# Assessing user engagement in a health promotion website using social networking

Rhys TAGUE<sup>a,1</sup>, Anthony J MAEDER<sup>a</sup>, Corneel VANDELANOTTE<sup>b</sup>, Gregory S KOLT<sup>c</sup>, Cristina M CAPERCHIONE<sup>d</sup>, Richard R ROSENKRANZ<sup>e</sup>, Trevor N SAVAGE<sup>c</sup>, Anetta VAN ITALLIE<sup>b</sup>

 <sup>a</sup> School of Computing Engineering & Mathematics, Telehealth Research & Innovation Laboratory, University of Western Sydney, Sydney, Australia
 <sup>b</sup> Centre for Physical Activity Studies, School for Human Health and Social Science, Central Queensland University, Rockhampton, Australia

<sup>c</sup> School of Science and Health, University of Western Sydney, Sydney, Australia
 <sup>d</sup> School of Health and Exercise Science, University of British Columbia, Canada
 <sup>e</sup> Department of Human Nutrition, Kansas State University, United States of America

Abstract. Remote provision of supportive mechanisms for preventive health is a fast-growing area in eHealth. Web-based interventions have been suggested as an effective way to increase adoption and maintenance of healthy lifestyle behaviours. This paper describes results obtained in the "Walk 2.0" trial to promote physical activity through a self-managed walking programme, using a social networking website that provided an online collaborative environment. Engagement of participants with the website was assessed by monitoring usage of the individual social networking functions (e.g. status post). The results demonstrate that users generally preferred contributing non-interactive public posts of information concerned with their individual physical activity levels, and more occasionally communicating privately to friends. Further analysis of topics within posts was done by classifying word usage frequencies. Results indicated that the dominant topics are well aligned with the social environment within which physical activity takes place. Topics centred around four main areas: description of the activity, timing of the activity, affective response to the activity, and context within which the activity occurs. These findings suggest that strong levels of user awareness and communication occur in the social networking setting, indicative of beneficial self-image and self-actualisation effects.

Keywords. Health promotion, online collaborative environment, physical activity, preventive health, social networking, user engagement, website, user profiling

<sup>&</sup>lt;sup>1</sup> Corresponding Author: R. Tague, School of Computing, Engineering & Mathematics, University of Western Sydney, Locked Bag 1797, Penrith NSW 2751, Australia; Email: r.tague@uws.edu.au

#### Introduction

In the light of issues such as escalating costs, constrained resources, and the aspiration to improve longevity while maintaining the highest achievable quality of life, there is a global impetus for health system reforms. One area of emphasis in many reform agendas has been gaining increased value from health promotion and associated behaviour change supportive measures. For instance, greater use of preventive health interventions has been identified as one of the top national health priorities in Australia, as a means to reduce downstream utilisation impact on the health system [1]. Preventive health reforms can address issues arising at a population level, such as demographic changes and ageing profile, where there is much concern over increased prevalence of lifestyle related diseases, or infectious diseases and public health issues.

Recently, there has been much enthusiasm for remote provision of supportive strategies for preventive health and health promotion, making this a new and fast-growing area in eHealth and Telehealth. Web-based or online interventions have been suggested as an effective way to increase adoption and maintenance of healthy lifestyle behaviours, such as increased physical activity, improved nutrition, and reduction of alcohol and smoking habits [2, 3]. These interventions have the advantages of reaching a large user community, easily and at an affordable cost, while allowing individualised usage patterns to be developed to suit user preferences.

Online health applications are a fast growing area within the scope of Telehealth, both due to the remote nature of the computer-based source, and due to their connection with personal monitoring through self-reporting or logging data from wearable devices. The ease of access through conventional computers equipped with web browsers, or mobile devices such as computer tablets and smart phones, ensures that this area will continue to develop as consumer attractiveness and demand increases.

#### 1. Social Networking Interventions

Within the web-based interventions domain, a particular area of focus has been the provision of social networking and social media interventions, to provide collaborative online environments in which users can interact and thereby mutually reinforce behaviour change activities. Reviews on the efficacy of these interventions [4] reveal that current evidence is not strong for the degree of behaviour change, nor can the influential factors affecting it be readily identified [5]. User engagement and motivation have been suggested as factors contributing to behaviour change [6, 7], despite a lack of clear and widely applicable definition of these aspects.

