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# Development of a self-guided web-based intervention to promote physical activity using the multi-process action control framework

Sam Liu<sup>\*</sup>, Casandra Husband, Henry La, Madeline Juba, Raven Loucks, Aimee Harrison, Ryan E. Rhodes

School of Exercise Science, Physical and Health Education, University of Victoria, Victoria, British Columbia, Canada

## ABSTRACT

**Purpose:** Physical activity promotion has mostly focused on theories of intention-formation, with the assumption that positive intentions will lead to behaviour. Though necessary, exercise intentions alone are often not sufficient to improve physical activity behaviour. The Multi-Process Action Control (M-PAC) framework builds on previous intention-based theories by including both determinants of intention formation and its translation into behaviour. The purpose of this study was to describe the process of developing a self-guided web-based intervention to promote physical activity among adults using the M-PAC model.

**Procedures:** The development process consisted of the following three phases: 1) Intervention planning: determine intervention needs and requirements; 2) Intervention development: use an iterative process to design a web-based physical activity intervention based on the M-PAC framework; 3) Pilot testing: conduct usability and acceptability assessment on the web-based intervention to further enhance user experience.

**Principal results:** The intervention planning phase suggested that there is a need for web-based physical activity interventions and there is currently no web-based intervention designed using the M-PAC model. In phase two, we adopted an iterative process to develop a 10-week self-guided web-based intervention to help adults (> 18 years of age) to meet 150 min of moderate to vigorous physical activity per week. The pilot testing phase yielded valuable feedback on usability, content, and design of the web-based intervention.

**Major conclusions:** The development of a web-based physical activity intervention using the M-PAC model could further enhance the effectiveness of web-based interventions and have a significant impact on extending the reach of existing physical activity promotion programs. This study has reinforced the importance of an iterative development process that involves a multi-disciplinary team to design a web-based intervention to promote physical activity. The process enabled the team to clarify the needs for an intervention for our target users, and provided valuable feedback on the design and content of the web-based intervention. Future studies are now needed to evaluate the effectiveness of our web-based intervention.

## 1. Introduction

Regular physical activity is associated with risk reduction of all-cause mortality (Andersen et al., 2000), cardiovascular disease (Thompson et al., 2003), stroke (Do Lee et al., 2003), hypertension (Liu et al., 2018, 2013, 2012), colon cancer (Wolin et al., 2009), as well as reduced symptoms of depression and anxiety (Biddle and Asare, 2011; Penedo and Dahn, 2005). Despite the well-known benefits of physical activity, up to 80% of adults in North America do not meet the recommended amount of daily physical activity (Colley et al., 2010).

Several behaviour change theories have been developed to provide health researchers and practitioners with a framework to promote physical activity. The most researched and commonly used theories in physical activity promotion include the theory of planned behaviour (Hobbis and Sutton, 2005), theory of reasoned action (Sheppard et al., 1988) and social cognitive theory (Young et al., 2014). These intention-based theories primarily focus on intention formation as the most

proximal antecedent to physical activity (Kaushal et al., 2017; Rhodes and Yao, 2015; Vallerand et al., 2016, 2017). Though necessary, exercise intentions alone are not sufficient to improve physical activity behaviour for many people. For example, a recent meta-analysis reported that 48% of intenders failed to follow through with physical activity (Rhodes and Bruijn, 2013). This has prompted our team to apply the Multi-Process Action Control Framework (M-PAC) to understand physical activity because it augments traditional social cognitive theories with constructs to both help form intentions and translate positive intentions into behaviour (Rhodes, 2017; Rhodes and Yao, 2015).

The M-PAC framework suggests that initiating *reflective* processes (thoughts about behavioural experiences, outcomes, barriers, perceptions of capability) influences the development of intention, congruent with almost all social cognitive theories (Fishbein et al., 2000). Translation of intention into physical activity, however, is reliant on both strong ongoing reflective processes (i.e., perceived opportunity,

<sup>\*</sup> Corresponding author at: School of Exercise Science, Physical and Health Education, University of Victoria, McKinnon Building 124, PO Box 1700 STN CSC, Victoria, BC V8W 2Y2, Canada.

E-mail address: [samliu@uvic.ca](mailto:samliu@uvic.ca) (S. Liu).

