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Symmetrical Hardware-Software Design for Improving Physical Activity with a Gamified Music Step Sensor Box

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Abstract: Physical inactivity, the fourth leading cause of death worldwide, can harm the economy, national growth, community welfare, health, and quality of life. On the other hand, physical activities (PA) have numerous advantages, including fewer cardiovascular diseases, cancer, and diabetes, fewer psychological disorders, and improved cognitive abilities. Despite the benefits of PA, people are less likely to participate. The main factor is a lack of entertainment in exercise, which demotivates society from engaging in healthy activities. In this work, we proposed a hardware-software symmetry that can entertain people while performing PA. We developed a step-box with sensors and a gamified music application synchronized with the footsteps. The purpose of this study is to show that incorporating appropriate gamification allows participants to engage actively in tedious and economic exercises. Participants (N = 90) participated in 20-min daily exercise sessions for three days. A 5-point Likert scale was used to assess efficiency, effectiveness, and satisfaction following exercise sessions. The results show that the gamified sensor step-box increased efficiency, effectiveness, and participant satisfaction. The findings suggest that gamification fundamentals in simple exercises increase excitement and may help people to maintain PA.

Keywords: physical activity; improve cognitive abilities; exergame; hardware-software symmetry; gamification; music application; footstep-box; economic exercises

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Citation: Ahmed, B.; Putra, H.A.; Kim, S.; Im, C. Symmetrical Hardware-Software Design for Improving Physical Activity with a Gamified Music Step Sensor Box. *Electronics* **2023**, *12*, 368. https://doi.org/10.3390/electronics12020368

Academic Editors: Juan M. Corchado, Byung-Gyu Kim, Carlos A. Iglesias, In Lee, Fuji Ren and Rashid Mehmood

Received: 20 December 2022
Revised: 8 January 2023
Accepted: 9 January 2023
Published: 11 January 2023

1. Introduction

The development of societies is directly proportional to the economy's progression, community welfare, healthiness, and quality of life. At the same time, these factors are correspondingly dependent on the communities' physical activities (PA). Increased physical inactivity negatively impacts countries' growth [1–3]. World Health Organization (WHO) has launched the Global Action Plan on PA 2018–2030 to increase PA worldwide. According to WHO, it is the collective responsibility of governmental organizations and the local community to promote and enhance the opportunities and encourage people to PA. WHO suggested at least 2.5–5.0 h or a minimum of 1.25–2.5 h weekly low-intensity aerobic exercises for ages 18–64. Likewise, it can be a combination of moderate and hearty PA [4].

PA has impressive benefits, specifically preventing cardiovascular diseases, cancer, and diabetes [5]. The one who is regular in PA has fewer psychological disorders and better cognitive abilities [6–10]. 80% of teenagers are not efficiently physically active and have a 20–30% increased risk of death [3]. Five million deaths occur worldwide, and unambiguously 8% only in the United States annually due to lack of PA. This mortality rate and decline in PA significantly burden the health economic system [11]. That's why it's been the fourth leading cause of death worldwide [12].

A physically active person generally has the better physical capability [13]. Even simple aerobic or plyometric exercises profoundly impact the neuromuscular system to harmonize movements. When the heart inflates, the oxygen and nutrients distribute around the body effectively, and the metabolic process works proficiently [5,14–16]. Regardless of the benefits of PA, people show less interest and motivation to participate in regular exercises [17]. The punitive reality is that with the growing age of people, commitment to PA gradually declines [14]. Undoubtedly, the individual's economic situation and everyday work-life schedule harm the PA. Still, the main factor is the lack of enjoyment in exercise, which demotivate participants from healthy activities [18]. Fitness requires individual motivation and excitement [19], and relatively, participants show more encouragement and retention while enjoying exercise [17].

Technology advances progressively, and as many concepts as possible have been established to promote healthy activities for the laity. The gamification methodology uses game fundamentals in non-gaming environments [20,21]. Studies have shown that gamification can effectively enhance motivations and performances in the education, health, entertainment, and business industries [22–24]. Similarly, gamification applies to simple boredom exercises that are economically friendly to stimulate people to PA as entertainment [25] and generate relatively more impact and retention than non-gamified PA [26,27]. The gamification approach enhances the participants' enjoyment, retention, and motivation. Significant evidence indicates that gamification is less demanding and more attractive to engage in ability development [28,29]. It was confirmed that enacting the gamified fundamentals, even for the Ecuadorian police in a virtual training environment based on real-life scenarios, was effective [24].

Additionally, Tom Baranowski et al. have demonstrated that enjoyment plays a vital role in facilitating exercise and can reveal the feeling of optimism [30]. Exergaming, health-fitness digital device applications, interactive virtual exercise environments, and medical devices each offer practical solutions for motivation, effective diagnosis, and treatments [31,32]. Furthermore, mobile health care and fitness applications are designed around gamification theory to motivate users to engage in nutritional and healthy activities [33,34].

