Review Article

Blended face-to-face and online/computer-based education approaches in chronic disease self-management: A critical interpretive synthesis

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ABSTRACT

Objective: To review the literature on chronic disease self-management programs that blend face-to-face and online/computer-based education design and delivery.
Methods: A critical interpretive synthesis was conducted. Studies that described blended chronic disease self-management programs were reviewed. Two reviewers performed independent database searches, eligibility screening, and data extraction. Findings were synthesized using a conceptual mapping process.
Results: Twelve articles were included in the final review. Studies focused on patients with diagnoses of diabetes, asthma, and chronic obstructive pulmonary disorder. Factors influencing the design and delivery of programs focused on patient characteristics (such as disease prognosis, time since diagnosis, social determinants of health, health literacy, and proficiency with online/computer-based technologies).
Conclusions: Blended learning self-management programs should consider the suitability of programs in light of health conditions and patient characteristics. Individual patient needs can be identified through clinician-driven assessments, including collaborative goal setting and the selection of pertinent educational tools.
Practice Implications: When considering the design and delivery of chronic disease self-management education programs, healthcare providers should consider three factors: 1) *patient characteristics*, 2) *learning perspectives*, and 3) *design technology options* that best meet patient abilities, clinician expertise, and administrative capacity.

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1. Introduction

The likelihood of being diagnosed with a chronic condition is increasing for North Americans over the age of twenty [1,2]. Living with one or more chronic conditions directly impacts a person's health-related quality of life [3]. Thirty-three percent of Canadian adults living with chronic conditions have reported restrictions in performing activities of daily living [4]. A cumulative increase in the number of chronic conditions has also been correlated with increased health service utilization and associated healthcare costs [5]. In the most populated Canadian province, persons with a minimum of three chronic conditions represent the largest share of hospitalizations and emergency department visits compared to the general population [6]. Re-hospitalization for those with poor chronic disease self-management skills is associated with low health literacy, a modifiable risk factor that can be ameliorated by patient education [7].

Patient education programs that teach disease self-management strategies to persons with chronic disease have been shown to reduce negative disease outcomes and related health care costs [8,9]. These programs aim to improve patients' health knowledge, symptom control, self-care behaviours, self-efficacy, and overall health status [10–12]. Although there is no unified learning theory that best supports patient education, effective instruction uses a variety of teaching strategies based on the subject(s) being taught (*e.g.*, field of knowledge), the learning context (*e.g.*, situation, place, or circumstance), and learner diversity (*e.g.*, learners' background, learning style, ability, and age) [13,14]. Some strategies may include didactic face-to-face instruction or group/peer-learning, where learners participate in facilitated activities designed to enhance affective learning (*e.g.*, moral reasoning, decision-making) or psychomotor (*e.g.*, fine and gross motor dexterity, coordination, and movement) skill development [14–16]. Other instructional strategies, such as online/computer-based learning, where learners can control the amount and type of content being taught, have improved patients' disease-specific knowledge [14,15,17].

Combining face-to-face and online/computer-based platforms is one strategy being used with increasing frequency in healthcare education. As a teaching strategy, combining these approaches is known as 'blended education' or 'blended learning'. Although the term 'blended' has been used to describe a broad range of multi-strategy programs, for the purpose of this study, we refer to blended learning as learning supported by both face-to-face teaching and online/ computer-based education components [18,19]. Specifically, blended learning refers to the "thoughtful integration of classroom face-to-face learning experiences with online learning experiences" [20].

Blended learning works by integrating technology-enhanced instruction with conventional face-to-face teaching approaches to achieve positive learning outcomes [21]. Blended learning programs vary considerably in design and delivery, but missing from the patient education literature is a comprehensive framework that describes how blended learning programs are structured to promote program adherence. Systematic reviews of chronic disease self-management programs focus on the effectiveness of educational interventions and patient health outcomes without comparing and/or describing the actual program interventions in and of themselves. This gap in the literature poses a significant challenge in replicating the design and delivery of best-practice strategies for patient self-management education in clinical settings.

This review critically appraises the evidence on chronic disease self-management programs that use blended learning platforms in at least one study arm. For this review, we consider chronic diseases to be non-curable conditions for which symptom-management is ongoing or re-occurring and often physically and emotionally taxing to the individual [22]. We aimed to examine design and delivery methods for chronic disease self-management programs by answering the following questions:

Research questions

What role do face-to-face and on-line/computer-based education programs play within blended chronic disease symptom self-management education?

What factors influence the effectiveness of chronic disease symptom self-management education programs?

2. Methods

2.1. Study design

We used critical interpretive synthesis (CIS) [23] as a method to review chronic disease self-management education literature. CIS was first described by Dixon-Woods and colleagues [23] as a theory generation method to critically examine a complex body of literature by expanding conventional systematic review and interpretive synthesis techniques. Methodologically, it shares design features similar to meta-ethnography [24] in terms of its key interpretative synthesis steps: 1) reciprocal translation, 2) refutational synthesis, and 3) lines-of-argument synthesis. Unlike meta-ethnography, however, CIS does not use a step-wise approach in the review process. Rather, its "processes of question formulation, searching, selection, data extraction, critique and synthesis are characterised as iterative, interactive, dynamic and recursive rather than as fixed procedures to be accomplished in a pre-defined sequence" [23]. Steps taken in conducting the interpretative synthesis include: 1) reciprocal translation, 2) refutational synthesis, and 3) lines-of-argument synthesis. Through an iterative, reflective, and interpretive review process, emerging themes describe commonalities and variations in the current understanding of a concept. Hypothesized relationships between key themes/factors are explained using evidence from data (*i.e.*, primary studies in this case). Where traditional systematic reviews focus on aggregative construction and pooling of numerical data from study findings requiring comparable and tightly defined parameters, the product of CIS prompts

consideration of contextual factors, characteristics of the manuscripts, and conceptual underpinnings of reported research.