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affective attitude), and *regulation* processes (behavioural and cognitive tactics to maintain intention focus). Continued physical activity behaviour is assisted through the development of *reflexive* processes (habit and identity) that maintain the efficient translation of intentions into behaviour (Kaushal et al., 2017; Rhodes, 2017; Rhodes and Yao, 2015; Vallerand et al., 2017). We are conceiving the formation of habit and identity as a reflexive process. We are also conceiving the means in which they affect behaviour as a process, different from reflective and regulatory processes. Reflexive processes represent impulsive constructs that influence action control most often through learned associations and are triggered through particular circumstances and stimuli (Rhodes, 2017). M-PAC highlights the development of two critical reflexive processes, habit formation (i.e., behaviour performed from stimulus-response bonds) and identity formation (behaviour performed to minimize the dissonance between self-categorization and behaviour), as one begins to perform the behaviour more regularly. Thus, according to M-PAC, a developed pattern of maintained physical activity will include the contribution of reflective, regulatory, and reflexive processes (Rhodes and Bruijn, 2013; Rhodes and Grant, 2018; Teixeira et al., 2012).

Our research team has already shown in several studies, including a randomized controlled trial, that the M-PAC framework can be applied to promote physical activity in various community-based in-person programs (Kaushal et al., 2017; Quinlan et al., 2015; Vallerand et al., 2017, 2016). Although these community-based prevention programs can be effective, existing methods to deliver such programs that use the M-PAC model need to be improved. Community-based in-person programs have limitations due to the following: 1) limited reach, as these programs are only available at specific locations; 2) limited personalization, as it is challenging to tailor each group session to individual needs; and 3) resource intensity, as these programs require significant human input. With the advancement in Internet technology and improved access to the Internet, there is emerging evidence that Internet-based lifestyle interventions may be well-suited to meet these challenges. Currently, approximately 88% of Canadians have personal access to the Internet (Canada, 2011). This includes 63–78% of Canadians who are in the lowest income quartiles. Moreover, 72% of Canadians reported health information-seeking behaviours over the Internet, which suggests that there is a significant public interest in Internet-based lifestyle programs that promote physical activity (“Number of internet users in Canada from 2000 to 2016”, 2017). Recent studies have already suggested that the use of a self-guided web-based intervention could be effective to promote physical activity (Davies et al., 2012; Liu et al., 2013; Webb et al., 2010).

The purpose of this paper is to describe the process of developing a self-guided web-based intervention to promote physical activity using the M-PAC model. We applied the Integrate, Design, Assess, and Share (IDEAS) roadmap to facilitate the development of this web-based intervention (Mummah et al., 2016). The IDEAS roadmap is intended to accelerate the translation of behaviour theory and evidence into web-based interventions (Mummah et al., 2016). Thus, based on this roadmap, the study was broken down into three phases: 1) Intervention planning: determine intervention needs and potential design features that may enhance intervention effectiveness; 2) Intervention development: use an iterative process to design a web-based physical activity intervention based on the M-PAC framework; and 3) Pilot testing: conduct usability and acceptability assessments on the web-based intervention to further enhance user experience. A summary of the development timeline is shown in Table 1. In the following sections, the methods and results from each phase are described.

## 2. Methods and results

### 2.1. Phase 1. Intervention planning

We first formed a multi-disciplinary team which consists of domain

experts in physical activity (e.g., physical activity guidelines, safety and contraindications, activity modes and program design), behaviour science (e.g., exercise psychology, behaviour change techniques, best practice interventions), and web development (e.g. User-interface design, web-app development, database management). The goal of this team was to meet regularly to guide the intervention development process. We performed an exploratory literature search to gain a better insight into the web-based physical activity intervention needs and requirements. Specifically, our goal was to gain insights into the need for a web-based physical activity intervention using the M-PAC framework and determine intervention features that may enhance the effects of the web-based intervention (e.g. behaviour techniques, target behaviour).

