Majumdar, R. et al. (Eds.) (2025). Proceedings of the 1st International Conference on Learning Evidence and Analytics. Asia-Pacific Society for Computers in Education

Effects of Goal-Setting and Action Planning on Physical Activity and Self-Directed Behavior among Junior High School Students

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Abstract: Goal-setting is widely recognized as an effective strategy in both educational and health promotion contexts. However, its role in promoting self-directed behaviors among K-12 students remains considerably unexplored, especially the distinct effects of goal-setting and action planning on self-directed physical activity. This study investigated how these strategies influence students' physical activity achievements and self-directed behaviors in K-12 setting using smartwatches and a self-directed learning support system named GOAL. A total of 64 seventh graders (29 boys and 35 girls) participated in an 11-week physical activity promotion experiment. The results show that the students who set personal goal and action plans achieved the highest levels of physical activity (in both amount and days) and the highest engagement level of self-directed behaviors. In contrast, the students who didn't set personal goal and action plans exhibited the lowest physical activity levels and the lowest engagement level of self-directed behaviors. These findings suggest that integrating goal-setting and action planning with data tracking technologies can effectively promote self-directed physical activity among K-12 students.

Keywords: Goal-setting, action planning, physical activity, self-directed behaviors, learning analytics

1. Introduction

The twenty-first century demands the explicit integration of learning and innovation skills, information literacy skills, and life skills (Partnership for 21st Century Skills, 2016). With the inevitable digital transformation in education, there is a greater need for learners to active learning in a self-directed way, without being passively instructed by others (Morris, 2019). As a behavior change techniques, goal-setting are often included in learning and fitness technology (Cleary & Zimmerman, 2004; Greaves et al., 2011). Behavioral change theories recommend that it is important to break goals into short-term, specific, and attainable action plans, monitor progress regularly, and offer timely, relevant feedback (Bandura, 2004).

Despite goal-setting playing an important role in educational interventions and health practices, there has been little investigation on its effects on self-directed behaviors among K-12 students. In addition, although goal-setting and action planning are often discussed together as key components of self-regulation and behavior change (Bandura, 2004; Cauley & McMillan, 2010; Cleary & Zimmerman, 2004), their individual effects on actual behavior change have not been empirically examined.

To address these gaps, this study examines the effectiveness of a self-directed learning support system integrated with smartwatch tracking to promote physical activity. It specifically investigates how goal-setting and action planning independently influence students' physical activity achievements and self-directed behaviors among adolescent students in K-12 settings.

2. GOAL: Learning and Physical Activity Promotion System

Goal-Oriented Active Learner (GOAL) system is developed to facilitate learners' self-directed learning utilizing daily activities as context (Li et al., 2021). The GOAL architecture integrates learning logs from online environments and physical activity logs from wearable trackers to provide a data-rich environment for the learners to acquire their self-direction skills. The GOAL learners follow DAPER (Data collection - Analysis - Plan - Execution Monitoring - Reflect), a five-phase process model, to execute self-directed behaviors. The GOAL system has been implemented at a K12 public school in Japan. Learners used the online environments for extensive reading and smartwatches for tracking walk and sleep activities.

The home page of the GOAL system provides a list of activities that the learner can choose to learn in different contexts, such as reading, physical activity, or sleep promotion (Majumdar et al., 2024). For each activity, a dashboard presents aggregated indicators and options to set goal for the activity. This study focuses on walking activity promotion, which is from the physical activity context, and its main indicator is the number of steps taken.

Figure 1. Physical activity promotion support in GOAL system.

The physical activity promotion support in GOAL system is shown in Figure 1. Students can track their daily physical activity using the Garmin smartwatches. Their physical activity data can then be synchronized to GOAL system pseudonymously. Students can manage self-directed actions in physical activity dashboard in GOAL system.

3. Method

3.1 Participants and contexts

An experiment was conducted in a public junior high school in Japan. Garmin vivosmart3 smartwatches were distributed to 120 seventh grader students who aged around 13 years old. Since some students did not wear the smartwatch or synchronize their data, a total of 64 seventh graders (29 boys and 35 girls) participated in this experiment. The duration of the experiment is 11 weeks. The experiment was approved by the city school counsel and the informed consent was taken from the participants and their parents after the school described the objectives and details of the research project.

3.2 Data collected and measures

During the experiment, students executed the physical activities, such as walking or running, and tracked their daily physical activity using the smartwatches. At the same time, students synchronized their physical activity data to GOAL system and self-directed their physical activity in GOAL system. They were encouraged to set personal goals related to physical activities, and break down these goals into concrete action plans that detail the paths to goal attainment. For instance, a student could set a goal like "Walk at least 6,000 steps per day to reduce stress and build a habit," and then create weekly action plans such as "Walk 6,000

steps to and from school on weekdays, and 8,000 steps with friends on weekends". Within the GOAL system, students could also engage in data collection, trend analysis, self-monitoring, and self-reflection. All interactions with the GOAL system were automatically recorded.

Self-direction skill scores (SDS scores) are computed based on the daily indicators of physical activity and interaction logs between learners and the GOAL system, ranging from 0 to 4. The computation logic of SDS scores is shown in Table 1. SDS scores are considered as a proxy indicator of that learners' levels of self-directed behavior.