2.2. Search strategy

The literature search included Medline, CINAHL, and PsycINFO databases. A search strategy was developed for each database that included variations of the search terms. Recurrent appraisal of titles and abstracts was conducted in accordance with relevance to the research topic. Constructs used to identify search terms were *"patient education"* and *"symptom self-management,"* along with the following chronic diseases conditions: *"arthritis," "asthma," "diabetes," "chronic obstructive pulmonary disorder"* [*"COPD"*], and *"irritable bowel syndrome."* Based on this review's focus of disease-symptom self-management, we excluded studies focused only on patients with cancers, cardiovascular conditions, and serious mental illnesses for the following reasons: 1) not all cancers have chronic prognoses as certain cancers can be fatal or cured with medical intervention [22]; 2) nonpharmacological therapies in the primary care of cardiovascular disease have a unique goal of improving survival rates by preventing fatal acute events, such as cardiovascular death, myocardial infarctions, ischemic stroke [25] rather than prioritizing disease-symptom self-management; and 3) clinical care for serious mental illnesses most often takes a broader 'recovery-focused' approach extending beyond disease-symptom self-management alone [26]. Recognizing that co-morbidity increases with age, we included studies where participants had cancer, cardiovascular disease and/or mental illnesses in addition to the chronic diseases of interest.

Original research articles published in English between 2004 and 2019 were selected. This review focused on publications over a 15-year period to capture the rise in online/computer-based education programs, as over three-quarters of Canadian households reported having high-speed internet connections [27]. No restrictions were placed on study design or location. Studies that described adult participants (aged ≥18 years) with any of the aforementioned chronic conditions were included. Only patient education programs that combined face-to-face and online/computer-based strategies delivered or mediated by healthcare professionals in at least one study arm were included.

Results of database searches were exported to and managed in Mendeley®. Once duplicate studies were removed, at least two reviewers (RS, KB and/or SDS) examined titles and abstracts for eligibility. Discrepancies in determining eligibility were resolved through discussion. Full-texts were retrieved for review, and two reviewers confirmed the inclusion of selected studies.

2.3. Evidence synthesis

Charting of key data was performed independently by two reviewers (RS & SDS) using Microsoft Excel®. Extracted data included study authors, year of publication, study location, aims of the study, participant characteristics (*i.e.*, sample size and demographics), intervention types, design and duration (including comparators), study outcomes and critical considerations arising during the review. Some included studies described interventions as having multiple, distinct components. Therefore, these intervention components were examined separately (*i.e.*, face-to-face vs. computer-assisted). Three stages of interpretive synthesis (*i.e.*, reciprocal translational analysis, refutational synthesis, and lines of argument synthesis) guided data analysis. To initiate reciprocal translation, key concepts in individual studies were identified and critical questions of study rationale, methodology, execution strategy, and findings were posed. For example, in the paper by Gerber et al. [28], reviewers queried the purpose, benefits and drawbacks of using an online platform already familiar to the

patient population. Reviewers came together to compare their individual critiques and identify emerging concepts (*i.e.*, study's findings). Here, an emerging concept [28] was the 'selection of technological tools that enhance intervention-tailoring.' Upon consolidating emerging concepts into potential themes, the reviewers returned to the primary studies included in the CIS review to garner at least one example from each study that addressed the concepts identified. As such, concepts were refined, consolidated, or discarded so those retained as part of this study's findings are represented within all included studies.

Evidence gathered for each key concept was then examined across included studies in the refutational synthesis phase. Commonalities and discrepancies characterizing each concept were identified and described. To illustrates this process, consider the paper by Ryan et al. [29] that describes aesthetically tailoring an online platform to participants by using visual cues from a local mural familiar to the audience on the website's home page. This strategy was very different from all other included studies, as other investigators did not report considering aesthetics, familiarity, or usability in their selection of online platforms. As such, papers included in the CIS review were not only compared, but gaps in emerging concepts were also identified. Within the refutational synthesis phase of the appraisal, variations across studies were identified contributing to defining and describing the emerging themes.

The final stage of the CIS was to consolidate the themes into a coherent, synthesizing argument. Through an interpretive and iterative process, themes were mapped across concepts and study designs so that findings would be consistent when applied to each source of evidence. Following the lines of argument regarding evaluations of methodological quality [23], and given that the scope of this review was to capture the breadth of multi-component self-management education programs, we prioritized intervention relevance over methodological standards. Elements of study designs and intervention reporting, however, emerged as a key construct, illustrating the impact of methodological considerations in included studies. All articles were independently coded by two reviewers (RS & SDS). To enhance the reliability of the appraisal, the final themes and synthesizing argument were reviewed by a third reviewer (KB).