#### 2.1.1. Literature scan

The literature scan revealed that the use of a self-guided web-based intervention could be effective to promote physical activity (Davies et al., 2012; Liu et al., 2013; Webb et al., 2010). A recent meta-analysis reported a significant improvement in physical activity level following Internet-based interventions (effect size = 0.24, 95% CI 0.09 to 0.38) (Webb et al., 2010) which is comparable to face-to-face physical-activity interventions (Rhodes et al., 2017). Several intervention protocol components were associated with increased effectiveness for Internet-based health programs (Liu et al., 2013; Webb et al., 2010). First, we found that web-based interventions that provided at least five behaviour change techniques to modify diet or exercise (e.g. providing information on consequences of behaviour in general; incorporating feedback on performance prompting self-monitoring of behaviours; and instructions or modelling on how to perform the targeted behaviour) were more effective in improving health outcomes (Liu et al., 2013). This suggests that a certain number of techniques may be required to build a flexible repertoire of skills that are necessary to overcome situational stressors that might otherwise impede therapeutic lifestyle change. Second, web-based interventions that proactively sent reminder emails to participants can also enhance the effectiveness of a web-based intervention (Liu et al., 2018; Nolan et al., 2012). The proactive method of delivery may have enhanced the degree to which the web-based program was perceived as providing sufficient support to modify exercise behaviour. Finally, Internet-based interventions that used behaviour change theories more extensively (e.g. targeted a larger number of available constructs within the theory) were significantly associated with increased intervention effect size (Webb et al., 2010). The most common theories used in Internet-based interventions aimed at behaviour change were the theory of planned behaviour (TPB), the trans-theoretical model (TTM), and social cognitive theory (SCT). Out of these three theories, the use of the TPB (ES = 0.36) to inform intervention design led to a larger effect compared with SCT (ES = 0.2) and TTM (ES = 0.15) (Webb et al., 2010).

Congruent with the use of intention-based theories, we identified no web-based interventions that focused on action control such as the M-PAC framework. M-PAC is an extension of TPB and includes multiple behaviour change techniques similar to the techniques identified in our literature scan. An advantage of the M-PAC model is the ability to address the ‘intention to behaviour’ gap. This ‘intention to behaviour’ gap posed a particular challenge for web-based physical activity intervention because almost all participants joining the intervention had already formed an intention to exercise. By addressing the ‘intention to behaviour’ gap may further enhance web-based physical activity intervention effectiveness. In addition, we found no interventions that addressed reflexive processes, which have been found to predict the intention-behaviour gap and augment the traditional reflective approaches of social cognitive theories (Kaushal et al., 2017; Rebar et al., 2016; Rhodes et al., 2016).

Overall, the intervention planning phase suggested web-based physical activity interventions designed using the M-PAC model may further enhance the effectiveness of physical activity promotion via the

**Table 1**  
The developmental phase of the web-based program.

Phase	Activities	Dates
1. Intervention planning	Determine intervention needs and requirements	March–April 2017
2. Intervention development	Use an iterative process to design the web-based intervention	May–Sept., 2017
3. Pilot testing	Usability and acceptability testing	Oct.–Dec., 2017
	Revise web-based intervention based on usability and acceptability testing.	January 2018

Internet. Given the lack of research studies in web-based interventions designed using the M-PAC model, our team decided that we would develop the intervention to be evaluated in a randomized controlled trial. The content of the web-based intervention was developed based on our previous M-PAC studies that aimed to promote physical activity (Rhodes and Grant, 2018). Because of the choice for implementing the web-based program in a research setting, physical activity researchers were identified as an important stakeholder group throughout the intervention development phase.

## 2.2. Phase 2. Intervention development

In this phase, we determined the intervention design, program content, method of delivery, and the web-based features to be included in the web-based program. We used a highly iterative design process during this phase. The multi-disciplinary team met for a series of group brainstorming sessions and group meetings to develop the intervention. Including the initial brainstorming and creation meeting, there were 10 group meetings to create our initial version of the intervention. Each meeting consisted of progress updates from the web-development and intervention content team, brainstorming sessions for content of upcoming lessons (e.g., key published research, prior available content from interventions), and discussion of miscellaneous items related to the development of the platform. Once some content had been created, the team members also had the opportunity to provide on-going feedback regarding content and aesthetic appeal of the program. A summary of the team meeting development activities is presented in Table 2.

### 2.2.1. Intervention design

The goal of the self-guided web-based intervention was to promote physical activity for adults over the ages of 18. The web-based physical

activity intervention was developed based on the content from an existing in-person physical activity program, which has been evaluated in previous studies (Kaushal et al., 2017; Rhodes et al., 2010; Tanna et al., 2017; Vallerand et al., 2018). Similar to our previous studies, the web-based intervention was 10 weeks in length. Participants were introduced to a weekly online interactive lesson that takes about 30–60 min to complete. It is important to continue to examine the past intervention material now adapted to a web-based format. It is this redevelopment of material and the new material that culminates to form the intervention. Building on the content from our previous interventions, we incorporated the latest web-technology to help participants to further enhance the development of the reflective, regulatory, reflexive processes. These web features include: i) integrating self-monitoring data (active minutes, steps, heart rate and stairs climbed) from wearable devices (e.g. Fitbit) into the weekly lesson; ii) creating weekly interactive quizzes to help participants assess and strengthen their self-guided learning; iii) creating a secure online diary to allow participants to reflect on their progress and set new weekly goals; iv) designing a proactive online messaging system to enable the platform to automatically send notifications about new content, login-reminders and survey assessments. A summary of the weekly lesson plan is presented in Table 3.

