating text messaging and diabetes outcomes, especially within the setting of a diabetes group education program.

DNP Essentials

The American Association of Colleges of Nursing published *The Essentials of Doctoral Education for Advanced Nursing Practice*, outlining the eight core elements that should be included in a DNP program (2006). The DNP student should be competent in all eight areas which cover evidence-based practice, health care policy, leadership, interprofessional collaboration, and more (AACN, 2006). Table 4 shows how each of the eight essentials have been integrated in this quality improvement project.

Table 4

Integration of DNP Essentials in Quality Improvement Project

DNP Essential	Integration in DNP Project
I: Scientific Underpinnings for Practice	• Use of science-based theories to design, lead, & implement a quality improvement project
II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking	• Implementation of educational text messaging to improve outcomes for diabetes patients • Knowledge of the quality improvement process & strategies needed to introduce new interventions to improve patient care, administrative processes, or organization workflow
III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice	• Critical analysis of available evidence & evaluation of clinical areas needing improvement to create interventions to improve practice • Development of unique solutions to clinical problems/needs by utilizing best available evidence • Literature search, critique, & synthesis of mobile health & diabetes using research databases PubMed, CINAHL

	• Use of the ARCC model as a conceptual framework to design & lead a quality improvement project based on best evidence
IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	• Understanding of available technologies and their value in improving patient care • Implementation of text messaging as a tool to improve self-management, patient satisfaction, and attendance rates for patients in a type 2 diabetes education program • Knowledge of mobile health technologies and integration in today's health care system
V: Health Care Policy for Advocacy in Health Care	• Advocate for the advanced nursing profession in the workplace setting, among family/friends, & within project site • Recognize flaws within health care system & understand how to influence & enact health care policy change • Advocate for the needs of the diabetic population through implementation of a text messaging program designed to improve self-care and address barriers to self-management of diabetes
VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes	• Lead an interprofessional team including diabetes educators, dieticians, nurse practitioners, IT, and administrative assistants to execute a quality improvement project
VII: Clinical Prevention and Population Health for Improving the Nation's Health	• Understanding of current needs of Hawaii's diabetic population to improve local & national health status • Implementation of mobile health interventions to improve diabetes health promotion & prevention of serious complications
VIII: Advanced Nursing Practice	• Utilization of critical thinking, advanced clinical judgment, knowledge of evidence-based practice, and leadership skills to introduce text messaging intervention to improve diabetes outcomes • Collaboration and guidance from other advanced practice nurses in completing this quality improvement project

Limitations

This quality improvement project included limitations. While the intervention is based on high-quality evidence, the literature search only included articles that were free and full-text available. This restriction could have excluded studies that provide additional evidence for mobile health and diabetes.

There were also limitations in study design and data collection. A delay in receiving permission to use an electronic version of the DSMQ resulted in the pre-intervention survey being completed through paper form for the August classes, while the post-intervention surveys were sent through text message link. Using a paper version for the pre-intervention survey led to a high participation rate and a false assumption that there would be a similar rate of participation for the electronic post-intervention survey. As participants did not respond to the post-intervention survey, an analysis of improvement in self-management behaviors was not possible. Results of the baseline DSMQ surveys may have been skewed as this data was self-reported by patients. Wording of the questionnaire could have been confusing as it contained both positively and negatively worded questions regarding self-care. The length of the survey (16 questions) may have limited participation.

The text messaging enrollment process was more difficult than expected and additional staff support would have been beneficial. It was time-consuming to enroll participants as some were not comfortable with technology and required assistance. One patient desired to participate but was unable to enroll as his/her cell phone did not accept text messages from a toll-free number. Additionally, some patients participated in the diabetes education program but missed the first group class. These patients did not have the opportunity to enroll in the texting program as it was introduced during class one. Having additional staff support to assist with enrollment in the texting program could ensure that all patients had the opportunity to enroll. A final limitation is the small number of participants, which may not be representative of the entire population engaging in DSME. While there were two cohorts of classes in August, there was only one in September. Expanding this project to include more classes could capture more participants and lead to stronger results.

Implications/Conclusion

There are many ways this project could be expanded and improved. A more rigorous design and data collection could lead to stronger results. A structured enrollment process including ample staff support could ensure that all participants are given the opportunity to enroll in the texting program. Use of a patient-friendly measurement tool could lead to a higher response rate for the post-intervention survey assessing satisfaction and self-care behaviors. Analyzing the literature could reveal how other similar studies collected post-test data. With the feedback of the diabetes educator and nurse practitioner, the text messaging content could be improved to integrate seamlessly with topics covered in group classes. Future text messaging programs should also incorporate the preferences of patients to improve the content and frequency of text messages.

Using the platform Simple Texting, there are many ways to customize the design and schedule of the text messages. There is also an opportunity for bidirectional texting and the development of unique messages tailored to fit the needs of each individual. For example, patients could identify weaknesses in self-care and then request to receive messages specifically designed to address areas in need of improvement. Bidirectional texting also provides the opportunity for one-on-one virtual contact between the patient and the diabetes educator or nurse practitioner. To assess sustainability, the text messaging program should be expanded to continue longer than 3 months after completion of group classes. Text messaging provides an easy, convenient, and cost-effective way for diabetes educators to remain in contact with patients even after completion of the group education program. This mobile health intervention may also be adapted to support the care of patients with other chronic diseases.