Exergaming enhances the motivation and satisfaction that generate intentions for future healthy activities [35]. Mateus Nunes et al. proposed a "motivational system—an exergame". People use virtual environments to perform PA and interact with others within the system. They found that social interaction elements work as enjoyment, are competitive and collaborative, and this immersion could lead to cognitive input, thus reducing perceptual effort during exercise [36]. Correspondingly, gamification elements' effects in treating psychological disorders are conspicuous [27]. Xiaozhou Li et al. found that gamified exercise therapy had enormous relief than simple exercise therapy for anxiety disorder [37]. Even dancing is a healthy activity for people who are unwell or getting old and is considered a therapy because it affects cognitive function and stamina. Alethea L. Blacker et al. have proposed adding enjoyable elements to this therapy to keep people motivated, satisfied, and fit [38]. Studies indicate that all types of PA are effective for health and can increase endurance and personal satisfaction [39]. Nobuko Hongu et al. found that even stairclimbing plays an essential role in PA, so they recommended stairclimbing as part of their daily workout routine [40]. Likewise, simple aerobic exercises and step box exercises profoundly affect human health. Hundreds of thousands of exercises and equipment could use to keep the body healthy. Step exercise is not only an economic exercise but also improves work performance by improving aerobic capacity and reducing stress [41].

Based on prior research about healthy activities using technologies [18,28–30,34,42], the author introduces the simple exercise system using a step-box with modifications, providing an economical solution, gratification, and motivation toward PA. The step-box workout is a straightforward PA that improves overall fitness by building strength and strengthening cardiovascular health [15,43]. Our step-box system is different from the regular step-box and is named Sensor Step-box (SSB). We have attached the sensors with a simple step-box, which counts the left and right footsteps of the participant. The digital devices-based music application called "Gamified Music Steps, including the gamification fundamentals, has been made. The "Gamified Music Steps" contains slow and fast music tracks synchronized with the footsteps. The authors named the system "Gamified Music Sensor Step-Box" (GMSSB). The development of the GMSSB is the symmetrical design of hardware and software, and it is the synchronization between "Gamified Music Steps" and SSB. GMSSB was made to motivate people for the PA. Some exercise systems are available and even contain enjoyment, but they are much more expensive and require ample installation space. Our proposed GMSSB is economically friendly and exciting [44].

This research aims to demonstrate that the inclusion of appropriate gamification allows participants to engage in tedious exercises actively. Furthermore, the authors discuss the development of GMSSB, how GMSSB is efficient and effective for the participant motivation towards PA, and how the authors have found the participants are satisfied after using this system.

2. Materials and Methods

2.1. Gamified Music Sensor Step Box (GMSSB)

The development of the GMSSB is the symmetrical design between hardware and software. The architecture of SSB hardware consists of copper plates, conductive fiber sheets, four copper plate sheets of the thickness of 1.5 mm with 33 × 33 cm dimensions, and two conductive fabric sheets with an extent of 33 × 33 cm. Two copper plates for the left and two for the right footstep; in between, we arranged the conductive fabrics sheet of 0.2 mm on each side. The Arduino board is attached with small wires and placed on a step box. The Arduino board included the power chip, batteries, Bluetooth module, red and green light, and a switch. The Sensor Step Box was developed using two copper plate sheets and two conductive fiber sheets. The goal of the proposed device is to use gamification principles to encourage people to exercise. The perceived usability of the Gamified Music Sensor Step Box is unaffected by the room's temperature since it is intended for indoor use. The "Gamified Music Steps" is an interactive software with UNITY 3D [45], built for windows, android, and IOS devices. The participants start by signing up in "Gamified Music Steps", storing information in the database through the network, and the application starts working. The application includes Korean and English Language, music tracks, workout time records, and leaderboard results. The connectivity between SSB and "Gamified Music Steps" is based on Bluetooth's preamble bit synchronization signal. Figure 1 shows the architecture of GMSSB. When the participants put their feet.