Table 1. *The level and description of self-directed behavior*

Behavior level	Data sufficiency	Status identification	SMART planning	Regular monitoring	Strategic reflection
4	76-100%	Check data and successfully identify status without system recommendation	Set appropriately challenging plan after analysis	Check progress and report more than twice	Reflect by self-rating and further comments
3	51-75%	Check data and successfully identify status with system recommendation	Set too difficult plan after analysis	Check progress and report twice	Reflect by self-rating but did not write comments
2	26-50%	Check data but partially identify status	Set too easy plan after analysis	Check progress and report once	Reflect on personal plan and achievement
1	1-25%	Check data but did not identify status	Set plan without analysis	Check progress but did not report	Reflect on personal plan only
0	No data collected	Never analyze	Never plan	Never monitor	Never reflect

The behavioral measures and their descriptions in this study are shown in Table 2. Four measures were mainly used: daily steps taken, total exercise days, SDS scores, and Total SDS days. Daily steps taken are measured by students' physical activity data from smartwatches. Total exercise days are the total days when the student engaged in physical activity during the experiment. SDS scores are the sum of the self-direction skill scores of data collection, analysis, planning, monitoring, and reflection in GOAL system. Total SDS days are the total days when the student operated within the GOAL system.

Table 2. *Behavioral measures and descriptions in this study*

Measure	Description
Daily steps taken	Average steps taken per day
Total exercise days	Number of days when the student engaged in physical activity
SDS scores	Sum of the self-direction skill scores of data collection, analysis, planning, monitoring, and reflection
Total SDS days	Number of days when the student operated within GOAL system

3.3 Data analysis

The students were divided into three groups: no-goal-planning (NGP), planning only (P), goal-planning (GP). NGP group students (n = 12) neither set goal nor made action plans for physical activity. P group students (n = 46) didn't set goal but made action plans for physical activity. GP group (n = 6) set both goal and action plans for physical activity.

In order to investigate the difference of physical activity achievements among three groups, the daily steps taken and total exercise days were compared and visualized. Furthermore, the SDS scores and total SDS days were compared and visualized to examine the difference of self-directed behaviors among three groups.

4. Results

4.1 Difference of physical activity achievements among three groups

The results show that NGP and GP groups had significant difference of physical activity achievements (see Figure 2). NGP group had the lowest daily steps taken and total exercise days (3780 steps; 24 days). P group showed moderate daily steps taken and total exercise days (5261 steps; 26 days). GP group achieved the highest daily steps taken and total exercise days (6331 steps; 47 days).

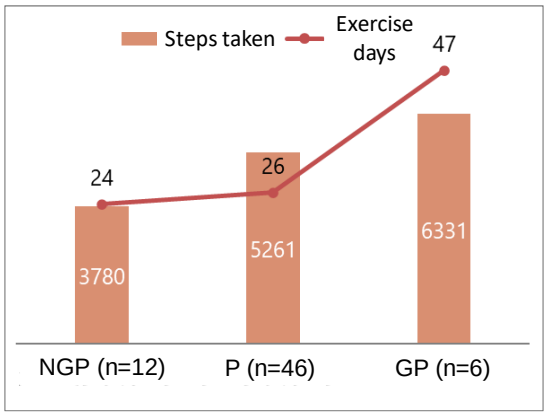

Figure 2. Difference of daily steps taken and total exercise days in three groups

4.2 Difference of self-directed behaviors among three groups

The results show that NGP, P, and GP groups had significant difference of self-directed behaviors (see Figure3). NGP group had the lowest SDS scores and total SDS days (1.4 scores; 2 days). P group showed moderate SDS scores and total SDS days (5.6 scores; 5 days). GP group received the highest SDS scores and total SDS days (11 scores; 13 days).

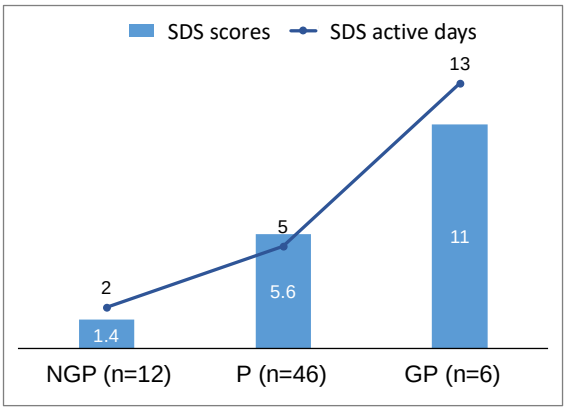

Figure 3. Difference of SDS scores and total SDS days in three groups

5. Conclusion and Discussion

This study investigated how goal-setting and action planning strategies affect students' physical activity achievements and self-directed behaviors using smartwatch tracking and the

GOAL system. The findings reveal that students who set personal goals and action plans engaged in more physical activity, developed better exercise habits, and achieved higher self-direction skills. These findings suggest that both goal-setting and action planning play influential roles in the levels of physical activity and the engagement of self-directed behaviors.

This study makes three key contributions. First, it demonstrates that a goal-setting support system combined with smartwatch tracking offers an effective technological approach to promoting physical activity among adolescents. This extends previous research, which has largely relied on self-reported measures or interviews (Ezati et al., 2025; Taylor et al., 2025) and focused primarily on adult populations (Degroote et al., 2021). Second, the study shows that goal-setting and action planning independently enhance physical activity, providing behavioral evidence in support of Bandura's (2004) social cognitive theory. Third, the findings highlight the leading role of goal-setting and action planning in fostering self-directed physical activity across the self-direction cycle.

This study also has limitations, including the use of a single grade level with imbalanced sample sizes, which may limit the generalizability of the results. Additionally, relying on step count alone may not fully reflect the variety or intensity of physical activities related to goal-setting and action planning.

Acknowledgements

This work was partly supported by NEDO Special Innovation Program on AI and Big Data JPNP18013, JSPS KAKENHI Grant-in-Aid for Scientific Research (B) 22H03902.

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