Spatial Interaction that Motivates Physical Activity in the Workplace


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Abstract: Due to sedentary lifestyles, physical activity is widely promoted in the workplace. In this paper, we present HealthQuest, a mixed-reality system to motivate employees’ physical activity in their workplace. By taking a few extra minutes for their usual walk to the coffee machine or trip to the restroom, employees achieve the recommended 30 minutes of physical activity per day.

Key words: Pervasive Health, Health Promotion, Interactive Kiosk, Health Management System, Physical Activity, Smart Environment

1. Introduction

In their report on Workplace Health Promotion, the World Health Organization (WHO) emphasized that the workplace is a priority setting for health promotion [1]. The workplace directly influences the physical, mental, economic, and social wellbeing of workers to improve their health and wellbeing of people at work. The sedentary nature of this work can contribute to employees’ unhealthy habits, causing them to develop obesity, diabetes and other chronic diseases [2]. However, most wellness and health promotion programs are not effective. Many programs simply provide printed health educational materials or brochures, which have not shown to be an appealing approach for employees.

The most popular wellness and health promotion programs cover increasing physical activity, as well as promoting healthy nutrition knowledge. Studies on health behavior change suggest that people should start with small steps in order to develop new habits [3]. For example, walking just ten minutes a day can have long-term health benefits. Rather than looking for a place to walk outside of a company, our system utilizes the existing physical infrastructure to encourage taking small steps toward new habits. Employees can also be socially engaged through team collaboration and competition. We developed HealthQuest, our mixed-reality system that (1) encourages employees to increase everyday steps by walking around the existing physical environment; (2) educates employees on wellness awareness through kiosk-based quests; and (3) stimulates social interaction through team activity. We believe that technology can play a significant role in helping employees develop healthy behavior.
Our lifestyles in the 21st century lack the basic recommended daily physical activity. This sedentary way of living causes several major public health problems [4]. Research shows that people who are physically active can reduce their risk of developing major chronic diseases such as coronary heart disease, stroke, and type 2 diabetes by up to 50% and the risk of premature death by about 20~30% [5]. Older adults in particular can have significant benefits from regular lifestyle activity. Simply walking 30 minutes a day can help older adults maintain their mobility and independent living. Moreover, it can also help improve emotional and mental well-being because physical activity is associated with reduced risk of developing depressive symptoms [5].

Figure 1 shows a hypothetical model of the key stages of disease development throughout life, proposed by the British Department of Health [6]. Each line on the graph represents the theoretical rates of progression, from growth and development, risk factors, disease and disorders, to premature mortality. This model shows how physical inactivity at all stages of life contributes to negative effects. The gap widens as we age. This implies the importance of physical activity of older adults.

![Figure 1. A lifecourse perspective on the effect of activity on disease risk](image)

Even though the scientific evidence illustrates the positive impact of physical activity on older adults’ health, the current situation for many older adults does not seem to foster physical activity [7].

2 Related Work

Information Communication Technology (ICT) can play an important role in encouraging people to develop healthy behavior [8]. Previous research shows several ways to support this development through ambient displays, monitoring systems, and tracking systems.

2.1. Technology to Encourage Behavior Change: Breakaway

Breakaway is an ambient display that is designed to change human behavior, specifically people who spend most of their time in offices [9]. Breakaway is a small sculpture placed on the desk of stationary office workers. As an ambient display, it encourages people to take breaks more frequently. This sensor-driven ambient sculpture takes information from the user’s chair. The device then suggests times to take a break by changing shape. The preliminary user study shows promise for ambient displays that make use of aesthetics to positively change human behavior [9]. Figure 2 shows how Breakaway moves.
2.2. Technology for Monitoring and Promoting Physical Activity: Nike + iPod Sport Kit

One of the commercial products that encourage people to exercise is the Nike + iPod Sport Kit [10]. As seen in Figure 3, users place the iPod sensor in a specifically designed pocket in their Nike + shoe, and they will receive interactive feedback. For example, if users run, their iPod or iPhone 3GS displays and records their time, distance, pace, and calories burned. The kit can also give users a workout with encouraging feedback, such as letting them know that they are at the halfway point and in the final lead-up to their goal. Users can also choose Nike-created Sport Music or create their favorite workout playlist. The selected songs will also empower users with the motivation to run. Moreover, after finishing a workout, users can connect their iPod or iPhone to a computer to automatically synchronize their workout data with nikeplus.com. Nikeplus.com is a social networking site that provides people with the ability to share their motivation to walk across the world. This is one of the world’s largest virtual running clubs.