It is likely that mobile health use will continue to grow as smartphone ownership increases and patient preferences concerning the receival of health information evolves. This quality improvement project was successful in piloting an evidence-based practice change that introduced educational text messaging as an additional service for participants of a diabetes group education program. The results of this project demonstrate that an automated texting program including self-management education and reminders can increase patient attendance. Utilizing text messaging to send reminders frees up staff time for services that are best delivered in a face-to-face setting. Communicating with DSME participants through texting can provide valuable insights into patient progress and can illuminate areas needing improvement. While it is not likely that mobile health can effectively replace all face-to-face contact, it can improve attendance rates and provide additional support and encouragement for DSME participants. Overall, text messaging is an innovative tool that will continue to transform chronic disease self-management.

Appendix A

American Family Physician's Strength of Recommendation Taxonomy

TABLE 2

Assessing Quality of Evidence

Study quality	Diagnosis	Treatment/prevention/screening	Prognosis
Level 1: good-quality, patient-oriented evidence	Validated clinical decision rule Systematic review/meta-analysis of high-quality studies High-quality diagnostic cohort study*	Systematic review/meta-analysis or RCTs with consistent findings High-quality individual RCT† All-or-none study‡	Systematic review/meta-analysis of good-quality cohort studies Prospective cohort study with good follow-up
Level 2: limited-quality patient-oriented evidence	Unvalidated clinical decision rule Systematic review/meta-analysis of lower quality studies or studies with inconsistent findings Lower quality diagnostic cohort study or diagnostic case-control study	Systematic review/meta-analysis of lower quality clinical trials or of studies with inconsistent findings Lower quality clinical trial Cohort study Case-control study	Systematic review/meta-analysis of lower quality cohort studies or with inconsistent results Retrospective cohort study or prospective cohort study with poor follow-up Case-control study Case series
Level 3: other evidence	Consensus guidelines, extrapolations from bench research, usual practice, opinion, disease-oriented evidence (intermediate or physiologic outcomes only), or case series for studies of diagnosis, treatment, prevention, or screening		

RCT = randomized controlled trial.

*—High-quality diagnostic cohort study: cohort design, adequate size, adequate spectrum of patients, blinding, and a consistent, well-defined reference standard.

†—High-quality RCT: allocation concealed, blinding if possible, intention-to-treat analysis, adequate statistical power, adequate follow-up (greater than 80 percent).

‡—In an all-or-none study, the treatment causes a dramatic change in outcomes, such as antibiotics for meningitis or surgery for appendicitis, which precludes study in a controlled trial.

Reprinted from: Ebell, M. H, Siwek, J., Weiss, B. D., Woolf, S. H., Susman, J., Ewigman, B., & Bowman, M. (2004). Strength of recommendation taxonomy (SORT): A patient-centered approach to grading evidence in the medical literature. *American Family Physician*, 69(3): 548-556.

Appendix B

Literature Matrix

Authors/Title	**Year**	**Purpose**	**Results**	**Level of Evidence**
Adu, Malabu, A. E. Malau-Aduli, B. S. Malau-Aduli / Enablers and barriers to effective diabetes self-management: A multi-national investigation	2019	To identify gaps in diabetes self-management and discover factors that are enablers and barriers to diabetes self-management.	Enablers of self-management included patients' desire to prevent diabetes complications and the use of mobile technology. Barriers to self-management include weariness towards the chronic nature of diabetes, financial burden, work and environment-related conditions, and unrealistic demands. Ongoing support offered through mobile technology can address some of these barriers to effective self-management.	Level 2: Mixed Methods

Authors/Title	Year	Purpose	Results	Level of Evidence
Arambepola, Ricci-Cabello, Manikavasagam, Roberts, French, & Farmer/ The Impact of Automated Brief Messages Promoting Lifestyle Changes Delivered Via Mobile Devices to People with Type 2 Diabetes: A Systematic Literature Review and Meta-Analysis of Controlled Trials	2016	To determine the effectiveness of automated brief messaging in changing lifestyle behavior in patients with type 2 diabetes.	Most of the interventions lasted 7 months. 75% of the interventions address both diet and physical activity. Nine interventions used unidirectional messages and 6 used bidirectional messages. Most bidirectional messages consisted of the patient texting their glucose results using their cell phones. In 3 out of 5 trials that examined if unidirectional messages were acceptable to patients, participants reported high acceptability and satisfaction. One study reported moderate usability with almost half of the patients requesting to stop receiving the messages before the completion of the study. Out of four trials that examined the impact of unidirectional messages on diet and physical activity, 2 reported statistically significant improvement in diet and physical activity. Out of two studies reporting the impact of unidirectional messaging on behavior change, one study found a significant improvement in diabetes knowledge and self-efficacy. Most	Level 1: Systematic Review

			of the trials reported on clinical impacts of the interventions including A1c. Mean A1c difference between intervention and control groups was 0.53% and there did not seem to be a difference in A1c changes with bidirectional vs. unidirectional messages. Interventions had a greater impact in low & middle income countries compared to high income countries.	