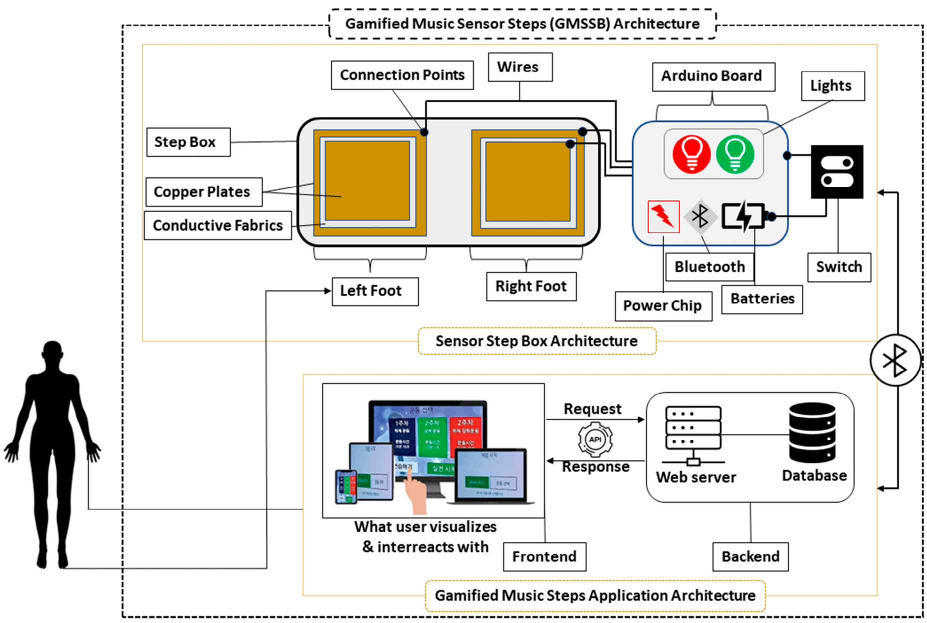

Figure 1. System architecture diagram of Gamified Music Sensor Step Box, showing the connectivity between SSB and "Gamified Music Steps" via Bluetooth.

The attached sensor finds the left or right foot on the step-box, and the green light turns on the Arduino board. Green light shows the pressed state, and the same pressed state can be shown on the smart device screen. The sensors on the step-box have been defined based on the pressure threshold value. In the proposed GMSSB, we have set the value for foot pressure as 700 PSI or greater according to the suitability of the participants to experiment. This pressure threshold can easily change (increase or decrease) according to the requirements. If the level of foot pressure is greater or equal to the threshold, then the green light turns on, and if the level of foot pressure is less than the threshold value, then the red light turns on. The threshold has represented as:

$$\textit{Pressure} \geq 700 \text{ psi} = \textit{green light on}$$

$$\textit{Pressure} < 700 \text{ psi} = \textit{red light on}$$

Furthermore, the synchronization between the footsteps and music is based on the conductor class written in C sharp programming language. The conductor class algorithm, consists of the song beat per minute, song duration per second, current song position in seconds, and the song position in moments shown in Table 1. When the music plays a beat per minute, the left or right foot displays on the screen. The participants step into the step box accordingly. The score will increase based on the number of feet you stepped on the sensors of the Step-box. The graphical user interface, which is very simple and easy to interact with the "Gamified Music Steps", is shown in Figure 2. The authors have made the GMSSB source code algorithm publicly available using two GitHub repositories. This repository contains the "Gamified Music Steps" application source code (accessed on 6 January 2023) "https://github.com/Bilal-Gameobject/GMSSB-Gammified-Music-Sensor-Step-Box.git" and similarly (accessed on 6 January 2023) https://github.com/Bilal-Gameobject/Pseudo-Code-GMSSB.git" this repository consists of pseudocode of developed algorithms.

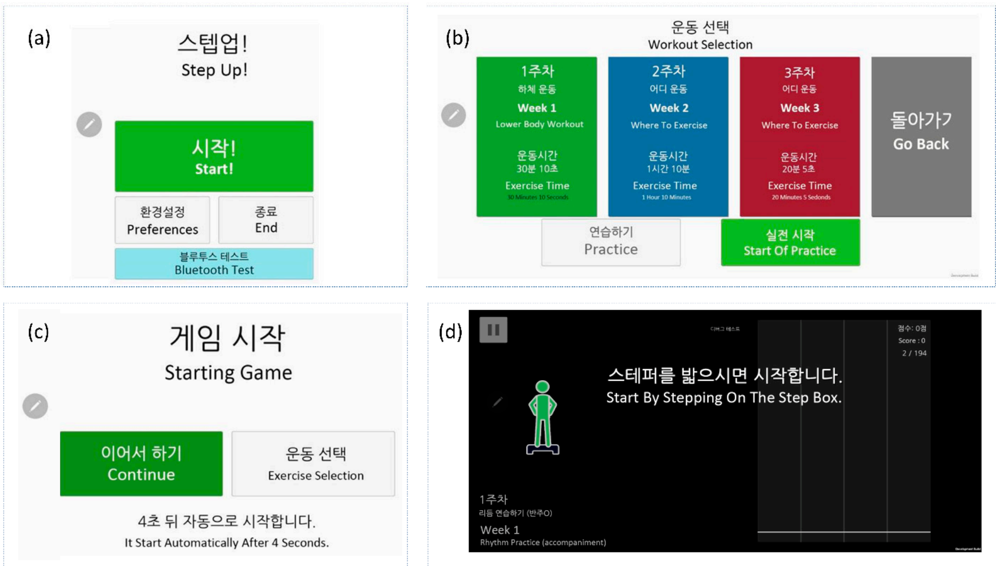

Figure 2. (**a**)The "Gamified Music Steps" interface shows the application's opening screen (Bluetooth connectivity test and start exercise), (**b**) explains the exercise/workout type selection screen, (**c**) the application screen starts the selected exercise, and, (**d**) activity start interface.