3. Methodology

Our research followed a human-centered design process. In order to understand our target users and their environment, we conducted case studies of three onsite health centers at nationwide multinational companies, namely Turner Broadcasting Company, Blue Cross Blue Shield at Tennessee (BCBSTN), and McKee Foods. The case studies focused mainly on understanding employees and their environment through site observations and informal contextual interviews.

Most Onsite Health Centers run preventive care services focusing on employees’ wellness, disease management, and lifestyle behavior changes. They also hire their own wellness coaches and nutrition experts. These were key factors in conducting informal interviews with each of these companies. Each stated that most employees are aware of the importance of health problems, especially obesity. However, simply knowing that these messages are important does not always translate directly to reducing obesity. This is illustrated by the fact that employees currently spend a significant portion of their time at their office working. Two of the companies, BCBSTN and McKee Foods, have their own health promotion programs, which include an onsite gym. The most popular method used to promote health is to provide printed handouts. These are ineffective for people not actively
engaged in health promotion. Figures 4 and 5 below show diverse ways to utilize wellness and health promotion programs.

Figure 4. Health information brochures (left) & a screen showing today’s tip on healthy eating (right)

Figure 5. Walking track outside company building (left), Team competition board to encourage employees’ exercise and nutrition (middle), Educational materials, which health promotion coaches use (right)

☐ Location matters.
   There is no single unique ideal onsite health location for every employee, especially for a larger company. Employees seek health information by visiting onsite health centers. However, it is difficult to determine the ideal physical location for everyone. Tele-health, kiosks in each building, or virtual encounters can be one of the best solutions to avoid under utilization of a single physically based center.

☐ Communication and Advertisements matter.
   Printed material has limited accessibility. Employees do not make special efforts to look for brochures. In order to increase communication, information technology can play an important role in enhancing awareness and educating employees on health issues.

☐ Personalization matters.
   In order to reinforce specific healthy behaviors, such as increased physical activity or prevention of sugar intake, personalization is key. If the behavior is personally meaningful for an individual’s needs, then motivation can be established. Providing incentives to employees for participation is an example of personalization. Companies could reward employees with lower insurance rates. Personalized SMS (Short Message Service) can be an effective way to notify specific incentivized employees.
4. HealthQuest System

The HealthQuest System uses a combination of spatially distributed interactive kiosks and personal monitoring via the web with an easy-to-follow point system. The HealthQuest System focuses on getting employees to walk and engage in physical activity for short breaks at work. Users are led on quests from kiosk to kiosk, learning about wellness. During quests, maps of employees’ wellness knowledge are formed, and physical activity is traced. The system extends upon existing web-based personal health recording systems by integrating knowledge maps and physical activity. A point system allows individuals to compare their progress with themselves, their teams, and the company as a whole.

4.1. System Architecture

The HealthQuest System is composed of a set of kiosk terminals that are wirelessly connected to a central server through the existing wireless infrastructure of a given company, as shown in Figure 6. It also coordinates information with a learning management system, a content delivery system, and a web server. The user interacts with the system on two ends. The primary interface is through a set of spatially distributed kiosks. Users track and set goals for their personal performance through a secondary interface on the web.

The touch screen kiosk is composed of a touch screen monitor embedded or offset from a wall within a shared environment. A thin client processes information from the touch screen monitor and provides the graphics back to the monitor. The thin client connects to an existing wireless network in the work environment. A barcode reader, magstripe reader, or RFID reader is attached next to the touch screen monitor and connected to the thin client to provide identification. The choice of reader depends on the existing identification system in place within the given company.