3. Results

A total of 1588 papers were identified in the initial database search and were screened for eligibility. Twelve studies met inclusion criteria (Fig. 1) and originated from the United States (*n* = 7), Norway (*n* = 1), the Netherlands (*n* = 2), Taiwan (*n* = 1), and Thailand (*n* = 1). Study designs included feasibility studies (*n* = 3), pilot studies (*n* = 1), pilot and feasibility study (*n* = 1), case-control designs (*n* = 1), cluster-randomized trials (*n* = 1), and randomized-controlled trials (*n* = 5). Diabetes and/or pre-diabetes (*n* = 10) was the most common participant diagnosis, followed by chronic obstructive pulmonary disorder (*n* = 1) and asthma (*n* = 1). All included studies described face-to-face clinician-directed educational components and online/computer-based self-directed educational components for at least one intervention. Given the breadth of study designs, outcomes varied from aspects of program acceptability to disease-specific outcomes. Study characteristics are described in Table 1.

Our critical interpretive synthesis generated three over-arching themes with sub-themes to describe a framework for designing technology-enhanced patient self-management programs: 1) *the ideal participant,* including time since diagnosis which we identified as a potential gap in the literature, 2) *why it might work,* including the types of learning perspectives influencing information uptake, and 3) *rolling it out,* including role of the

n=1588

(on-line academic databases searched; duplicates removed)

⬇

n=66

(1,522 articles eliminated by screening titles and abstracts)

⬇

n=11

(55 articles eliminated by reading full-texts)

⬇

n=12

(1 article included after review of reference lists and reading full-texts)
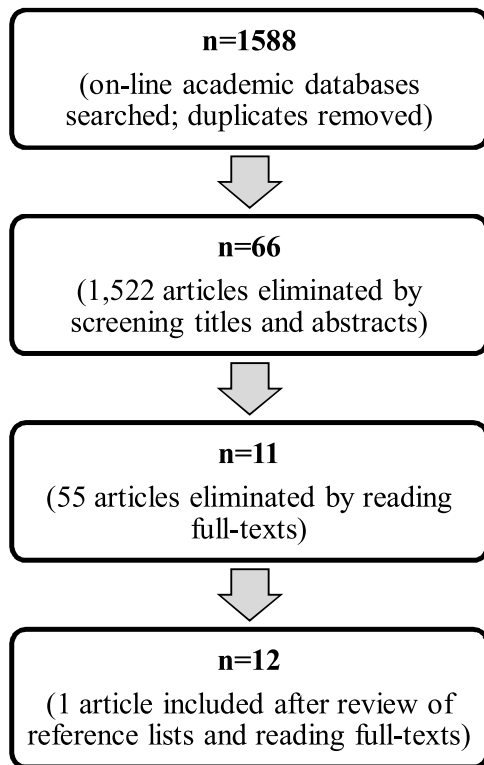
Fig. 1. Article selection process.

healthcare provider, technology application and the interplay between face-to-face and online/computer-based interventions. The proposed relationships between themes are illustrated in a nested conceptual model (Fig. 2).

3.1. The ideal participant

Multiple participant characteristics emerged as a central concept to informing a synthetic construct of the 'ideal participant' that may benefit most from self-management programs. In their rationale for program design and delivery, studies inconsistently considered the ideal participant or who might benefit the most from an education program. We considered the ideal participant in terms of his/her individual characteristics, such as participant engagement, education/demographic factors, health literacy, and proficiency with online/computer-based technologies. Characteristics of the chronic condition, such as time since diagnosis, disease trajectory, symptom severity, and self-management tasks also contributed to identifying the ideal participant.

3.1.1. Characteristics of the individual

Given the goal of self-management programs is self-directed behaviour change leading to symptom-control, patient engagement varied extensively across studies. For example, 42.9% of participants dropped out of a program targeting young adults with prediabetes [30]. We attributed high attrition and non-compliance to factors of intervention design, patient illness perception, self-efficacy, and competing work-life demands. These factors are likely to have contributed to participants' motivations and engagement in interventions [28–34]. As such, barriers to intervention uptake and retention were identified as individual, specific, and distinct from external predictors such as social determinants of health.

Social determinants of health addressed by reviewed studies included economic status, geographical location, literacy, health behaviours, and technology. For example, Glasgow, Strycker, King,

and Toobert [32] determined demographic characteristics that might predict improved symptom-management at different time points of a diabetes self-management program. This investigation, described in three articles, focused on tailoring interventions to low-income individuals [28,29,32]. Only one other study considered optimizing intervention effectiveness by partially administering patient education at a distance to address geographical location as a social determinant of health barrier (i.e., by targeting rural-dwelling participants) [34].

We considered identifying computer literacy, also described as 'internet access', as a factor that directly linked to the appropriateness of the interventions for the target populations [28–31,35,36]. In studies that did not screen potential participants by this factor, the use of personnel and equipment resources to establish computer literacy prior to beginning the intervention were described by authors [29,34,37].

3.1.2. Characteristics of the condition

An identified gap across eleven studies was that none selected for, nor considered the relevance of, "time since"/ "duration of" diagnosis when targeting patient populations. Given that chronic diseases have a natural life-long prognosis, treatment goals may differ for patients who are 'newly-diagnosed' versus patients who are in the 'chronic' phase of their illness. Only Cha et al. [30] intentionally selected participants in a pre-diagnosis phase, taking a preventative intervention approach towards symptom-management.