Authors/Title	Year	Purpose	Results	Level of Evidence
Capozza, Woolsey, Georgsson, Black, Bello, Lence, Oostema, North / Going Mobile With Diabetes Support: A Randomized Study of a Text Message-Based Personalized Behavioral Intervention for Type 2 Diabetes Self-Care	2015	To determine if a two-way text messaging program that provides behavioral coaching, education, and testing reminders improves glycemic control, patient interaction, and satisfaction for type 2 diabetic patients in a clinic setting.	No significant difference in A1c between the intervention and control group at 90 or 180 days. High satisfaction was reported by patients in the intervention group. At least half of the participants continued using the program even after this study.	Level 1: Randomized controlled trial
Dobson et al. / Effectiveness of a text message based, diabetes self management support program (SMS4BG): two arm, parallel randomized controlled trial	2018	To determine the effectiveness of a theoretically based and individually tailored text messaged based diabetes self-management support intervention in adults with poorly controlled diabetes.	There was a significant reduction in A1c at 9 months for the intervention group. For secondary outcomes, significant improvements were seen for foot care behavior, overall diabetes support, health status on the EQ-5D visual analogue scale, and perceptions of illness identity. There was a high level of satisfaction with the text messaging program itself, with 95% of participants rating it to be useful and 97% willing to recommend the program.	Level 1: Randomized controlled trial

Authors/Title	Year	Purpose	Results	Level of Evidence
Dobson, Whittaker, Pfaeffli Dale, Maddison / The effectiveness of text message-based self-management interventions for poorly-controlled diabetes: A systematic review	2017	To determine the effectiveness of text-messaging based diabetes self-management interventions on glycemic control in adults with poorly controlled diabetes.	3 of the 7 studies used text messaging as the sole intervention, while the others also included pedometers/activity monitors, glucometers, web-based tools, and home gateway systems. Most of the interventions were tailored to the patient to some degree (patient chooses content and frequency preferences, provides feedback based on data received from pedometer/activity monitor). Most of the studies targeted the following self-management behaviors: healthy eating, physical activity, blood glucose monitoring, and taking medication. While all studies showed a decrease in HbA1c for the intervention group, a significant difference in HbA1c from baseline to follow up in the intervention group was only observed in 3 of the 7 studies. Some studies also included self-management outcomes such as knowledge, self-efficacy, improvement in diet/exercise. For the studies reporting on satisfaction/acceptability, patients generally rated high satisfaction, usefulness, and recommendation of	Level 1: Systematic Review

			the program to others. Frequency of text messages for the most effective interventions ranged from 4 to 8 messages per week.	

Authors/Title	Year	Purpose	Results	Level of Evidence
Greenwood, Gee, Fatkin, Peeples / A Systematic Review of Reviews Evaluating Technology-Enabled Diabetes Self-Management Education and Support	2017	To summarize how technology impacts outcomes for diabetic patients.	Mobile phones were the most frequently evaluated technology, then secure messaging. 9 studies included text messaging. Other technologies were smart phone applications, email or video conferencing, and telehealth. Most effective interventions used 2-way communication to connect patients to their health care providers, tailored education, and individualized feedback. 18 of the studies resulted in a significant decrease in A1c.	Level 1: Systematic Review
Holcomb / A Taxonomic Integrative Review of Short Message Service (SMS) Methodology: A Framework for Improved Diabetic Outcomes	2015	To synthesize the evidence for text messaging programs and their impact on A1c, medication adherence, and participant satisfaction.	5 of the 6 studies used 2-way messaging in which participants could respond to the researchers. Daily messaging over a 6 month period resulted in A1c decrease of 0.7%. There was a significant decrease in A1c in 3 studies that used weekly text messaging. For studies that lasted 3 months or longer, the largest A1c decrease was seen in the first 3 months of intervention.	Level 3: Taxonomic Integrative Review

Authors/Title	Year	Purpose	Results	Level of Evidence
Iribarren, Cato, Falzon, Stone / What is the economic evidence for mHealth? A systematic review of economic evaluation of mHealth solutions	2016	To assess & summarize the body of evidence related to economic evaluations of mHealth interventions.	Behavior change communication interventions were the most represented mHealth intervention type. 69.2% of the studies used short messaging system (SMS). Messages were used to send reminders, information, provide support, conduct surveys, or collect data. The most frequent disease or condition focuses were outpatient clinic attendance, cardiovascular disease, and diabetes. 74.3% of the studies reported that the intervention was cost-effective, economically beneficial, or cost saving at base case.	Level 1: Systematic Review