Table 1. C sharp language Algorithm program design: Basic parameter of the Conductor class is used to synchronize footsteps with beats.

Basic Design for Conductor-Class for Synchronization between Footsteps and Music Beats	
Input:	**SecPerBeat**: predetermined beat length for each song;
	AudioSettings.dspTime: Song length; **dspSongTime**: Current time position;
Output:	**Time to instantiate music note**
1	songPosition = (float) (AudioSettings.dspTime - dspSongTime); //finding song position
2	songPositionInBeats = songPosition / secPerBeat; // calculate position in sec
3	songPosition = (float) (AudioSettings.dspTime - dspSongTime);// track position changes from-
4	songPosition = (float) (AudioSettings.dspTime - dspSongTime - firstBeatOffset); // this is the current track position
5	// calculate loop position: if
6	{
7	(songPositionInBeats >= (completedLoops + 1) * beatsPerLoop) completedLoops++;
8	loopPositionInBeats = songPositionInBeats - completedLoops * beatsPerLoop;
9	}

10	//relative position with Conductor Instance
	loopPositionInAnalog = loopPositionInBeats/beatsPerLoop;

11	transform. position = Vector2.Lerp()
12	Conductor Instance: if
11	{
12	if (nextIndex < notes.Length && notes[nextIndex] < songPosInBeats + beatsShownInAdvance)
13	}
14	{
15	Instantiate (/* Music Note Prefab */); nextIndex++;
16	}
17	**Synced rotation**: this. gameObject.transform.rotation = Quaternion.Euler(0, 0, Mathf.Lerp(0, 360, Conductor.instance.loopPositionInAnalog));
18	**// Interpolate!** Moving the track Notes: SpawnPos,
19	RemovePos,
20	(BeatsShownInAdvance - (beatOfThisNote - songPosInBeats))/BeatsShownInAdvance);

2.2. Participants and Study Design

This study was conducted with Keimyung University students (N = 90, age: 25–35 years, male 55 and 35 female) majoring in Computer Science related field in South Korea. Participants were recruited by selecting those who voluntarily agreed to contribute and were not restricted from PA by a physician or medical practitioner. All participants were allowed to join according to their available time as scheduled. Each participant participated in exercise sessions for 20 min daily for three days.

The framework provided by ISO 9241-11:2018 helps us understand the concept of usability and apply it to scenarios where people utilize interactive and other systems. Referring to ISO 9241-11, usability is defined as “the extent to which specified users can use a product to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context” [46]. Specifically, the perceived usability scale has some grants, such as being easy to use, providing reliable results, and effectively differentiating between usable and unusable systems [47,48]. Consequently, we have used the Perceived Usability Scale to evaluate our GMSSB. The standard 5-point Likert scale questionnaire was used with usability testing because of its application as one of the most critical and repeatedly used psychometric tools in various research fields [44]. The 5 points of scale are: strongly disagree, disagree, neutral, agree, and strongly agree [49].

The average, standard deviation, and percentage were applied to the collected data to determine the effectiveness, efficiency, and satisfaction of SSB and "Gamified Music Steps", respectively. The authors wanted to understand whether adding gamification would improve participants' usability, so SSB and "Gamified Music Steps" were measured separately. Subsequently, the calculated data was processed in Origin software to demonstrate the results in graphical format. Equations (1)–(3) show the authors' mean, standard deviation, and percentage formulas to evaluate the results.