Symptom severity emerged as a consideration for study inclusion [29,35,38] and educational program acceptability by a patient [35]. Given that chronic conditions can be characterized by fatigue or decreased mobility, participants with COPD indicated that they were able to conserve energy by participating from home [35]. Similarly, patients who presented at primary care settings with inadequate awareness of their risk for hypoglycemia were identified as potential participants by healthcare providers [38]. Remaining studies only considered symptom severity in terms of study outcomes and intervention effectiveness.

Interventions described in the studies were not generalizable beyond the chronic diseases for which they had been developed. Only one intervention included participants with either severe COPD or diabetes [35]. Although administered on the same technological platform, both patient groups received condition-specific education [35]. As such, interventions were designed to develop disease-specific self-management skills. For example, Rondags, de Wit and Snoek [38] required participants to track the frequency of hypo- and hyperglycemia episodes to increase their symptom self-awareness. Though the aspect of self-monitoring may be generalizable across chronic conditions, the specific program purpose and self-assessment skills developed in this intervention was disease-specific.

3.2. Why might it work?

Our analysis highlighted a lack of explicit rationale informing selection of program content and delivery. We captioned the second synthetic construct as 'why might it work?' as a prompt for investigators to articulate, not only the self-management theories targeting behaviour change outcomes, but also the types of learning perspectives that may influence information uptake.

3.2.1. Self-management theories

We concluded that 'knowledge increase to affect behaviour change through the development of self-management skills' was the underlying goal within the papers. Articles that referenced specific behavioural change theories included social cognitive theories [29–31], social-ecological models [31], self-management

Table 1
Study characteristics of included articles.

Primary Author, Year, Country of study	Study Purpose	Study Design, Participants (# completed the study), Diagnoses, Age	Intervention: Frequency Duration Self-directed Component (S/C) Clinician-directed Component (C/C)	Outcomes/Outcome Measures Data Analysis	Findings
Burkow, 2013 [35] Norway	Patient acceptability of internet-enabled group programs delivered at home.	Feasibility study n = 10 (5 female) COPD or Diabetes Age 35+	6-weeks S/C: Weekly digital health diary and disease-specific educational videos designed by health professionals (10-40 minutes) C/C: Weekly individualized consultations and group exercise (30 minutes) facilitated by multidisciplinary health team through videoconferencing	Program acceptability through semi-structured interviews. Data categorised into themes.	Overall positive impression. Group videoconferencing allowed for social aspect of exercise, clarifying questions from educational videos, and preserving energy to attend. However, less peer-dialogue due to video-conferencing system only hosting 6 participants.
Cha, 2014 [30] United States	Examine efficacy of prevention program in young adults	Feasibility study One-group pretest-post-test design n = 13 (10 female) Prediabetes Age 22-27	12-weeks S/C: Daily dietary and exercise habits tracked via hand-held devices and digital platforms. C/C: Initial 2 hr healthy-lifestyle education session followed by weekly lifestyle coaching via phone by undergraduate student (5-20 minutes)	Prediabetes perceptions, health literacy, self-efficacy, therapeutic efficacy, dietary behaviour, physical activity, and clinical outcomes (via validated measures); Program accessibility (via questionnaire) Data analyzed via paired-samples t-tests.	Overall participant satisfaction. Improved dietary habits, physical activity, and clinical outcomes.
Gerber, 2007 [28] United States	Evaluate usefulness of self-management program in adolescents and young adults.	Pilot Study One-group post-test design n = 19 (13 female) Type 1 and 2 diabetes Age 19 – 26	STYLE Internet-based transition support program: 6-months S/C: 5 monthly delivery of disease-specific education modules; Feedback links to external websites; Discussion board with peers C/C: 3 individualized consultations with health professionals; Role playing and goal setting exercises; Regular telephone contact by diabetes educator	Time spent on modules and usage patterns (via frequency and topics of interest); Feedback (via individual and group sessions) Descriptive statistics	50% indicated modules were easy to complete. 67% had difficulty completing modules due to work, school and family commitments. Positive response to diabetes educator's telephone interactions. Discussion board was primarily used for social/ emotional conversation.
Glasgow 2006 [37] United States	Evaluate effects of computer-assisted self-management on dietary, biological and quality-of-life in primary care.	Randomized controlled trial. Two-group pretest/post-test design n = 301 (151 female) Type 2 diabetes Age 61.5 (± 11.3)	2-months S/C: Computer-assisted self-management assessment (via CD-ROM Program) assessing current health behaviour, feedback, identification of benefits and barriers to change, and tailored goal-setting and action-planning. C/C: Motivational interviewing by health educators to support patients' goal attainment.	Dietary change; Diabetes-specific quality of life and depression; Changes in biological markers (HbA1c, lipid ratios, & HDL levels) Descriptive and inferential statistics	Treatment group showed significant improvement in estimated daily fat intake and weight loss; No significant change in not fruit and vegetable intake, quality of life and depression scores, or biological markers.
Glasgow, 2012 [31] United States	Evaluate effects of two internet-based diabetes self-management programs on lifestyle behaviours.	Randomized controlled trial. A three-group pretest/post-test design n = 358 (178 female) Type 2 diabetes; BMI ≥ 25 kg/m^2; at least 1 heart disease factor Age 58.4 (± 9.2)	12-months CASM (Computer-Assisted Self-Management) S/C: Goal development/ tracking with feedback on achievement, forum, community resources, and action planning. C/C: Research staff assisted with website navigation CASM+ S/C: [As above] C/C: [As above] + 2 weeks – Follow-up phone call from research staff to discuss action plan; 8 weeks – 3x group education sessions	Behavioural outcomes (eating patterns, fat intake, caloric expenditure, medication adherence); Psychosocial outcomes (self-efficacy, problem-solving skills, supportive resources, health status, quality of life); Biological outcomes (BMI, hemoglobin, A1c, lipids, blood pressure). Descriptive statistics, analysis of variance, prediction models.	No significant differences between intervention groups. Significant improvements in behavioural outcomes and modest improvement in biological and psychosocial outcomes over 12 months.