Authors/Title	Year	Purpose	Results	Level of Evidence
Kannisto, Koivunen, Valimaki / Use of mobile phone text message reminders in health care services: a narrative literature review	2014	To review the literature on the use of mobile phone text message reminders in health care.	The main purposes of mobile phone text message reminders were 1) to remind patients about their medication or treatment (63%) or 2) increase attendance to clinical appointments (37%). Adherence to medication/treatment improved in 24 studies, and appointment attendance improved in 11 studies. Non-attendance rates decreased in 11 studies. Patient satisfaction was assessed in 15 studies and overall, patients said that text messages were easy to use, they were willing to receive them, and they were satisfied with the text messages. Some advantages of using text message reminders include that they can be sent simultaneously, are always available, cost effective, and required less staff. One study found that text messages were as effective as telephone reminders but were lower-priced.	Level 1: Systematic Review

Authors/Title	Year	Purpose	Results	Level of Evidence
Lopez et al. / Understanding preferences for type 2 diabetes mellitus self-management support through a patient-centered approach: a 2-phase mixed-methods study	2016	To assess utilization of diabetes management program and patient preferences and perspectives on self-management support.	Out of the 285 participants, 2/3 reported not ever or not currently participating in a diabetes management program. For the participants currently in a diabetes management program, almost 2/3 reported a positive change in their diabetes. The type of program most commonly utilized were clinic or hospital-based programs (50.5%), followed by online programs (24.8%). Diet & weight loss support was the most preferred type of support. The formats of support most preferred were online information, then print materials, then verbal information from a doctor.	Level 2: mixed methods study

Authors/Title	Year	Purpose	Results	Level of Evidence
Marcolino et al. / The Impact of mHealth Interventions: Systematic Review of Systematic Reviews	2018	To assess the impact or effectiveness of mobile health (mHealth) interventions in different health conditions and in the processes of health care service delivery.	The most frequent mHealth intervention was text messaging for reminders, education, motivation, or prevention. Primary outcomes were clinical outcomes, behavioral or lifestyle changes, and processes of care (attendance rates, compliance with meds, data management, etc.). Positive impact was reported on clinical outcomes, adherence to treatment and care, health behavior changes, disease management, attendance rates, and others. Some reviews showed conflicting results with no significant differences between intervention and control groups. Diabetes education and advice via text messaging significantly reduced A1c. Text messages plus postal reminders improved attendance rates at appointments compared to postal reminders. Text message reminders improved the rate of attendance at health care appointments compared with no reminders. Text message reminders were more cost-effective than phone calls and equally efficacious.	Level 1: Systematic Review

Authors/Title	Year	Purpose	Results	Level of Evidence
Nepper, McAtee, Wheeler, & Chai/Mobile Phone Text Message Intervention on Diabetes Self-Care Activities, Cardiovascular Disease Risk Awareness, and Food Choices among Type 2 Diabetes Patients	2019	To examine the effects of educational text messages on diabetes self-care activities, CVD risk awareness, and home food availabilities in patients with type 2 diabetes.	Participants in the intervention group received 3 text messages per week for 12 weeks, each with a link to an AADE7 handout. The intervention group experienced small improvements in self-care activities including significant improvements in CVD risk awareness, availabilities of fresh food in the home, and weekly exercise time. Measurement tools used in this study include the Summary of Diabetes Self-Care Activities questionnaire, the home food self-inventory checklist, and the Block-Fat-Sugar-Fruit-Vegetable Screener, and the Block Physical Activity Screener.	Level 2: Quasi Experimental

Authors/Title	Year	Purpose	Results	Level of Evidence
Nundy et al. / How Do Mobile Phone Diabetes Programs Drive Behavior Change? Evidence from a mixed methods observational cohort study	2014	To investigate the behavioral effects of a mobile phone intervention that uses an automated, interactive text messaging system.	At 3 months & 6 months, the number of days in the past week that participants performed a self-foot exam and exercised for at least 30 min significantly improved when compared to baseline. Self-efficacy significantly improved at 3 months and remained improved at 6 months. The in-depth interviews revealed several themes. Participants described having a more positive attitude about their diabetes and overall health, being less in denial about diabetes, and more aware of the seriousness and consequence of their condition. Patients noted that the intervention helped them recall information they had previously learned and also helped them learn new information. Finally, patients said that the program made them feel more "accountable" for their diabetes.	Level 3: observational study

Authors/Title	Year	Purpose	Results	Level of Evidence
Owolabi, Goon, & Ajayi/Efficacy, acceptability, and feasibility of daily text-messaging in promoting glycemic control and other clinical outcomes in a low-resource setting of South Africa: A randomized controlled trial	2019	To determine the impact of daily educational text messages on blood glucose levels, BMI, and blood pressure for adults with uncontrolled diabetes living in resource-poor South Africa.	The majority (90.74%) of the participants that answered the post-intervention survey indicated that the daily text messages were helpful. After 6 months, both the intervention and control groups experienced improvements in blood glucose levels, with no significant difference between the 2 groups. There was also no significant difference in weight or BP reduction between the 2 groups. There was a high rate of acceptability of the text messages.	Level 1: Randomized controlled trial
Russell, Vess, Durham, Johnson / Text-Messaging to Support Diabetes Self-Management in a Rural Health Clinic: A Quality Improvement Project	2017	To determine if a bidirectional DSME text messaging system can improve fasting blood glucose levels.	The mean fasting blood glucose after the intervention was 11.3% lower than in the pre-intervention period.	Level 3: Quality Improvement
Sahin, Courtney, Naylor & Rhodes/ Tailored mobile text messaging interventions targeting type 2 diabetes self-management: A systematic review and a meta-analysis	2019	Summarizes the available evidence on tailored text messaging for diabetes self-management.	As in similar studies, tailored text messaging has a small but significant effect on HbA1c values. Results show that patients prefer personalized communication, but not necessarily interactivity or frequent contact.	Level 1: Systematic Review & meta-analysis