The primary target behaviour that we chose was to meet 150 min of moderate-to-vigorous physical activity (MVPA) per week by the end of the 10-week program. This target behaviour was based on current recommended guidelines which suggest 150 min of moderate-to-vigorous physical activity per week to achieve health benefits, including a reduced risk of eight health indicators (Tremblay et al., 2011). The web-based intervention was developed using the M-PAC model (Rhodes, 2017; Rhodes and Yao, 2015). Thus, the lessons start with intention formation (lessons 1–6), move into action control adoption (lessons 7–8), and finish with action control maintenance (lessons 9–10). Topics

**Table 2**  
Summary of the team meetings to develop the intervention.

Team meeting dates	Development activity	Committee feedback
April 27, 2017	Initial meeting Choose theory Brainstorming final product	N/A
May 31, 2017	Brainstorm lessons 1 & 2 Review lessons 1 & 2, brainstorm lessons 3 & 4	N/A –Committee feedback on lesson 1 & 2 content
June 14, 2017	Review lessons 3 & 4, brainstorm lessons 5 & 6	–Create 3-page categories for each lesson (learn, watch, do) –Committee feedback on lesson 3 & 4 content
June 28, 2017	Review lessons 5 & 6, brainstorm lessons 7 & 8	–Make content more readable and less complex –Committee feedback on lesson 5 & 6 content
July 11, 2017	Review lessons 7 & 8, brainstorm lessons 9 & 10	–Time released lessons –Find a way to print off activities –Committee feedback on lesson 7 & 8 content
July 26, 2017	Review lessons 9 & 10, brainstorm revamp for lesson 2	–Add intro and wrap-up pages –Committee feedback on lesson 9 & 10 content
Sept 9, 2017	Brainstorm intro, conclusion, & resources page	–Create lesson descriptions for home page –Create an “about us” section –Create a certificate of completion –Committee feedback on lesson 2
Sept 27, 2017	Brainstorm questionnaire at lesson 1 & 10 to show participant progress/comparison to norms Brainstorm content for video producer	–All infographics need to be larger –Activities need to be adjusted to make them clearer –Two committee members provided detailed feedback on lessons 1–10