In social networking theory, the use of web-based online collaborative environments equates to the forming of social groups [8], which can provide certain influences for behaviour change [9]. These influences may be inferred from characteristic usage patterns observed within these environments [10] and the corresponding formation of social ties and norms [11]. The principles of collaboration as described theoretically in sociology [12] can be realised by establishing the existence of a number of collaborative usage patterns [13] in a certain social interactive setting, and classifying user habits accordingly.

An open issue is the choice of suitable models and metrics to describe these usage patterns, especially in a way that they can be causally linked with behaviour change. Simple measures such as degree of connectivity and volume of interaction traffic [14]

have been augmented by measuring communication, engagement and relevance [15]. The characterisation of engagement is of particular interest here, as the working hypothesis in this project has been that increased engagement through social network collaboration is the primary factor in achieving participant behaviour change. Indicators for engagement are typically related to stereotypical relationships developed between a user and the technology [16], and so the appraisal of engagement depends on the choice of the model used for describing such relationships.

## 2. "Walk 2.0" Project

The "Walk 2.0" study was established in 2010 with funding from the Australian National Health and Medical Research Council to develop and investigate the use and efficacy of Web 2.0 features in a physical activity promotion website to enhance self-managed programmes for daily walking and associated exercise. Using Internet or web-based physical activity interventions such as this, which incorporate innovative Web 2.0 features [17] including social networking support, have the potential to reach large groups of individuals and contribute to physical activity promotion.

The project aims to determine the effectiveness on participant attraction, engagement, retention and physical activity behaviour change in a 3-arm randomised controlled trial with sample size of more than 500 participants [18]. A further ecological trial component will explore the behaviour and experiences of users in the online aspects, based on open recruitment of a much larger number of users. It is expected that the findings from the two trials will enable generalisation of the functions provided in the web-based setting, and allow informed design, development and customisation of further online social collaborative environments for other health promotion purposes.

The study has involved the development and testing of a Web 2.0 based collaborative environment [19] (embodied in the Walk 2.0 website, www.walk.org.au) to investigate the effects of a "new generation" web-based application offering options such as blogs, posts and other social networking functions (see Figure 1). This intervention is being compared with an existing publically available Web 1.0 physical activity promotion website (the Australian 10.000 Steps website. www.10000steps.org.au) which provides a more conventional static environment, and also compared with manual logging of physical activity without computer assistance (via logbook).

By the end of the study, participants in the randomised controlled trial will have been monitored over 18 months using pedometers to log actual daily step counts, and presenting for detailed follow-up physical examinations and interviews. The information collected will enable the investigators to assess changes in levels of physical activity and other health indicators, as well as comparative impacts of utilization of the websites compared with each other and with the logbook, for user engagement and retention. It is hoped that understandings gained from analysing the characteristics of usage patterns and the influence of user interactions on the participants, will provide insights to inform the design of similar web-based interventions in the future.

		Welcome Home Profile Forum Library FAQ Account Settings Administrator	Sign o
My Steps	View/Delete Steps	My Progress Daily   Weekly   Monthly My Spaces	
Date	DD/MM/YYYY	This Week's Daily Progress My Messages	0
		- Baseline Steps - Daily Goal Strends	0
Steps	Steps	A My Groups	0
Moderate	Minutes	12,000 Wy Updates	0
Hoverete	minutes	My Posts	0
Vigorous	Minutes	9,000 My Blog	0
		5 000	
Total	Steps	Search people, groups, posts	Q
	140	3,000 1,000	_
My Goale		entire conversitation around a to Stepper Stream the world to see. By asking a qu	pic for
View Goal:	Edit Goals	you can also help someone find shart a conversation with other sleppers! 140	l an
View Goal:	Edit Goals Select : 110,000 steps Goal	Start a conversation with other steppensi 140 Invite My Friends Invite a find to bit visu on the	a Walk
/iew Goal: Neekdy Goal -	Edit Goals Select : 110,000 steps Goal Progress	Start a conversation with other steppersi Post Post Post Post Post Post Post Post	e Walk
iew Goal:	Edit Goals	Bart a convension with other steppensi         140           Post         Invite My Friends           Motion 4 3456 steps on the 24/08/2014, Wolking to the 70         Invite My Friends	estion I an Walk
Neekly Goal -	Edit Goals Select : 110,000 steps Progress	Start a conversation with other stappersi         140           Post         Invite My Friends           Walked 6,146 steps on the 24/08/2014 - Walking to the sime state	i an I an e Walk
View Goal: () Weekly Goal -	Edit Goals Select : 110,000 steps Goal Change Group	Start a conversation with other steppersi     140       Post     Post       Walker 6,146 steps on the 24/08/2014 - Walking to Today Ø 7:48 am   452,218 steps taken   Add as friend     Invite My Friends	estion I an
View Goal: Weekly Goal - Weekly Goal - My Group ( Group: My Fin Monthly Goal:	Edit Goals Select s 110,000 steps Goal Change Group 8 Group 1,000,000 Steps	Bart a conversation with other steppensi     140       Post     Post       Wolker 6,146 step on the 24/85/2014 - Walking to     Invite My Friends       Today 0 7.46 am   452,213 steps taken   Add as friend     Invite My Friends       Walked 12,573 steps taken - Quite day experimenting with     Image 10       Walked 12,573 steps taken - Quite day experimenting with     I Might Know	estion I an
My Group M Group: My Fin Monthly Goal	Edit Goals	Start a conversation with other steppers!       140         Post       Post         Walkes 6,146 steps on the 24/08/2014 - Walking to schedic op seek in no. 24       Invite M Friends         Today 07 748 am   452,218 steps takm   Add as friend countic on greater than (Add as friend water and the filter to raise the phone with phone static and phone steps takm   Add as friend water and phone steps takm	estion I an