Authors/Title	Year	Purpose	Results	Level of Evidence
Wang, Xue, Huang, Huang, Zhang / A Systematic Review of Application and Effectiveness of mHealth Interventions for Obesity and Diabetes Treatment and Self-Management	2017	To determine the effectiveness of three types of mHealth interventions (mobile phone text messaging, wearable or portable monitoring devices, and smartphone applications) on management & treatment of obesity and diabetes.	Text messaging interventions were used to support behavior changes in patients with obesity or diabetes by providing knowledge and tips for weight and blood sugar control. Five of the ten studies on diabetes reported statistically significant results in clinical outcomes such as blood glucose or A1c. The greatest reduction in A1c was approximately 1%. Mobile interventions were less successful at changing behavior.	Level 1: Systematic Review

Appendix C

Text Messaging Content

Week/Topic	Reminder	Link to educational resource	Interactive Question
1 Intro to diabetes/blood glucose testing	No reminder for week 1- participants enroll during class #1	Need help checking your blood sugar? Review this short video: https://www.webmd.com/diabetes/video/video-how-to-check-your-blood-sugar	Did you meet your short-term goal this week? Yes No Response message: Thank you for your response. Every small step is progress toward building a new, healthy habit.
Pre-test: Link to DSMQ	Please take 5 minutes to fill out this anonymous survey. Thank you! https://forms.gle/AMBJ63qpsQiaoa619 *Note: Pre-test was given via paper form for August classes.		
2 Physical Activity, stress-breathing exercises, hypoglycemia	Learn about physical activity and stress reduction this week. Please bring your food, activity, and blood glucose record to class on *Tuesday at 5PM at Castle Wellness Center. *time & day was adjusted	It is important to recognize hypoglycemia (low blood sugar) and know how to manage it. Click on this link for a quick overview: https://www.diabeteseducator.org/docs/default-source/legacy-docs/_resources/pdf/general/Hypoglycemia_Tip_Sheet.pdf	On average, how many minutes have you exercised every day this week? A. 30+ min per day B. 20-29 min per day C. 10-20 min per day D. Less than 10 min per day Response: If you are moving less than 30 min per day, click on this link for some ideas to stay active: Physical Activity Tips

	for each diabetes class		
3 Diet, carb counting, reading food labels	Learn about a healthy diet at this week's diabetes class. See you on Tuesday at 5PM. Please bring your blood sugar record.	Finding it challenging to stick to a healthy diet? Click here for some fun, low-carb recipes: https://www.diabetesfoodhub.org/lower-carb.html?prev_scroll=1278	Hope you have been eating healthy this week. Which snack contains 15 grams of carbs: A. Manapua B. Small apple C. Doughnut D. 1 cup fried rice Response: If you chose apple, you are correct! This is a healthy, low-carb snack.
4 Weight loss, complications, heart health, A1c goals	This week's diabetes class we will discuss prevention of complications. See you Tuesday at 5PM.	To learn more about diabetes and the risk of heart disease, click this link: https://www.diabeteseducator.org/docs/default-source/living-with-diabetes/tip-sheets/cardiovascular-disease/cvdprevention.pdf?sfvrsn=12	The HbA1c goal for most patients with diabetes is < 7%. Do you feel confident in reaching this goal? A. Yes B. No Response: If you are not meeting your HbA1c goal, please speak with your diabetes educator for support.
5 Foot care, dental care, medications	Learn the importance of foot and dental care at your	It is important to take care of your feet. Click this link for a 1 minute video about foot care: https://www.youtube.com/watch?v=SulNOSMMNLY	It is important to see your eye doctor yearly and get your teeth cleaned twice a

	last diabetes class. See you Tuesday at 5 PM!		year. Have you been able to do this in the past year? A. Yes B. No Response: If you have not already, how about taking 5 minutes to make sure you are up to date on all doctor's appointments.
Completion of Group Class			
Week 6	Congratulations on completing the diabetes group class! The Adventist Health Castle Wellness & Lifestyle Medicine Center wants you to remember that you are not alone. Call 263-5050 to schedule a follow-up appointment today.		
8	Remember, healthy eating can help control your blood sugar. Learn about 5 nutritious foods by clicking the link below: https://www.youtube.com/watch?v=-qoRA-4w65E		
10	Keep up the good work! Stress from time to time is natural. This link can teach you how to manage stress: https://professional.diabetes.org/sites/professional.diabetes.org/files/media/Emotions_-_Stress.pdf		
12	How are you doing with checking your blood sugars? Click on this link for some tips & tricks: https://www.diabeteseducator.org/docs/default-source/living-with-diabetes/tip-sheets/blood-glucose-monitoring/insidertipstricks-final.pdf?sfvrsn=12		
14	You're never alone. Call the Adventist Health Castle Wellness & Lifestyle Medicine Center at 263-5050 to schedule a diabetes follow-up. We would love to hear from you.		
16 Post-test: Link to DSMQ & satisfaction survey	Please take 5 minutes to fill out this anonymous survey: https://forms.gle/wse2PCWz2m9ULarw8 Thanks!		
18	Thank you for participating in the diabetes education program. This concludes the text messaging service. Please call the Wellness Center at 263-5050 to schedule your diabetes follow-up.		