$$Mean = \frac{Sum\ of\ data}{Number\ of\ dat} \tag{1}$$

$$Mean = \frac{Sum\ of\ data}{Number\ of\ dat} \tag{2}$$

$$Percentage\ (\%) = \frac{Part}{Whole} \times 100\% \tag{3}$$

3. Results

Participants N = 90, with an average age of 30, participated in the 60 min exercise session with GMSSB over three days. Figure 3 shows the graphical data of the ages of the participants. After the exercise sessions, each participant filled out two feedback forms. Each feedback form has ten statements for Usability scale measurements. Tables 2 and 3 demonstrate the questionnaire statements and the average percentage of agreements on the Likert points for the SSB and "Gamified Music Steps". Furthermore, efficiency values were the Likert scale for SSB: strongly disagree 1.11 $\pm$ 0.78, disagree 3.70 $\pm$ 0.78, neutral 14.44 $\pm$ 0.78, agree 48.14 $\pm$ 11.56, strongly agree 32.59 $\pm$ 10.32. Likewise, effectiveness values were for SSB: strongly disagree 1.11 $\pm$ 0.78, disagree 3.33 $\pm$ 2.22, neutral 17.03 $\pm$ 7.56, agree 41.11 $\pm$ 6.28, strongly agree 37.40 $\pm$ 12.57. Then satisfaction values were for SSB: strongly disagree 0, disagree 0.83 $\pm$ 0.64, neutral 13.61 $\pm$ 2.77, agree 32.22 $\pm$ 7.08, strongly agree 53.33 $\pm$ 10.34. Table 4 demonstrates the average and standard deviation data of SSB. Moreover, efficiency values were the Likert scale for "Gamified Music Steps": strongly disagree 0.37 $\pm$ 0.78, disagree 1.48 $\pm$ 1.28, neutral 14.04 $\pm$ 4.49, agree 39.25 $\pm$ 11.56, strongly agree 44.81 $\pm$ 11.18. Similarly, effectiveness values were for "Gamified Music Steps": strongly disagree 0, disagree 0.37 $\pm$ 0.64, neutral 3.70 $\pm$ 1.57, agree 32.22 $\pm$ 1.57, strongly agree 63.70 $\pm$ 8.41. In addition, satisfaction values were for "Gamified Music Steps": strongly disagree 0.27 $\pm$ 0.55, disagree 0.27 $\pm$ 0.64, neutral 2.22 $\pm$ 0.78, agree 30 $\pm$ 5.77, strongly agree 67.22 $\pm$ 5.59. During three days of the exercise session, Table 5 demonstrates the average and standard deviation data of "Gamified Music Steps". N = 90 showed an encouraging and agreeing response toward the SSB's efficiency, effectiveness, and satisfaction and "Gamified Music Steps".

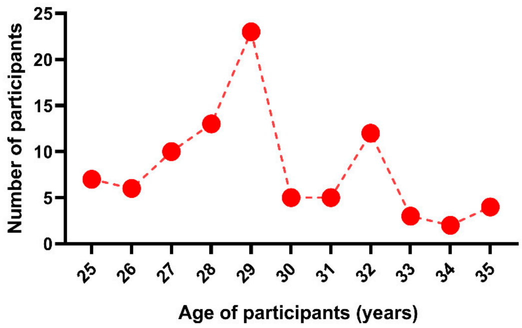

Figure 3. This graph shows the number of participants and their ages.

Table 2. Usability scale questionnaires average responses of SSB for N = 90.

Usability Scale Subcategory		Percentage of Agreements				
	Questionnaires for SSB	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Disagree**
Efficiency	It is easy to use the SSB for exercise	1.11	4.44	11.11	38.89	44.44
	Doing exercise with SSB is time efficient.	0	1.11	10	61.11	27.77
	The SSB is simple to assemble and easy to move from one place to another.	2.22	5.55	22.22	44.44	25.55
Effectiveness	The SSB provides the confidence to engage in physical activity	0	3.33	25.55	52.22	18.88
	Using SSB for exercise is a feeling of positive health	1.11	1.11	14.44	27.78	55.55
	Exercise with SSB provides mental alertness and better fitness.	2.22	5.55	11.11	43.33	37.77
Satisfaction	Using SSB for exercise is far better than the usual step box.	0	0	13.33	25.56	61.11
	SSB provides an opportunity to improve health with entertainment.	0	0	10	26.67	63.33
	I want to exercise with SSB every day because it provides a feeling of self-motivation and personal accomplishment.	0	1.11	14.444	38.89	45.55
	Overall, I feel satisfied	0	2.22	16.66	37.78	43.33

Table 3. Usability scale questionnaires average responses of SSB for N = 90.

Usability Scale Subcategory		Percentage of Agreements				
	Questionnaires for "Gamified Music Steps"	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Disagree**
Efficiency	The interface of the musical application is friendly, and the graphics are mesmerizing.	0	0	13.33	30	56.66
	This application has all the features and resources I anticipated.	0	2.22	18.88	35.56	43.33
	I don't need technical support to use this application.	1.11	2.22	10	52.22	34.44
Effectiveness	The application helps get me involved in physical activity in a fun way.	0	0	3.33	36.67	60
	The application entertains with self-competition for physical activity	0	0	1.11	25.56	73.33
	Application synchronization provides accurate responses and understanding of the correct workout	0	1.11	6.66	34.44	57.77
Satisfaction	Doing exercise using this music application is more fun.	0	0	0	13.33	86.66
	Footsteps displayed in the application interface are properly synched between music and GSSB.	1.11	1.11	2.22	28.89	66.6
	The gamification and entertaining elements provided in the app are enough to keep me engaged in my physical activities.	0	0	5.55	38.89	55.55
	Overall, I feel satisfied	0	0	1.11	38.89	60

Table 4. Summary of responses for the Usability evaluation of SSB.