Figure 1. The "Walk 2.0" health promotion website, with social networking features.

### 3. User Engagement

The project methodology was not designed to specify a particular model for user engagement with the website, so a simple set of web usage measures were adopted, loosely based on the work of Burke et al. [20]. Posting was chosen as the surrogate for engagement on the basis that it offered users options for communicating with each other comparable to traditional offline conversational communication. The raw data for assessing user engagement was derived from a total of 5,481 user posts generated by 254 active and unique users on the Walk 2.0 website over a 3-month period determined by a user's registration date, observed via transaction counts for all sessions logged in the application database. The transaction counts indicated an average of 21.6 posts per user (with standard deviation of 123.3), based on a total of 132,185 words posted by all the users. The average number of words per post was 24.1, equating to an average of 520.4 words per user overall.

Five separate posting functions were provided for users in the application: Progress, Status, Private, Blog, and Forum. Progress is a public posting of an automated fixed single line message of user step count combined with open text situational information (comment) provided by the user, which is broadcasted to the user base upon posting (users keep track of daily number of steps taken using a pedometer provided by the research team). Status is an open-text user-entered short public posting of current user situational information. Private is an open-text userentered private posting of a message sent to another user profile. Blog is an extended open-text user-entered long public posting to an individual user-designated posting area through the user profile. Forum is an open-text user-entered public posting in one of six public topic categories, to allow discussion in a series of interleaved messages from multiple users responding to each others' comments. Only Forum posts can be publicly replied to by all users. Table 1 shows the distribution of posting function usage across the 5,481 user sessions. The automated Progress posts made up by far the greatest volume of session traffic on the website at 79.4%: it is surmised that this is because of the ease of generating the posting automatically. The next highest source of traffic was Status posts at 13.3%, a form of public post with wide visibility without initiating further direct interactive public communication. Private posts were at 4.0% and Blog posts at 1.8%: this indicates that users were disinclined to post where exposure was limited and/or less social in nature. Use of Forum posts was negligible at 0.5%. These results reveal that users generally preferred contributing through broadcasting of semi-automated open text information about their individual physical activity, with some lesser amount of private communication with friends and reflective blogging, than seeking a highly collaborative mode of communication.

<b>Posting Function</b>	Posting Count	Posting Percentage
Progress	4350	79.4
Status	727	13.3
Private	220	4.0
Blog	96	1.8
Forum	26	0.5

 Table 1. Overall posting function usage across all users.

Next, we considered the habits of users who were most active in the online collaborative environment to establish whether they showed similar usage patterns. It was established that 50% of the posts (2,781) were made by 21 users out of 254 (8% of all users), and 25% of the posts (1,416) were made by 8 users (3% of all users). The highest number of posts made by the top user was 259, almost 5% of the total number of posts and equating to a rate of approximately 3 posts per day. The average number of posts was equalled or exceeded by 65 users (25% of all users). Fewer than 5 postings were made by 126 users (50% of users), and only one posting was made by 77 users (30% of all users). This highly skewed distribution is typical of social networking sites [20]. Figure 2 shows the posting rate, ordered (left to right) from most to least active users.



Figure 2. Cumulative posting rate for all users.