Appendix D

Conceptual Framework: ARCC Model

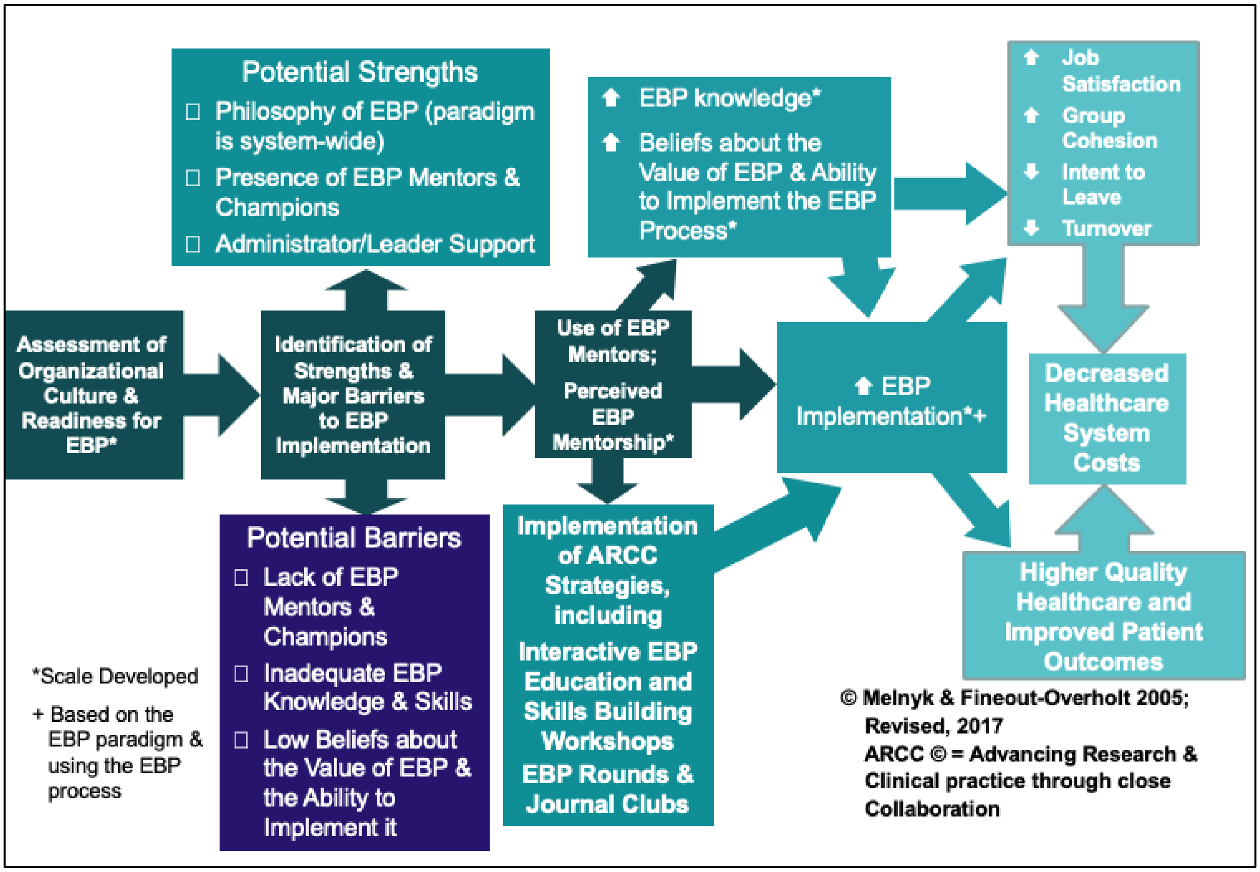

Figure D1. Advancing Research & Clinical practice through close collaboration (ARCC Model). Reprinted from: Melnyk, B. M., & Fineout-Overholt, E. (2018). *Evidence-based practice in nursing & healthcare, 4th edition.* China: Wolters Kluwer.

Melnyk, Bernadette 1:53 AM (9 hours ago)
to me

Hi Angelica—it is great to hear from you. As long as you cite us as authors, you are more than welcome to use our model as your framework. You can use the attached and cite our 2019 book "Evidence-based Practice in Nursing & Healthcare. A Guide to Best Practice (4th edition).
Best wishes!