Usability Scale Subcategory	Percentage of Agreements (Mean & Standard Deviation) for SSB				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Efficiency	1.11 ± 0.78	3.70 ± 0.78	14.44 ± 0.78	48.14 ± 11.56	32.59 ± 10.32
Effectiveness	1.11 ± 0.78	3.33 ± 2.22	17.03 ± 7.56	41.11 ± 6.28	37.40 ± 12.57
Satisfaction	0	0.83 ± 0.64	13.61 ± 2.77	32.22 ± 7.08	53.33 ± 10.34

Table 5. Summary of responses for the Usability evaluation of “Gamified Music Steps”.

Usability Scale Subcategory	Percentage of Agreements (Mean & Standard Deviation) for “Gamified Music Steps”				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Efficiency	0.37± 0.78	1.48 ± 1.28	14.07 ± 4.49	39.25 ± 11.56	44.81 ± 11.18
Effectiveness	0	0.37 ± 0.64	3.70 ± 1.57	32.22 ± 1.57	63.70 ± 8.41
Satisfaction	0.27 ± 0.55	0.27 ± 0.64	2.22 ± 0.78	30 ± 5.77	67.22 ± 5.59

Figures 4a–c and 5a–c show the graphical presentation of the Usability Scale measurements for SSB and “Gamified Music Steps”. The percentage of agreement can be seen as significantly high.

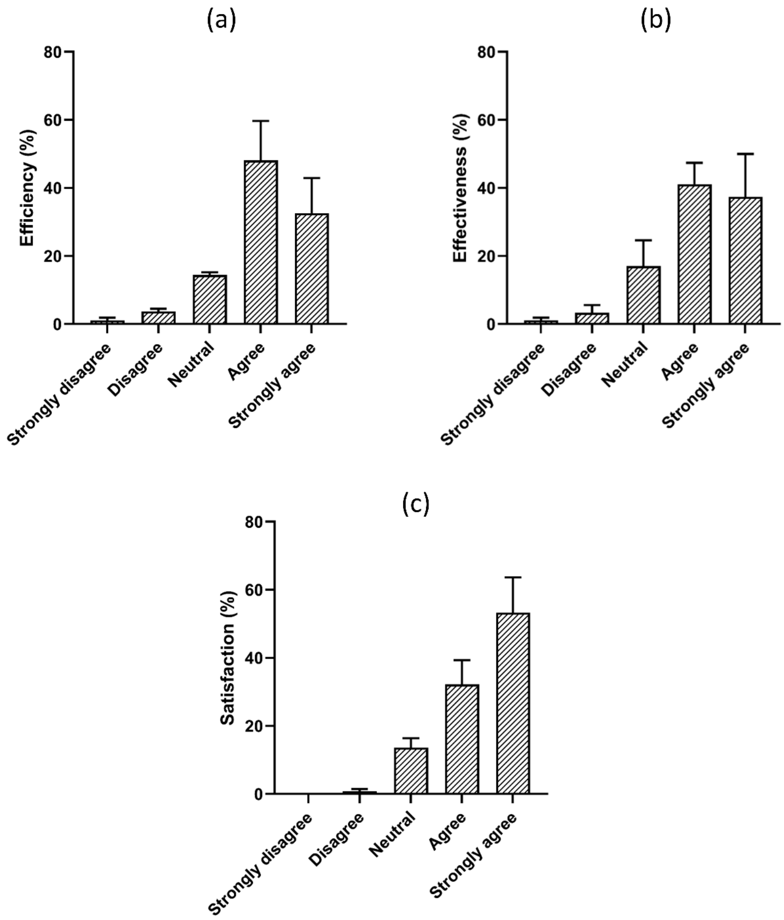

Figure 4. Is the graphical presentation of Table 4, where (**a**) shows high values for agreeing towards efficiency for the SSB, (**b**) shows high values for agreeing towards effectiveness for the SSB, and (**c**) shows high values for strongly agreeing towards satisfaction for the SSB.