**Table 3**  
Outline of the Intervention Content and Features.

Weeks	Topics covered	M-PAC construct targeted	Behaviour change technique used
1) Physical benefits of physical activity (PA)	<ul style="list-style-type: none"> <li>● Chronic disease prevention</li> <li>● PA and risk of death</li> <li>● Introducing WHO guidelines</li> </ul>	Initiating reflective processes (instrumental attitude, outcome expectations)	Information about health consequences (5.1)*, Behavioural practice/rehearsal (8.1)*
2) Mental benefits of physical activity	<ul style="list-style-type: none"> <li>● Productivity</li> <li>● Reduced symptoms of depression and anxiety</li> <li>● Happiness</li> </ul>	Initiating reflective processes (instrumental attitude, outcome expectations, affective attitude)	Information about emotional consequences (5.6)*, Behavioural practice/rehearsal (8.1)*
3) Increasing self-confidence for physical activity	<ul style="list-style-type: none"> <li>● Self-efficacy</li> <li>● FITT principle</li> <li>● Progression principle</li> </ul>	Initiating reflective processes (perceived capability)	Goal setting (1.1)*, Self-monitoring (2.3)*, Behavioural practice/rehearsal (8.1)*, Graded tasks (8.7)*
4) Emotional regulation	<ul style="list-style-type: none"> <li>● Introducing affect</li> <li>● The importance of enjoying PA</li> <li>● How to deal with setbacks or failure</li> </ul>	Ongoing reflective processes (affective attitude)	Goal setting (1.1)*, Self-monitoring (2.3)*, Monitoring of emotional consequences (5.4)*, Behavioural practice/rehearsal (8.1)*, Distraction (12.4)*
5) Building social support	<ul style="list-style-type: none"> <li>● The 4 types of social support</li> <li>● Self-determination theory</li> <li>● Building your social support network</li> </ul>	Ongoing reflective processes (perceived opportunity)	Goal setting (1.1)*, Self-monitoring (2.3)*, Social support (practical) (3.2)*, Social support (emotional) (3.3)*, Behavioural practice/rehearsal (8.1)*
6) The environment	<ul style="list-style-type: none"> <li>● The Social Ecological Model</li> <li>● The influence of environment on behaviour</li> <li>● Changing one's environment to promote PA</li> </ul>	Ongoing reflective processes (perceived opportunity)	Goal setting (1.1)*, Self-monitoring (2.3)*, Prompts/cues (7.1)*, Behavioural practice/rehearsal (8.1)*, Restructuring the physical environment (12.1)*, Adding objects to the environment (12.5)*
7) Goal setting and planning	<ul style="list-style-type: none"> <li>● Goal setting</li> <li>● SMART goals &amp; flexibility</li> <li>● Action and coping planning</li> </ul>	Regulation processes	Goal setting (1.1)*, Problem solving (1.2)*, Action planning (1.4)*, Self-monitoring (2.3)*, Behavioural practice/rehearsal (8.1)*
8) Self-monitoring	<ul style="list-style-type: none"> <li>● Self-monitoring &amp; related self-monitoring tools</li> <li>● Barriers</li> </ul>	Regulation processes	Goal setting (1.1)*, Action planning (1.4)*, Self-monitoring (2.3)*, Behavioural practice/rehearsal (8.1)*
9) Habit formation	<ul style="list-style-type: none"> <li>● Introducing habit</li> <li>● Relating habit to physical activity</li> <li>● How to form a habit (repetition, scripts, environmental cues)</li> </ul>	Regulation processes, reflexive processes (habit)	Goal setting (1.1)*, Self-monitoring (2.3)*, Behavioural practice/rehearsal (8.1)*, Habit formation (8.3)*
10) Identity formation	<ul style="list-style-type: none"> <li>● Introducing exercise identity</li> <li>● Ways to increase exercise identity (commitment, enjoyment, social comparison, passion)</li> </ul>	Regulation processes, reflexive processes (identity)	Goal setting (1.1)*, Self-monitoring (2.3)*, Behavioural practice/rehearsal (8.1)*, Incompatible beliefs (13.3)*, Valued self-identity (13.4)*

Note: \*The numbers in the brackets refers to the behaviour change techniques in the CALO-RE taxonomy (Michie et al., 2011).

include the following: physical and mental health benefits of physical activity; building perceptions of capability; emotional consequences/regulation; restructuring the physical and social environment to build physical activity opportunities; goals and planning; feedback and monitoring; habit formation; and identity formation. Each lesson begins with a review of progress from the previous week and contains a combination of educational text, educational videos, infographics, graphics from scientific literature with explanations, and interactive activities. The content has Flesch-Kincaid grade level of less or equal to grade 11.

### 2.2.2. Iterative design progress and rapid prototyping

Prototypes of the intervention were created to share and discuss with team members and to facilitate both further ideation and the rapid gathering of user feedback. We used the Digital Behaviour Intervention Platform to rapidly develop prototypes and gather feedback. The Digital Behaviour Intervention Platform is a content management system designed by our team to enable health researchers and clinicians to create interactive Internet-based interventions using “drag and drop” web tools instead of coding. This platform allowed our team to quickly and cheaply gather feedback on many different possible intervention approaches before investing significant resources. See Figs. 1 and 2 for the design of the homepage and a weekly lesson. The feedback process after each group meeting was two-fold. First, each team member had the opportunity to edit the content document that was to be uploaded to the online platform. Once the content was on the platform, the committee members again had the opportunity to edit the layout and general appeal of the content. After this process, the rest of the edits were carried out by the lead content developer and computer programmer, with input from the rest of the team.