Warm and well regards,
Bern
Bernadette Mazurek Melnyk, PhD, RN, APRN-CNP, FAANP, FNAP, FAAN
Vice President for Health Promotion
University Chief Wellness Officer
Dean and Professor, College of Nursing
Professor of Pediatrics & Psychiatry, College of Medicine
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Figure D2. Permission to use ARCC Model.

Appendix E

Measurement Tools

	The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the **last 8 weeks**, please specify the extent to which each statement applies to you. Note: If you monitor your glucose using continuous interstitial glucose monitoring (CGM), please refer to this where 'blood sugar checking' is requested.	applies to me very much	applies to me to a consider-able degree	applies to me to some degree	does not apply to me
1.	I check my blood sugar levels with care and attention. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
2.	The food I choose to eat makes it easy to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
3.	I keep all doctors' appointments recommended for my diabetes treatment.	☐3	☐2	☐1	☐0
4.	I take my diabetes medication (e. g. insulin, tablets) as prescribed. ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
5.	Occasionally I eat lots of sweets or other foods rich in carbohydrates.	☐3	☐2	☐1	☐0
6.	I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
7.	I tend to avoid diabetes-related doctors' appointments.	☐3	☐2	☐1	☐0
8.	I do regular physical activity to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
9.	I strictly follow the dietary recommendations given by my doctor or diabetes specialist.	☐3	☐2	☐1	☐0
10.	I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
11.	I avoid physical activity, although it would improve my diabetes.	☐3	☐2	☐1	☐0
12.	I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets). ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
13.	Sometimes I have real 'food binges' (not triggered by hypoglycaemia).	☐3	☐2	☐1	☐0
14.	Regarding my diabetes care, I should see my medical practitioner(s) more often.	☐3	☐2	☐1	☐0
15.	I tend to skip planned physical activity.	☐3	☐2	☐1	☐0
16.	My diabetes self-care is poor.	☐3	☐2	☐1	☐0

Figure E1. Pre-intervention Survey (DSMQ)

Please fill out the following anonymous survey about your experiences with the text messaging service.

1. How satisfied are you with the text messaging service?

Not satisfied Somewhat Satisfied Satisfied Very Satisfied

2. Did the text messages you received help to supplement the material covered in the diabetes group classes?

Yes No

3. Would you like to continue to receive text messages?

Yes No

4. List any suggestions you have for improving the frequency or content of text messages you received.

Figure E2. Post-intervention patient satisfaction survey.

Nelson-Hoy, Timothy <Timothy.NelsonHoy@mapi-trust.org> Mon, Aug 19, 2019, 6:28 AM

to me

Hello Angelica,

Thank you for your submitted screenshots of the DSMQ. The electronic version is approved for use, please proceed with your project.

Best regards,

Tim

Timothy Nelson-Hoy

Client Services Assoc. II

PROVIDE

Tel: +1 857-300-4541

Timothy.NelsonHoy@mapi-trust.org

www.mapi-trust.org, https://eprovide.mapi-trust.org/

Please, note my email address has changed to Timothy.NelsonHoy@mapi-trust.org Please update your directory with my new information

Mapi Research Trust

Figure E3. Permission to use electronic version of DSMQ.

Appendix F

Consent Form

Consent to Receive Text Messages

Adventist Health
Castle

- I agree to participate in this quality improvement project. I understand that the purpose of this project is to help the Wellness Center learn how automated text messaging can be used to improve diabetes outcomes.
- I agree to receive up to 4 text messages per week from the Wellness Center about diabetes education and reminders to attend group classes, sent to my personal cell phone. I understand that standard text messaging rates & fees apply.
- I understand that I can choose to stop receiving text messages at any time by texting "STOP."
- I understand that no protected health information will be shared or published.

______________________________ ______________________________

Participant Name Participant Signature

____

Date

Appendix G

Logic Model

Inputs	Outputs: *Activities*	Outputs: *Participation*	Outcomes -- Impact: *Short*	Outcomes -- Impact: *Medium*	Outcomes -- Impact: *Long*
♦ Automated text messaging service (Simple Texting) ♦ Text messaging schedule for class reminders and self-management education ♦ Self-management education text messaging content ♦ Pre & post-intervention surveys ♦ Wellness Center Staff: Director, registered dietician/diabetes educator, NP, administrative staff ♦ DNP Student ♦ Financial resources to purchase Simple Texting program ($25-$45 per month)	♦ May 2019: Collect baseline data from 2018 on diabetes group class attendance ♦ Aug 2019-Jan 2020: Implement automated text messaging service -Participants to fill out consent form during first group class - Link to surveys sent during first and final month of implementation ♦ Jan 2020: Analyze data to determine if attendance increased compared to 2018; calculate % of pts that return for f/u within 3 months of group class completion, compare baseline average DSMQ score to post-intervention average DSMQ score, % of patients satisfied with the text messaging	♦ 15 adult patients (estimated sample size) with a diagnosis of type 2 diabetes mellitus that have been referred to the education program at Castle wellness Center and have a cell phone with text messaging capability ♦ Registered dietician/diabetes educator (group class leader) ♦ Wellness Center Director ♦ Wellness Center Administrative & Assistant Staff ♦ DNP Student	Within time frame of DNP Project ♦ Between Aug 2019 to Nov 2019, increase patient attendance in the diabetes program by 15% compared to Aug to Nov 2018 ♦ 50% of patients will return for a f/u within 3 months of completing group class education ♦ Increase in self-management behaviors as indicated on pre & post-intervention surveys ♦ By Jan 2020, 75% of participants will be "satisfied" or "very satisfied" with the text messaging service	2-5 years ♦ Expand automated text messaging services: bidirectional texting capability ♦ Offer automated text messaging for all wellness center programs & services ♦ Increased # of PCPs referring patients to Wellness Center programs	5+ years ♦ Create opportunities for hard to reach populations to engage in diabetes education by offering alternative formats (online classes, hybrid online & face-to-face sessions, remote viewing and/or online modules) ♦ Increase patient's confidence in their diabetes self-management skills ♦ Decrease the # of diabetic patients with A1c > 7% on the Windward Side ♦ Decrease hospital readmissions for diabetes related complications