Author, Year, Location	Aim	Study Design	Intervention	Measures	Findings
Glasgow, 2014 [32] United States	Identifying subgroups associated with success at each of 6 steps in a diabetes self-management program.	Randomized Controlled Trial n = 462 Diabetes	12-months CASM (Computer-Assisted Self-Management) S/C: Goal development/ tracking with feedback on achievement, forum, community resources, and action planning. C/C: Research staff assisted with website navigation CASM+ S/C: [As above] C/C: [As above] + 2 weeks – Follow-up phone call from research staff to discuss action plan; 8 weeks – 3x group education sessions	Two sets of potential demographic and behavioural predictor variables of 6 binary outcomes of participation and intervention success. Recursive partitioning with signal detection analysis.	Demographic factors were associated with initial participation but not with later steps. Health behaviour variables were associated with later steps but not initial participation.
Jaipakdee, 2015 [33] Thailand	Evaluate effectiveness of computer-assisted diabetes self-management support program.	Cluster Randomized Controlled Trial n = 378 (76.7% female) Type 2 Diabetes Age 61.3 (± 9.6)	3 hrs/ month 6 months S/C: Computer-assisted instruction (CAI) in education sessions (videos on diabetes related information with embedded pre-post tests) C/C: Step-by-step instruction provided by nurse supporters to manage conditions and change lifestyle.	HbA1C level, fasting plasma glucose, health behaviour, body weight, depression, and QOL assessed at baseline, 3 months and 6 months. Statistical analysis (various)	Intervention group had significant improvements in all outcomes except depression, compared to usual care. Sustained improvements in fasting plasma glucose, health behaviour and QOL at 6 months.
McIlhenny, 2011 [34] United States	Evaluate effectiveness of one-on-one health education and web portal navigation instruction as compared to traditional verbal instruction and printed material.	Case-Control Study n = 53 (31 female) Type 2 Diabetes Intervention group Age 65.8 (± 14.04) Control group Age 61.8 (± 10.88)	Weekly 6 weeks S/C: Access to My Health Education & Resources Online (MyHERO) web portal at home or from a computer in the clinic. C/C: One-on-one healthcare education and hands-on instruction for web portal from a nurse educator.	Clinical data (weight, vital signs, serum glucose, HbA1c and lipid panel) collected at baseline, 3 month, and 6 months. Disease knowledge, quality of life, behaviour and satisfaction surveys collected at baseline and 6 months. Descriptive statistics.	Intervention group had significantly lower glucose levels, and improved knowledge and glucose monitoring, compared to control at 6 months. No changes in vital signs, lipid levels, quality of life, and behaviour change.Internet usage decreased over time. Receiving information from nurse educator preferred over web portal.
Rondags, 2016 [38] Netherlands	Assess the feasibility and acceptability of a partly online psychoeducational group intervention.	Pilot & Feasibility Study n = 40 (16 female) Type 1 and 2 Diabetes Age 54.4 (± 12.6)	3 × 2.5 hr sessions 4 weeks S/C: Online modules (educational media and interactive activities) C/C: Diabetes professional-facilitated structured online group discussions.	Diabetes profile, HbA1c values, frequency of mild hypoglycaemia per week (self-reported blood glucose level), hypoglycaemia awareness, fear of hypoglycemia, diabetes-related distress and self-efficacy, subjective health stats, well-being and psychological distress). Feasibility outcomes. Descriptive statistics and qualitative analysis.	Worries about hypoglycaemia, diabetes, distress and confidence in self-care improved significantly, but frequency of hypoglycaemia and hypoglycaemia awareness did not. No major issues identified with regards to intervention feasibility.
Ryan, 2013 [29] United States	Assess the feasibility of an internet-based intervention targeted at low income minority patients at high risk of not engaging in self-management.	Feasibility study n = 21 (66.6% female) Type 2 Diabetes Age 54.36 (± 4.09)	1 educational campaign per 3 months 13 months S/C: Glucometer data upload with contextualized electronic feedback, patient-centered and culturally aligned diabetes education, peer networking. C/C: Portal access to nurses and in-person appointments, and computer literacy training.	Clinical Outcomes collected: A1C levels, LDL levels, HDL levels, Triglyceride, total cholesterol, and blood pressure. Weight, Height, BMI.Self-Management and Participation Data: Frequency of uploading data, logging into the site, engaging in chats, generating messages to nurses. Self-reported health QOL reported on SF-36. Inferential statistics and correlations.	Clinically important changes in A1C, LDL cholesterol, total cholesterol, and triglycerides associated with associated with use of chat messages and interactive activities. Improvement in health-related quality of life domains.
Van der Meer, 2009 [36] Netherlands	Evaluate the effectiveness of Internet-based asthma self-management	Randomized controlled trial n = 183 (59.7% Intervention group, 69.5% control group female) Asthma Intervention Group Age 36 (19-50) Control Group Age 37 (18-50)	12 months S/C: Internet-based treatment plan and online education. C/C: Web communication with specialized nurse, 2 in-person group education sessions.	Knowledge, inhaler technique, and medication adherence assessed at baseline and 12 months. Medication use reported at baseline, 3 months, and 12 months. Inferential statistics and repeated measures.	Non-significant improvements in intervention group's QOL, disease control, patient-reported symptom-free days, and lung function, compared to control. No between group differences in knowledge and inhalation techniques or symptom exacerbations.