Before users can log into the system, they must register their company identification number with the system by swiping or scanning their ID card at the kiosk or on the web if their identification number is visible. They then choose a login and password for later access through the web for customizing settings and tracking performance. Once users are registered with the system, they start a quest at a kiosk, or a quest notification is sent to their email or via SMS, according to user preferences.

![Figure 6. System Architecture](image)
A user enters a quest by swiping or scanning the user’s ID card, using the reader next to the touch screen. The system authenticates the user and loads the content for that user. Upon completion of an individual learning object, the quest instructs the user to the next target kiosk location. Each kiosk is stored as a node in the system, and each is linked to every other kiosk node. The link table stores each link between a pair of nodes, and the distribution of the time taken for all users. The time distributions are used to automatically weight each link.

4.2. Link Weights

Let us suppose a Node A and a Node B, which represent two different locations within a company. There are two links, Link AB and Link BA, which correlate to the direction in which a user is moving. The time distributions would be different in this case because Node A is on the second floor, and Node B is on the first floor, with a stairwell in between. More effort, and therefore, more time is required to move up from Node B to Node A than down from Node A to Node B. Let us then suppose that the sum of the distribution of the time taken by all users for Link AB is to be given by Group_AB in Figure 7. If we then suppose that an individual has a lower variance, and this particular individual has less ability to apply effort, then that person’s time distribution could be given by Individual_AB. Notice that the mean of Individual_AB is higher than that of Group_AB. This simply tells the system that in general, our user takes longer to go from Node A to Node B than the group. However, we cannot immediately conclude that the individual is applying less effort.

![Time Distribution Diagrams](image)

**Figure 7. Time Distribution**

Since users must go upstairs to travel from Node B to Node A, the time taken would be more than from Node A to Node B. Therefore, the hypothetical distribution of Group_BA shows a higher mean value. The distribution of time from Node B to Node A for the user is shown in Individual_BA to increase. From these two time distribution comparisons, we can see that the user is generally slower than the group population. More links would establish this relationship further.

Users receive points for traveling from one node to another in a quest sequence. The points are calculated using the group weighting of the links, as well as the individual user weighting of the links. This method allows the
system to award points based on individual effort, taking into account user impairment. However, since the time is recorded each time a user moves from one node to another, the original data are available for more analysis. One method that the system can use is to look for specific walking patterns in either the length of time taken or in frequency.

Finally the system allows users to view their results on the web. In web-based monitoring, users view their points, graphs of their individual and group efforts, and their web of knowledge, based on their responses to the quest knowledge questions. This passive method of data collection allows users to focus on their activities rather than the recording of their activities.

4.3. Accessibility Features
To increase the potential number of users in the workplace, HealthQuest Kiosk is designed to include the elderly and people with functional limitations, such as visual disability and poor mobility. For the elderly and those with visual disability, our visual icons are as large as possible, and there is high contrast between touch areas, text, and background color, as shown in Figure 8. In particular, by following accessibility guidelines [11, 12], we provide larger type, a minimum of 18-point font, which significantly improves legibility for most people. Our wall-mounted kiosk (shown in Figure 9) is placed in the workplace for both standing and wheelchair users to access the screen. For wheelchair use, the maximum height of any interactive element on the kiosk system does not exceed 1.2 meters, and the lowest height of any operable part of the user interface is not less than 0.7 meters. Figure 9 shows the full mockup of the system use.

Figure 8. A sample touch screen interface

Figure 9. Renderings of the HealthQuest Kiosk (left) and physical mockup of the HealthQuest Kiosk (right)
5. Acknowledgement
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6. Conclusion
In this paper, we presented case studies and issues arising from the current state of onsite health centers. We also reviewed other techniques, devices, and systems for encouraging healthy behavior. Following a user-centered design process, we developed the HealthQuest System, which encourages physical activity and wellbeing in the workplace. Our system adjusts the internal point system by accounting for those with varying functional ability, which affects mobility. Additionally, the kiosk design is intended to provide accessibility to a wider population. In future studies, we plan to address specific group interaction apart from general socialization through movement in building environments. We also intend to explore the relationship between walking patterns and illness prevention.

References