Assumptions: Patient consent to participate in this QI project, text-messaging capability of patient's phones, low attrition rates (most patients that start the class will attend all 5 classes), patient's ability to subscribe to texting & remain engaged for entire implementation period, pt ability to fill out surveys sent via text, Simple Texting technological support

External Factors: Organizational funding of Simple Texting system, stakeholder engagement, goals, & priorities, engagement of participants with the text messaging system

Appendix H

Gantt Chart

	Responsible Person	Start date	Due Date	Comments
Major Task #1: Project Site & Stakeholder Engagement				
Identify Project Site & Content Expert.	Student, Dr. Kathman	August 2018	January 1, 2019	Project site is solidified: Castle Wellness Center Content Expert: Tracie Ann Tjapkes, MPH, Wellness Center Director
Identify major goals of project site.	Student	January 1, 2019	February 12, 2019	1st meeting: 1/15/19 2nd meeting: 2/12/19
Meet with content expert monthly during planning stages of the project.	Student, Content Expert, project chair periodically	January 2019	May 2019	
Major Task #2: Research				
Conduct literature search on patient engagement and recruitment in educational programs, specifically through the use of online platforms or text messaging.	Student	February 12, 2019	March 12, 2019	
Create revised literature matrix with at least 12 articles that provide a high level of evidence for text messaging self-management education & reminders.	Student	February 12, 2019	March 12, 2019	The text messaging service is an additional service for patients enrolled in 5-week diabetes program. Patients will receive class reminders and other self-management education tips.
Update content expert on the results of literature search.	Student, Content Expert	March 2019	March 15, 2019	
Gather baseline 2018 data from Wellness Center on # of patients enrolled in diabetes program, # of patients completing the program, and percentage of referred patients that enroll in program.	Student, content expert, Wellness Center administrative staff	March 2019	April 2019	
Research automated text messaging services, create table with prices & features for each company	Student	April 2019	May 2019	
Research validated tools used to assess diabetes outcomes & self-management	Student	March 2019	April 2019	Possible tools: DSMQ (more recent), SDSCA
Major Task #3: Implementation of Automated Text Messaging				
Castle Wellness Center to purchase Simple Texting	Castle Wellness Center Director & Staff	June 2019	July 2019	
Create schedule & content for text messages	Student, content expert, diabetes educator	May 2019	July 2019	
Create consent form for participants to fill out during the first group class	Student, content expert	May 2019		

Set up Simple Texting program: schedule & content of text messages for each cohort (August & September group classes)	Student, content expert, diabetes educator, NP	July 2019		- 1 weekly reminder text to attend group class, sent 2 days before scheduled class - 1 weekly educational resource sent via a link - 1 weekly self-management education tip - After completion of 5 group classes, 1 text message every 2 weeks for 3 months
Trial Simple Texting on personal cell phones	Student, content expert, diabetes educator, NP	April 2019	June 2019	
DNP student to explain quality improvement project to potential participants during group class #1, consent form passed out for patients that would like to participate	Student, diabetes educator	Aug 2019	Sept 2019	
Demonstrate how to enroll in text messaging service during group class #1	Student, diabetes educator	Aug 2019	Sept 2019	
Link sent via text message to pre & post-intervention surveys during first and final month	Student, diabetes educator	Aug 2019	Dec 2019	
Major Task # 4: Data Analysis				
Conduct trend analysis to determine if there was an increase in patient attendance in diabetes program compared to 2018.	Student	Jan 2020	Feb 2020	
Calculate % of participants that returned for a follow up visit within 3 months of completion of group classes.	Student, Wellness Center staff	Jan 2020	Jan 2020	
Determine if there was an increase in self-management behaviors by comparing results of DSMQ surveys	Student	Jan 2020	Jan 2020	
Analyze results of post-intervention survey to determine overall reaction and satisfaction to the intervention.	Student	Jan 2020	Jan 2020	
Assess # of participants that opted out of text messaging during middle of study & reasons why.	Student	Jan 2020	Feb 2019	
Discuss results of project and next steps for Wellness Center.	Student, content expert, diabetes educator, NP, Wellness Center support staff	Feb 2020	March 2020	

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