Table 1 (Continued)

Primary Author, Year, Country of study	Study Purpose	Study Design, Participants (# completed the study), Diagnoses, Age	Intervention: Frequency Duration Self-directed Component (S/C) Clinician-directed Component (C/C)	Outcomes/Outcome Measures Data Analysis	Findings
Yeh, 2006 [43] Taiwan	Evaluate outcomes of an internet-based education system.	Randomized controlled trial n = 274 (43% intervention group, 54% control group female) Diabetes Mellitus Intervention group age 66.0 (±8.5) Control group age 61.2 (±12.7)	8 months Patient-Oriented Education Management system for diabetes using the internet (POEM) S/C: Reviewing tailored educational material, demographic information, medication and laboratory test results, and appointment schedule in online system. C/C: Clinic appointment with physician, and goal development and educational material tailoring by patient educator.	Laboratory tests (fasting blood glucose, HbA1c and total cholesterol level) compared between groups pre-intervention to post-intervention. Inferential statistics.	Change in fasting blood glucose, HbA1C and total cholesterol was significant between experimental and control group.

models [37], and generally stated 'principles of behaviour change' [38]. However, these studies only named and/or briefly described the theories that influenced intervention design. None indicated *why* these approaches were the most appropriate for their intervention, nor did they describe the theoretical constructs and relationships that influenced intervention design and delivery.

To identify the primary purpose for selecting an educational format, we conceptualized a continuum of uses for both face-to-face and online/computer-based strategies. This continuum spans increasing knowledge on one end to affecting behaviour change on the other (examples of educational formats are described in Fig. 3). For example, educating participants on disease-specific knowledge was delivered using online/computer-based strategies in all studies. However, some studies also provided disease-specific information or information on how to use the computer-based technology through face-to-face education by a health care provider [34,36]. Likewise, strategies for changing behaviour were implemented in computer-based programs, such as online discussions [28,35,38] or computerized goal setting [31,32], but also personal reflection on health behaviours and face-to-face facilitated goal setting [28,29,36,37].

3.2.2. Learning perspectives

Study findings raise the notion that patient self-management education programs might need to consider not only variability in individual learning styles and preferences, but also the type of knowledge influencing information uptake in their pedagogical design. Although there is no unified learning theory that best supports patient education, two common pedagogical perspectives used are cognitive (*i.e.*, learning that focuses on factual, procedural, and conceptual thinking) and constructivist (*i.e.*, learning that focuses on the way individuals make sense of their world by constructing personal representations of their experiences) [14]. Where cognitive learning perspectives involve ways to improve working memory and information processing [39,40] through the synchronized use of audio, visual, and/or kinesthetic schema [41], constructivist learning perspectives involve the social negotiation of beliefs, attitudes, and values [14].

In the cognitive learning domain, knowledge can be broken down into factual knowledge (*e.g.*, information needed to solve problems), procedural knowledge (*e.g.*, methods of inquiry, criteria for using skills, psychomotor techniques), and conceptual knowledge (*e.g.*, relational information) [42]. All studies included in our CIS review involved an element of factual, procedural, or conceptual learning, such as reviewing instructional content using online/computer-based platforms or learning how to manipulate medical devices and performing exercises through face-to-face interactions. Online/computer-assisted instruction delivered content using synchronized audio/videos, stories, animated images, graphics, textual documents, *etc.* [33,35,43]. Examples of knowledge delivery via online/computer-based instruction included factual knowledge related to food choices for diabetes and the mechanisms of medications [38], procedural knowledge about symptom recognition, physical activity and foot care, and conceptual knowledge about self-monitoring of clinical indicators [38]. Clinician-directed instruction delivered affective knowledge, such as empowerment of self-efficacy [36], and psychomotor knowledge, such as asthma inhaler techniques [36].