### 2.3. Phase 3. Pilot testing

We assessed the usability and acceptability of the web-based physical activity intervention during this phase. Usability assessment is a technique based on user-centred interaction design to evaluate how intended end-users interact with a web-based intervention and whether the web-based program meets its intended purpose. Acceptability testing was conducted to assess and increase the suitability of content for the intended audience (> 18 years of age). We asked the participants to complete one of the weekly lessons during the usability and acceptability assessment. We monitored how easily participants were able to complete tasks including: finding additional information about the creation team under the “about us” section, finding in text citations and corresponding full citations in the reference page, playing videos, completing lesson activities, and completing the lesson summary quiz. At the end of the assessment, participants completed a structured usability interview (Heckman et al., 2015), a system usability scale questionnaire (Brooke, 1996), and an acceptability survey (Heckman et al., 2015). The usability scale ranged from 0 to 100 and a score above 68 indicates above-average usability (Brooke, 1996). The acceptability score of the web-based intervention consists of three categories: likeability; usefulness; and personal applicability. The score is on a scale of 0–10, with 10 being the most acceptable and 0 being the least acceptable (Heckman et al., 2015). One research staff member, with experience in qualitative data collection, administered a structured interview to assess features that the participants found most, and least, helpful. Participants in each round provided both positive and negative feedback about the overall program design. The usability and acceptability assessments were conducted with a convenience sample of adults (> 18 years old) recruited at the University of Victoria.

## My Progress

3/3 Lessons Viewed

### Latest Lessons



#### Lesson 3 - Increasing Self Confidence for Physical Activity

Learn about strategies to improve your self-efficacy and confidence in the context of physical activity

27/6/2018

### Previous Lessons



#### Lesson 2 - Mental Benefits of Physical Activity

Learn about the numerous benefits physical activity provides for mental health

20/6/2018



#### Lesson 1 - Benefits of Physical Activity

Learn about physical activity's positive impact on health

Fig. 1. General homepage of the web-based intervention.

#### 2.3.1. Results: usability and acceptability testing

The demographic information about the participants is summarized in Table 4. 100% of participants were able to find additional information about the creation team under the “about us” section; 80% of participants found the in text citations and corresponding full citations in the reference page; 100% of participants were able to play the embedded videos; 80% of participants were able to open the PDF and complete a lesson activity, and 100% of participants were able to complete the summary quiz. Overall, our web-based physical activity intervention scored high on the system usability scale (Mean  $\pm$  SD:  $93 \pm 5.7$ ). The overall acceptability score was high among end-users (likeability:  $8.4 \pm 1.51$ ; usefulness:  $8.8 \pm 1.32$ ; and personal applicability:  $8.6 \pm 1.35$ ). The most helpful features identified by the users included the simplicity of navigating through the website, completing the activities, and learning helpful tips about health and physical activity from the information provided. The least helpful features of the program included an overload of text information, lack of interactivity and lack of guidance on how to start an exercise plan for themselves. Additionally, much of the text needed more explanation than initially expected in order to make the content readable and understandable for a common audience (Table 5). Based on these results, the team worked closely to adjust the intervention content to improve i) interactivity by incorporating interactive quizzes and activity trackers, ii) readability by using more infographics and videos, iii) exercise guidance by providing specific instructions on putting together an exercise plan. Other key changes included layout and aesthetic design of the platform, such as adjusting paragraph spacing, adding pictures, and hyperlinks.

### 3. Discussion

This study was aimed at describing the process of developing a self-guided web-based physical activity program using the M-PAC framework. To our knowledge, this is the first web-based physical activity intervention developed using the M-PAC model. The iterative development process enabled our team to discover issues that we needed to address quickly. Although our assessment highlighted some usability issues (e.g. content, overload of text information), we also received many positive comments about the layout and content of the web-based program. By identifying and addressing the various issues identified throughout the development process, we ensured that these issues are not going to confound the results when we evaluate our intervention in a randomized controlled trial.

The overall process of development was effective and we were able to complete the process in a relatively short time frame with a limited budget. The development of this web-based intervention using the IDEAS roadmap can serve as a guide for how a multi-disciplinary team can develop a web-based intervention. Three key factors contributed to the success of our intervention development. First, we adopted an iterative design strategy that enabled our multi-disciplinary team to build on knowledge from the previous steps and shape the future development work. Second, we were able to prototype the intervention rapidly using our customized Digital Behaviour Intervention Platform. This system significantly decreased the cost of our development work as our health experts could use the “drag and drop” web tools to edit the web-based intervention. Third, the usability and acceptability assessment enabled us to further enhance the web-based platform.

## Lesson 3 – Increasing Self Confidence for Physical Activity



### Reflect on your week

Think back to how you anticipated your mood to change with physical activity and compare it to how you actually felt this week. Was your prediction correct? Was there anything that surprised you this week regarding your mood and physical activity participation? Take some time to reflect on this before we move into lesson 3.