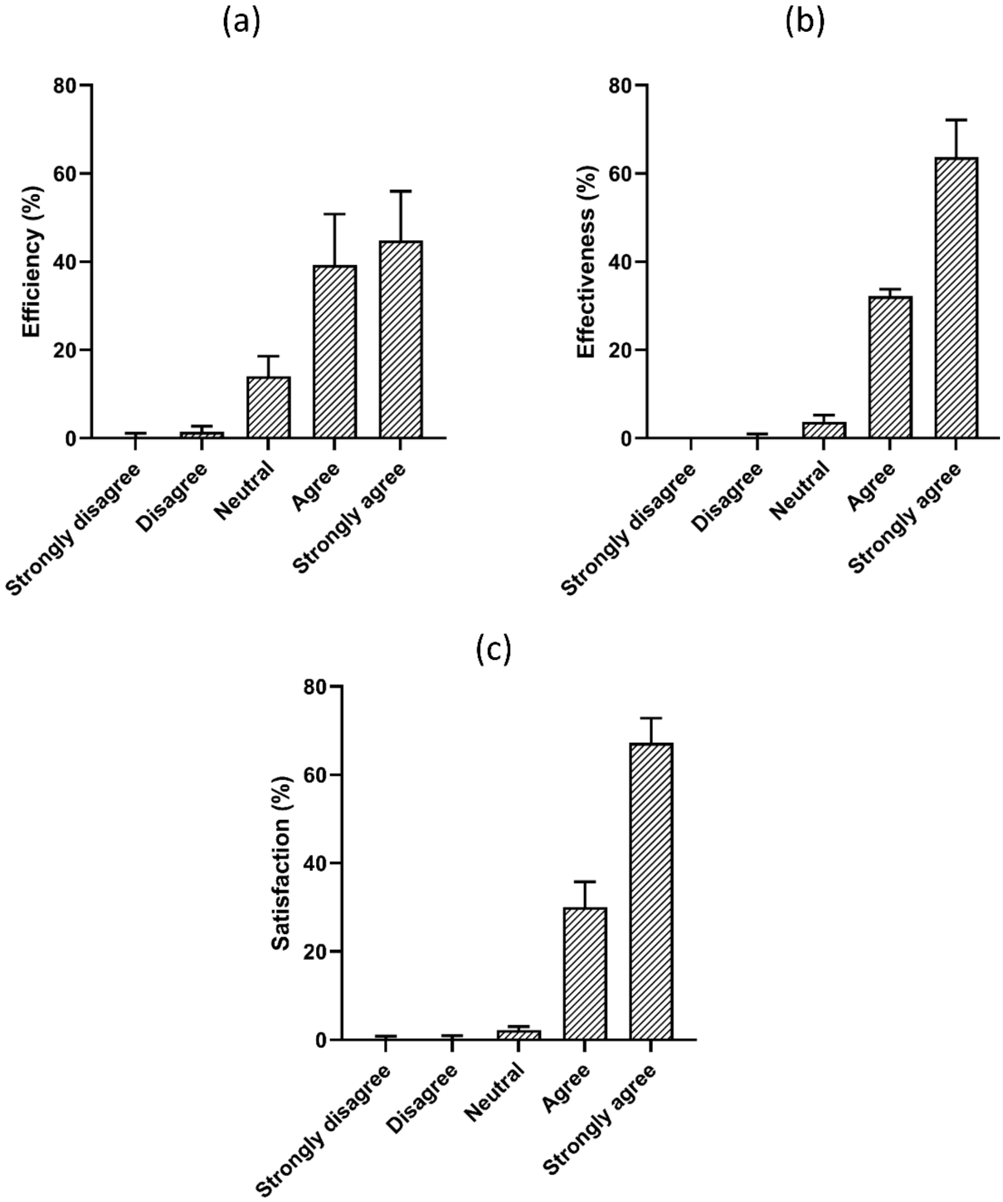

Figure 5. The graphical presentation of Table 5 shows (**a**) high values for strongly agreeing towards efficiency for the "Gamified Music Steps", (**b**) high values for strongly agreeing towards effectiveness for the "Gamified Music Steps", (**c**) showing high values for strongly agreeing towards satisfaction for the "Gamified Music Steps".

4. Discussion

A 2011 study shows 1 in 5 people are physically inactive [50]. Teenagers at this age do not physically engage in any activity that improves their quality of life. A study by the Centers for Disease Control found that 25% of adults only in the United States are physically inactive [44]. The main reason is that people aged 25–35 are too busy with their personal and professional lives to manage their schedules, and the age range is more involved in games and gamification [51]. The main thing is that they do not find entertainment in PA. Today, everything is done sitting at a desk and using electronic devices, or both. Physical inactivity can lead to health problems such as heart disease, high blood pressure, cognitive impairment, and cancer [5,6]. It can cause chronic diseases and disorders, reducing the quality of life and raising the mortality risk [51]. WHO and international experts are developing new techniques and tools for evaluating PA, and WHO launched a global plan for physical activity to increase PA to overcome this challenge. The World Health Assembly adopted the international goal of reducing physical inactivity by 15% by 2030 in 2018 [3,44].

Simple PA is necessary to keep the heart, lungs, and blood vessels healthy and improve muscular and cardiorespiratory health [44,48]. It confirmed that regular exercise significantly impacts mood, reducing frustration levels and the side effects of stress and improving self-esteem and cognitive function [52]. However, simple PA can be tedious. Adding some gamification elements makes it more exciting and motivates the participants to engage. Gamification principles indirectly affect happiness through physical activity and influence the mediated rise in self-efficacy [53]. Therefore, engaging people in PA should be kept in mind to make it enjoyable for the participants. Thus, gamification technology plays an essential role in this scenario.