In multiple studies, a health care professional facilitated participants' self-directed learning by tailoring the education plan to their needs. For example, in one study, educational content on an online platform was 'prescribed' by a physician and the educational recommendations were reviewed by a patient educator [43]. Other studies reported providing participants with access to resources
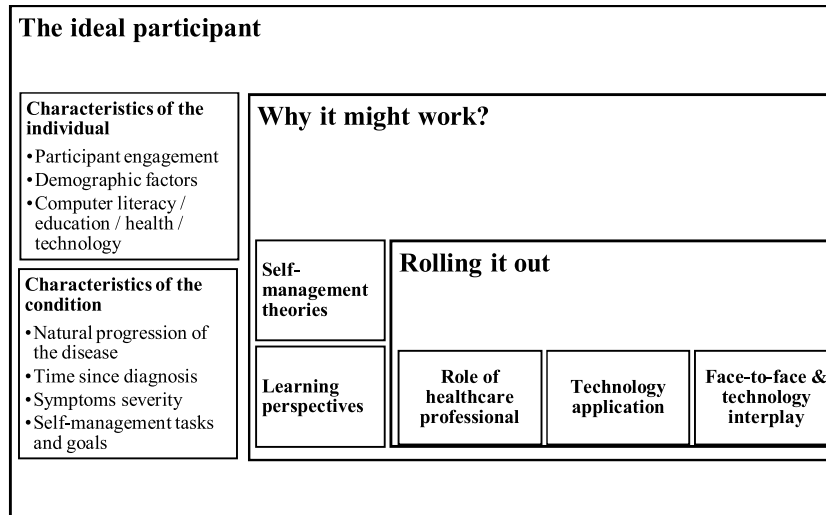
Fig. 2. Framework for designing technology-enhanced self-management programs.

which they could navigate and review, based on their personal interests and learning needs.

Peer-learning, an intentional opportunity for patients to teach each other by sharing their lived experiences, was also highlighted as an approach to information and experience sharing through online discussions [28,29], video-conferencing [35] or clinician-directed education sessions [31,36,38]. Individual experiences of peer-learning varied across studies. Where participants expressed an appreciation of hearing their peers' experiences of self-management in video-conferencing sessions [35], Gerber and colleagues [28] reported that only four of 19 participants made significant contributions to online discussion boards. Future research should consider investigating whether specific types of learning, such as affective, psychomotor or cognitive learning are better suited to support online versus face-to-face education.

3.3. Rolling it out

Pragmatic considerations that shaped the design and delivery of computer-based and face-to-face education programs were conceptualized as factors to be considered when 'rolling out' the program. Examples of such factors were the role of the healthcare provider in the educational program, the type and function of the technology used to deliver the program and logistical aspects of delivering and participating in the program.

3.3.1. Role of the health care provider

Specific roles of the health care provider(s) ranged from their traditional responsibilities (*e.g.*, medication prescription; therapeutic interventions) to more technical duties such as educating participants on how to use computer-based technologies. Communication with health care professionals occurred face-to-face during clinic appointments, and also via tele-health or online discussions and video conferencing [29,35,36,38]. Health care providers often initiated telephone contact to remind and encourage participants to continue with their self-management plans in addition to providing assistance to help participants mitigate any potential concerns [28]. One study identified a higher improvement in disease-specific outcomes following hands-on instruction on how to use an online platform versus only having access to the online platform itself [34].
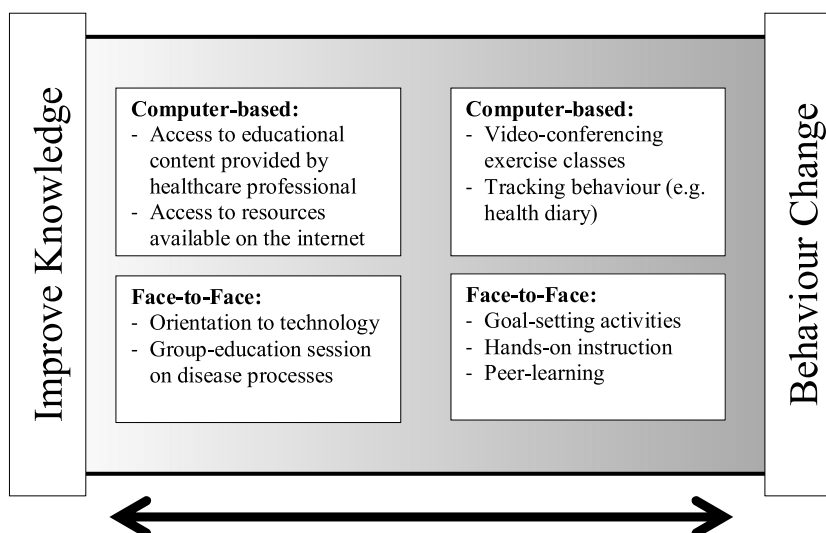

Fig. 3. Examples of program components provided by face-to-face or online/computer-based instruction across the continuum of self-management education.

3.3.2. Technology application

Significant variation existed in the types of technologies used to provide online/computer-based self-management programming. Programs selected for individuals that had access to home-internet developed complex online platforms specific to program goals [29,43]. Other studies facilitated uptake of the programs by ensuring participants were provided with the required technology through the use of recycled desktop computers [29,34]. In some studies, researchers went so far as to assist patients with establishing internet connections and providing in-home technical support [29]. Other computer-based technologies did not necessarily rely on internet access, rather, operated using computer programs that were locally installed on clinic computers [33,37].

3.3.3. Interplay between face-to-face and online/computer-based interventions

Given the imprecise interplay between face-to-face and online/computer-based education interventions, we were not able to garner an understanding of how the online/computer-based educational component complemented the face-to-face educational component. The purpose of complementing face-to-face group education sessions with computer-based programs, and vice versa, was inconsistently addressed, if at all. Some studies used the face-to-face component solely as a means of introducing participants to each other and to the computer-based component. Other studies explicitly described the role of technology to improve factual, conceptual, and procedural knowledge, which preceded a face-to-face educational component that prompted behaviour change [33,35].