Table 2 shows the distribution of the number of postings of all types made in the top 50% (25%) of postings. The patterns of usage are comparable with those in the whole population of users shown in Table 1, with some discernible increase in Progress postings and decrease in Status, Private and Blog postings, which is even more marked in the top 25%. It appears that more online-active users wish to spend less effort communicating in open text and instead concentrate on the easy automated broadcast mechanism offered by Progress postings.

<b>Posting Function</b>	Posting Count 50% (25%)	Posting Percentage 50% (25%)
Progress	2251 (1261)	80.9 (89.1)
Status	408 (116)	14.7 (8.2)
Private	78 (22)	2.8 (1.6)
Blog	37 (14)	1.3 (1.0)
Forum	3 (2)	0.1 (0.1)

Table 2. Posting function usage by most active users making 50% (25%) of all posts.

# 4. Topic Analysis

Further indication of engagement and the emergence of collaborative social norms between users can be gauged by analysis of task-related topics covered during postings. Following a simplified probabilistic topic modelling approach [21], a frequency count was made of all unique words occurring within the 132,185 words contributed by user open text. A total of 240 words were found to occur 50 or more times, with the most frequent words occurring almost 1,000 times (day = 974; steps = 885). Trivial words such as prepositions, which did not convey meaningful concepts, were excluded from the analysis.

A random sample of approximately 10% of the text in the 5,481 postings was read and four distinctive topics were identified, associated with the typical user behaviour and general social environment within which the main task (i.e. physical activity) takes place. These topics were:

- Description of the activity (e.g. intensity, timing, variety)
- Timing of the activity (e.g. time of day, duration, repetition)
- Affective response to the activity (e.g. emotions, reflections, attitudes)
- Context in which the activity occurs (e.g. other forms of physical activity, companionship, lifestyle, location).

Words associated with each of these topics were grouped according to similarity of meaning or intent. The similarity criteria were developed from the postings read, by establishing links between frequently occurring words. Table 3 provides details for some of the more frequent words in these groupings. There are relatively few groupings in each topic, indicating that the posts are generally narrowly focussed around topical themes and users are not directing their comments to matters outside the online social collaborative environment.

Торіс	Words
	step/steps/walk/walked/walking (2,245); pedometer
Description of the activity	(198); goal (121); extra (97); exercise (84); count
	(75);
	time/hour/day/week/month (1,224);
Timing of the activity	night/morning/early/late (359);
	today/tomorrow/yesterday/daily (279);
	few/some/more/short/long/many/much/again
Affective response to the activity	(1,023); good/better/hard (418); active/busy (234);
	hope/happy (115);
	house/home (286); weather/rain (174); gym (114);
Contant in which the activity accura	group/family/couple (203); dog/dogs (162);
Context in which the activity occurs	shopping (98); bike (71); beach (70);
	down/up/around/back (696);

 Table 3. Selection of frequent words for the four topics.

Considering the size of word counts for major groups of concepts associated with the undertaking of the desired physical activity, it can be inferred that users were posting comments that were highly relevant to their activities in meeting their goals. Very few words indicating distraction from purpose were detected. These findings suggest that strong levels of user awareness and communication of intent occur in the collaborative social media setting, which are indicative of beneficial self-image and self-actualisation effects. This claim is supported by the presence of a number of strong affective responses displaying positive attitudes and messages of mutual encouragement.

# 5. Conclusion

This paper has presented some initial findings from a project which aimed to explore the effect of a Web 2.0 based social collaborative user environment, specifically for influencing user engagement for increasing and maintaining their level of physical activity. Without a specific model for the emergence of social relationships which such an environment could support, a basic analysis was undertaken using simple models of social collaboration behaviour.

The patterns of use for website functions that were provided for posting information revealed that broadcast, non-interactive communications (in the form of comments) were preferred to interactive or private discussions. This may be a consequence of the focussed nature of the task, which is a highly individual and personal challenge endeavour, or the approach to recruitment being a randomised controlled trial where participants were socially unrelated. The topic analysis showed that users' attention is very well aligned with the task, as most high frequency words are directly related to the undertaking of the physical activity. Further insights could be gained by conducting interviews with users to establish reasons for their preferences in use of the functions, and whether they were subject to peer pressure when using those functions which encouraged them to adopt a different priority than they naturally would.

It is acknowledged in the literature [22] that web based interventions are complex to evaluate, and that their effectiveness is subtle to measure. It would be beneficial to develop and apply specific models to analyse such situations, based on the conjunction of available functions for user communication and interaction, and the user goals which exist in the underlying intervention. Use of such models could provide more consistent and comparable quantitative results concerning user engagement and reinforcement.