It is no exaggeration to say that the current generation is very interested in music and dance. Music and exercise make a great combination. You'll work out harder if you listen to fast music [38]. According to a study by Karageorghis published in the Journal of Sports Workout Psychology, motivating music can help people exercise while exhausted. He also claims that music can increase exercise endurance by 15% [54].

The Dance, Dance Revolution (DDR) is mainly used in gaming zones and is extremely popular worldwide among teenagers and young adults [55]. An arcade and home video game created by Japanese entertainment company Konami, players move their feet in set patterns to electronic dance music. Players must maintain high precision to move from one level to another. Although it is entertaining to use DDR, such machines can't be used in houses because of their large size and purchasing costs. Our study highlights that excitement, music, and exercise are essential for PA.

The system we designed, GMSSB, is based on the harmonization of hardware and software. The SSB and "Gamified Music Steps" connect via Bluetooth. Keimyung University computer science students (N = 90) were asked to test the system and provide feedback. The survey was conducted over three days, with participants participating in 20 min of physical activity daily. After completing the study, these participants filled out the questionnaires for SSB and "Gamified Music Steps". The system was evaluated using a perceived system usability scale based on a 5-point Likert scale.

The questionnaires were further categorized into three factors (1) Efficiency, (2) Effectiveness, and (3) Satisfaction, and were evaluated according to these factors in the SSB. The questionnaire efficiency has the highest rate of 44.44%, with an average rate of 32.59, which shows that participants strongly agreed that SSB. is easy to use. For effectiveness, 55.55% of participants support SSB. for positive health. Similarly, 63.33% of participants appreciated the SSB., which improves health with entertainment. Therefore, the satisfaction level has the highest average rate of 53.33%, and effectiveness has scored an average rate of 37.40%. Figure 4a–c represents the perceived usability results for SSB.

Similarly, in the "Gamified Music Steps" questionnaire, 56.66% of participants showed positive responses on music applications that interface is user-friendly; therefore, the average rate of strongly agreed is 44.81%. 73.33% of the total found GMS entertaining for physical activities, showing the system's average effectiveness rate of around 63.70%. Lastly, 86.66% of participants enjoyed the exercise using music application; therefore, the average satisfaction rate is 67.22%, the highest among the other two factors. Figure 5a–c represents the perceived usability results for "Gamified Music Steps".

Our results indicate that the excitement with exercise has a positive effect on the physical health of people. Overall, the system positively impacted participants, and they enjoyed the session. The study suggested motivating and engaging people to improve their health by doing such physical activities is essential. Easy-to-use interfaces help to keep individuals interested in the program. GMSSB could provide training to help maintain fitness and decrease health issues and risks.

5. Conclusions

The fourth leading cause of death worldwide is physical inactivity, which negatively impacts the quality of life, community welfare, national growth, and the economy. A nation's growth and development depend heavily on a healthy youth population, but fitness management trends are eroding over time. In contrast, PA offers many advantages, but fewer people might decide to participate, raising the physical inactivity of the societies with time. We hypothesize that the lack of entertainment during exercising, effort, and individual financial circumstances are the reasons for the lack of PA in society. In this work, we proposed a cost-effective solution to improve the PA in the community using a digital device (hardware-software symmetry) containing gamified music and a simple step box with small electronics connected via Bluetooth. This study aims to demonstrate how a GMSSB enables participants to participate in PA energetically. For three days, participants (N = 90) engaged in daily 20 min exercise sessions. Efficiency, effectiveness, and satisfaction were evaluated following exercise sessions using a 5-point Likert scale. The results indicate that GMSSB improved participant satisfaction, efficiency, and effectiveness, motivating participants to engage in PA. On the proposed step box, the PA was discovered to have significantly increased with ease and satisfaction of the users. As the lack of PA is extensively growing worldwide, we believe that the proposed GMSSB will assist in overcoming these difficulties and inspire society to engage in PA.

Author Contributions: Conceptualization, B.A. and C.I.; methodology, B.A.; software, B.A. and C.I.; validation, B.A. and C.I.; formal analysis, B.A., H.A.P. and C.I.; investigation, B.A. and C.I.; resources, B.A. and C.I.; data curation, B.A., H.A.P., S.K. and C.I.; writing—original draft preparation, B.A.; writing—review and editing, B.A., H.A.P., S.K. and C.I.; visualization, B.A., H.A.P., S.K. and C.I.; supervision, C.I.; project administration, C.I.; funding acquisition, C.I. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is available from the corresponding author upon request.

Conflicts of Interest: The authors declare no conflict of interest.

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