4. Discussion and conclusions

4.1. Discussion

The purpose of this review was to examine how chronic disease self-management programs combine face-to-face and online/computer-based educational interventions to improve knowledge and affect behaviour change leading to effective disease self-management practices. Given the increasing number of studies incorporating technology into new and existing self-management education programs, our CIS review highlights the lack of explicit rationale informing the selection, design and delivery of these new methods. Combined programs demonstrated a breadth in the rationale for using these tools (e.g., the need to increase knowledge to affect behaviour change) to their role in treatment delivery (e.g., self-directed vs. clinician-directed care). This synthesis summarizes key elements that should be considered when traditional face-to-face programs are supplemented with new, computer-based technologies. Compared to systematic reviews that determine intervention effectiveness, we identified concepts that contribute to achieving self-management effectiveness and patient adherence through blended learning platforms.

The most prominent consideration when designing blended learning patient self-management programs is to ensure that the educational program is suitable for the target population and the individual patient. In clinical practice, the most effective and adhered to treatment plans are informed by the subjective and objective assessment of patient needs, and the use of age-appropriate tools. For example, Morsa and colleagues suggest that young adults with chronic diseases transitioning from pediatric to adult care may be receptive to instructional strategies that involve role play (aimed at developing skills around the use of the healthcare system, such as speaking with healthcare professionals), case studies (to develop skills involved in decision making) and pictorial or video creation (to develop psychosocial skills such as defining oneself as a whole person rather than just a chronically ill patient) [44].

Through collaborative goal setting, an appropriate treatment strategy is developed by the clinician in collaboration with the patient. Although such a process may be intuitive in the clinical realm, the studies reviewed identified numerous patient-specific considerations that impacted program uptake. For example, computer literacy was only considered in a limited number of studies [29,35]. Patient familiarity with using computer-based learning approaches cannot yet be implied given the variability of patients' socio-economic status, learning styles (including health and technological literacy), physical limitations and experiences [45,46]. Developers of blended learning programs need to weigh the cost of individual-level computer literacy training against a patient's potential to improve their chronic disease self-management to ensure program sustainability.

Individual considerations also include time since diagnosis. The educational needs of individuals at the time of diagnosis, regardless of chronic condition, are likely different than needs of patients with longstanding disease. Information on disease processes, medications and symptom management may be critical for newly diagnosed patients. Bernstein and et al. [47] described the value patients place in the information provided by medical specialists at the time of initial diagnosis. General information (e.g., cognitive 'facts') may be most beneficial when disseminated through access to online/computer-based repositories, whereas patient education that addresses affective and psychomotor knowledge domains (e.g., growth in self-efficacy, coping skills, or manual and physical skills) may best be delivered by a trusted healthcare professional. As such, the timing when patients receive information, and how that information is accessed needs to be considered in the self-management education-trajectory. Time since diagnosis may be a key consideration when aligning program objectives with study inclusion criteria.

Beyond individual patient characteristics, the role of the clinical care setting should also be considered when developing program objectives. A primary consideration is the role that the healthcare provider plays in designing and delivering the program. Multiple studies described healthcare professionals taking on non-traditional roles while delivering the intervention [29,31,34,36,38]. Where explicit emphasis was made to train healthcare providers in administering the blended learning interventions, improved patient outcomes were observed [38]. Multiple interventions required healthcare providers to interact with patients using different forms of telecommunication, varying from phone calls to videoconferencing [28,30,31,35]. Use of such technologies are familiar to telehealth clinicians that provide health education to patients remotely. Clinicians' lack of expertise in designing programs to appropriately use technology [48], alongside their ability to manage on-going technical challenges [29], needs to be considered in terms of pragmatic feasibility for interventions. As frontline healthcare providers might not be able to use various online/computer-based technologies effectively or efficiently, their training as educators may need to be further explored.

4.2. Conclusion

This review identified that most research related to chronic disease self-management programs that blend face-to-face educational components with online/computer-based educational components remains at the level of pilot or feasibility studies. Despite programs generally being acceptable to patients, their effectiveness on self-reported or objectively measured outcomes varied. Given the diversity of program designs, we propose a definition of blended learning for patient education to be *a combination of face-to-face affective and psychomotor knowledge instruction enhanced with online/computer-based instruction related to disease-specific content knowledge*. Within patients' growing

familiarity and access to technological systems, there continues to be opportunity to leverage these resources for health care delivery. By designing patient education programs at the level of the technology, rather than at the level of the patient, we run the risk of designing hi-tech programs that are not effective from a patient self-management perspective and are not necessarily cost-effective.

4.3. Practice implications

When considering the design and delivery of chronic disease self-management education programs, health care providers should consider three factors: 1) *patient characteristics* in terms of their demographic/socio-economic status, time since diagnosis, disease trajectory, health and technological literacy (*e.g.*, the degree to which patients have the capacity to understand basic health information and use online/computer-based technology); 2) *learning perspectives* that best support the intended knowledge gains (for example, it would be valuable to investigate whether specific types of learning such as affective, psychomotor or cognitive learning are better suited to support online versus face-to-face education; and 3) *design technology options* that best meet patient abilities, clinician expertise and administrative capacity within the clinical practice setting.

Conflict of interest declaration

The authors declare that there is no conflict of interest.

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