#### Acknowledgement

This research was undertaken with partial support of the Walk 2.0 project funded by the National Health and Medical Research Council (Project Grant GNT0589903). The contributions of all members of the Walk 2.0 project are noted here with gratitude.

## References

- [1] Australian National Preventive Health Agency (ANPHA). (2013). *State of Preventive Health 2013*. Report to the Australian Government Minister for Health. Canberra; ANPHA.
- [2] Webb, T., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research 12*(1):e4.
- [3] Korda, H., Itani, Z. (2013). Harnessing social media for health promotion and behavior change. *Health Promotion Practice* 14(1):15-23.
- [4] Nakhasi, A., Shen, A. X., Passarella, R. J., Appel, L. J. & Anderson, C.A.M. (2014). Online social networks that connect users to physical activity partners: A review and descriptive analysis, *Journal of Medical Internet Research 16*(6):e153.
- [5] Kohl, L. F. M., Crutzen, R., & de Vries, K. (2013). Online prevention aimed at lifestyle behaviors: A systematic review of reviews. *Journal of Medical Internet Research* 15(7):e146.
- [6] Maher, C. A., Lewis, L. K., Ferrar, K., Marshall, S., De Bourdeaudhuij, S., & Vandelanotte, C. (2014). Are Health Behavior Change Interventions That Use Online Social Networks Effective? A Systematic Review. *Journal of Medical Internet Research* 16(2): e40.
- [7] Laranjo, L., Arguel, A., Neves, A. L., Gallagher, A. M., Kaplan, R., Mortimer, N., Mendes, G. A., & Lau, A. Y. S. (2014). The influence of social networking sites on health behavior change: a systematic review and meta-analysis. *Journal of the American Medical Informatics Association* amiajnl-2014-002841.
- [8] Backstrom, L., Huttenlocher, D., Kleinberg, J., & Lan, X.. (2006). Group formation in large social networks: membership, growth, and evolution. *Proceedings of the 12th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD '06)*. ACM, New York, 44-54.
- [9] Cao, L. (2010). In-depth behavior understanding and use: The behavior informatics approach. *Information Sciences 180*(17):3067–3085.
- [10] Benevenuto, F., Rodrigues, T., Cha, M., & Almeida, V. (2012). Characterizing user navigation and interactions in online social networks. *Information Sciences*, 195:1–24.
- [11] Cheung, C. M. K., & Lee, M. K. O. (2010). A theoretical model of intentional social action in online social networks. *Decision Support Systems* 49(1):24–30.
- [12] Wood, D. J. (1991). Toward a comprehensive theory of collaboration. The Journal of Applied Behavioral Science 27(2):139–162.
- [13] Thomson, A.M., Perry, J.L., & Miller, T.K. (2007). Conceptualizing and measuring collaboration. Journal of Public Administration Research and Theory 19(1):23–56.
- [14] Mislove, A., & Marcon, M. (2007). Measurement and analysis of online social networks. Proceedings of the 7th ACM SIGCOMM Conference on Internet Measurement 29–42.
- [15] Drula, G. (2012). Social and online media research data, metrics and methods. *Review of Applied Socio-Economic Research* 3(1):77-86.
- [16] O'Brien, H., & Toms, E. G. (2008). What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information and Technology 59*: 938–955.
- [17] OReilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & Strategies* 1:17-37.
- [18] Kolt, G. S., Rosenkranz, R. R., Savage, T. N., Maeder, A. J., Vandelanotte, C., Duncan, M. J., Caperchione, C. M., Tague, R., Hooker, C., & Mummery, W. K. (2013). WALK 2.0-Using Web 2.0

applications to promote health-related physical activity: A randomised controlled trial protocol. *BMC Public Health* 13:436.

- [19] Tague, R., Maeder, A., & Basilakis, J. (2014). Adaptive web framework for online collaborative environments. Australian Journal of Intelligent Information Processing Systems 13(4).
- [20] Burke, M., Kraut, R., & Marlow, C. (2011). Social capital on Facebook: Differentiating uses and users. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, New York 571-580.
- [21] Blei, D.M. (2012). Introduction to probabilistic topic models. Communications of the ACM 55(4):77-84.
- [22] Murray, E. (2012). Web-based interventions for behaviour change and self-management: potential, pitfalls, and progress. *Medicine 2.0 1*(2):e3.