We invite you to write down your reflection in the space below.

Fig. 2. Web-based intervention design showing a weekly lesson.

**Table 4**  
Demographics of user testing (usability and acceptability testing)  
N = 5.

Variable	N = 5
Age	43.2 ± 17.05
Sex (Female)	3 (60%)
Education	
College/University	1 (20)
Graduate school	4 (80%)
Computer use, hours per week	27.6 (13.74)

Note: Data are presented as mean ± SD or number of participants (percentage).

Our aim to develop this web-based physical activity intervention using the M-PAC framework is to have a significant impact on extending the reach of physical activity programs. A major challenge for a community-based programs aimed to promote physical activity is to extend the reach of these programs to individuals who may have limited access to these services. Web-based interventions may be well suited to address this challenge. As Internet usage continues to grow (“Number of internet users in Canada from 2000 to 2016”, 2017), it will

be increasingly important to evaluate ways to use Internet technology to help improve our health.

There were several limitations associated with this study. First, we did not involve end-users during the initial development stage of the intervention. However, the strategies employed and the content developed have been established in prior research (Liu et al., 2018; Nolan et al., 2013; Quinlan et al., 2015; Rhodes, 2017). This was reflected in our high usability and acceptability scores. Second, our target users, who were involved in the usability and acceptability study, were highly educated with a mean age of 43 ( ± 17.05) years. We did not assess our participant's physical activity level. It may be possible that individuals with different physical activity levels may have different usability and acceptability ratings. Thus, this may limit the generalizability of our findings. However, we developed the content to have a high-school readability level. Finally, not all steps in the IDEAS framework, involving the evaluation of the web-based intervention, were completed in this study. The IDEAS framework covers not only intervention planning and development but evaluating the effectiveness and the impact of the intervention (Mummah et al., 2016). Thus, we cannot determine whether our web-based intervention is successful in improving physical activity in the target users. Future studies are now warranted to assess intervention effectiveness, engagement, and impact.

**Table 5**  
Interview question responses.

Interview questions	(Theme/Summary)
Q1 Can you tell me what you liked best about the website?	Navigation; Participants were in agreement that the platform was very user-friendly; no one struggled to navigate easily through pages and exercises.
Q2 Can you tell me what you liked least about the website?	Text; Some participants felt there was too much information provided in text, and also that the font could have more variety (bold, word art, etc.) when an important term or tab (activity, page, title) is used.
Q3 Can you tell me about how easy it was to navigate or find your way around the website?	Straight forward; Participants found it easy to travel from page to page, experiencing very little, or no, difficulty.
Q4 Can you tell me about what you thought about the overall look of the website?	Professional; Participants felt the website was laid out clearly, and mimicked the layout of a textbook; could use some more eye-grabbing colours and images/videos.
Q5 Can you tell me what you thought about the information provided on the website?	Knowledgeable; Participants agreed the information provided was clear, accurate, valid, and reliable because of the cited sources.
Q6 Can you tell me about whether or not you would use such a site to learn how to better manage your health?	Positive; Although not all participants said they would use this site, most did. The ones who didn't said their reasoning was because they felt confident with the physical activity plan they currently follow.
Q7 Can you tell me about whether or not you think others would be interested in using this site to learn how to better manage their health?	Positive; Participants were in agreement about recommending this site to family and friends. They also felt it would be useful for those who need to increase physical activity, as recommended by a doctor, or even for those who want a lifestyle change but do not know how and/or where to begin.
Q8 If you could make changes to the website, what changes would you make?	Interactive; Some participants mentioned adding more pictures and/or videos to liven up the website. Has a technical design which is user-friendly but not overly encouraging for physical activity.
Q9 Is there anything else you would like to tell us about the website?	Examples; A participant suggested supplying a specific physical activity plan as guidance for users to follow. Some people may not have an idea of what moderate/vigorous activity is or could feel overwhelmed and deterred by having to come up with the work-out plan themselves.

#### 4. Conclusion

The present study describes the development process of a web-based physical activity intervention using the M-PAC framework. This study has reinforced the importance of an iterative development process that involves a multi-disciplinary team to design a web-based intervention to promote physical activity. The process enabled the team to clarify the design of an intervention for our target users, and provided valuable feedback on the design and content of the web-based intervention. Overall, the development process used in this study allows our team to enhance the quality of the web-based intervention.

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#### Conflict of interest

None.

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