Journal of Education and Learning (EduLearn)
Vol. 20, No. 4, November 2026, pp. 2642~2651
ISSN: 2089-9823, DOI: 10.11591/edulearn.v20i4.23471

Enhancing motivation in physical education through physical computing for obesity prevention: a preliminary exploratory study

Johny Ling Pik Neng[1], Nor Hafeizah Hassan[2], Raja Rina Raja Ikram[2], Ivy Ting Wei Wei[1], Noradilah Omar[3], Nurul A. Emran[2], Haw Yuan Kang[2]
[1]Sarawak State Education Department, Ministry of Education, Putrajaya, Malaysia
[2]Department of Software Engineering, Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia
[3]Malacca State Education Department, Ministry of Education, Putrajaya, Malaysia

Article Info

Article history:

Received Oct 3, 2024
Revised Apr 19, 2026
Accepted Jun 8, 2026

Keywords:

micro:bit integration
Motivation enhancement
Obesity prevention
Physical computing
Physical education

ABSTRACT

Addressing the challenge of sustaining student motivation in physical education (PE), this preliminary exploratory study examines the feasibility and motivational effects of integrating physical computing into PE activities using the micro:bit device. With only three primary school students participating in each experiment, this study used a quasi-experiment design to evaluate and compare students' performance on three different physical activities: hula hoop jumps, shuttle runs, and sit-ups, with and without physical computing integration. The physical computing tool used here is micro:bit, which provides gamified and real-time feedback to students through visual and auditory signals to improve their interest and engagement in physical activities. The completion times for all physical activities were recorded manually and compared to evaluate performance improvements. From this study's initial findings, physical computing integration can improve students' interest and performance in physical activities. Among those three activities, shuttle runs showed the highest performance improvement, up to 21.36%. That result supports the fact this study provides meaningful insights into the potential of physical computing to improve PE activities and prevent obesity. This study's focus on feasibility and application in real-world settings provides a solid foundation for further research on related fields and it's promoting an active and healthy lifestyles among children.

Corresponding Author:

Raja Rina Raja Ikram
Department of Software Engineering, Faculty of Information and Communication Technology
Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya, 76100 Durian Tunggal Melaka, Malaysia
Email: raja.rina@utem.edu.my

1. INTRODUCTION

As technology becomes a trend nowadays, it also becomes a key to transforming the educational system, especially physical education (PE) in our case. With the increasing demand of physical computing, educators are using innovative and creative strategies to make PE more interactive and exciting [1]. In order to motivate the students in engaging the PE lesson, here we have the importance of innovative strategies like wearable technology. The micro:bit, a mini computing device, has gained popularity as a powerful tool for incorporating technology into the classroom. This device provides students with the opportunity to learn physical computing concepts through physical activities [2]. The micro:bit can be programmed to increase student engagement and motivation by tracking students' movements and providing instant feedback. This change in incorporating technology into PE is transforming the classroom into a dynamic and responsive platform that meets the needs of modern students by incorporating physical activities and computing concepts [3]. This type of technology integration not only enhances student learning but also helps students understand scientific concepts [2].

One such device is the micro:bit, which is not only low cost and programmable but also has the ability to detect movement, thus being able to provide gamified PE experiences. Although the micro: bit has the ability to contribute to the PE sector, its use in PE has not yet been explored [2]. Considering the micro: bit's simplicity and flexibility, it has the potential to completely transform the conventional PE experience into an engaging and data-driven experience for the student, thus increasing their level of performance and motivation [4]. Interactive devices such as the micro:bit also have the ability to track the performance of the student, thus helping them feel a sense of achievement and pushing them to improve further [5], [6].

At the same time, the growing problem of obesity among children has become a point of concern, particularly in countries like Malaysia, where the obesity rates of primary school children have shown a significant increase in recent years [7]. In order to solve this problem, schools need to be more proactive in making PE classes more interactive and fun for the children. Research has shown that children are more likely to engage in physical activities if they find them fun and interesting to do [8], [9]. This will also motivate them to do more and push their limits to be more positive about being healthy and fit [9]. PE classes have become boring for children and do not seem to attract their interest. This has led to a lack of engagement and physical inactivity. The incorporation of technology like micro:bit in PE classes can be one of the key strategies to solve this problem and address the obesity epidemic among children in schools [10], [11]. One of the biggest challenges facing PE classes is sustaining the motivation and engagement of children after they have shown willingness to participate in physical activities. Research by Asare *et al.* [12] points out that by providing real time feedback and progress monitoring can effectively increase the motivation of students' engagement in PE and learning outcomes. Interactive technology like micro:bit has also been seen to have great potential in increasing the motivation of students in PE classes in schools as technology becomes more integrated into the learning process in schools [13]. This can be done using features like data tracking and gamification [14], [15].

According to Sousa *et al.* [16], the use of wearable technology for tracking and increasing physical activity in children and adolescents is increasing, yet its application in school settings is limited to descriptive tracking, not intervention outcomes. Although the application of wearable technology for movement tracking and increasing physical activity is considered an important tool for the assessment of movement and increasing physical activity behaviors, the potential effect of its application on PE efficiency has not yet been explored in practical settings. The application of wearable technology has been conducted by Seçkin *et al*. [17], which is researching the application of wearable technology in various sports. However, the research is not specific to PE or the micro:bit, it is focusing on general devices instead. There is also another research by Almusawi *et al*. [18] analyzing the application of wearable technology in the education sector, but it is focusing on devices such as smartwatches and virtual reality (VR), yet not for PE or the micro:bit either. In addition to this, research on exergaming and wearables in PE has shown positive effects on students' activity levels, especially for inactive students [19]. However, there is no clear indication of whether exergaming and wearables can improve the quality of PE experiences for students. This is an area that needs further research on how devices such as micro:bit can be used to improve not only participation but also to improve the quality of PE experiences for students. Another aspect that has shown to greatly influence the integration of wearable technology in PE is teacher readiness and attitude. Almusawi *et al.* [20] has shown that teacher readiness is influenced by factors such as attitude, convenience, and organizational support, which is crucial for the integration of wearable technology in PE. However, there is very little research on how devices such as micro:bit can be used to improve PE experiences for students.

Furthermore, Marttinen *et al.* [21] found that teachers prefer to use wearable technologies that enhance traditional PE programs instead of replacing them. This indicates that there is a possibility that the use of wearable technology in PE can be influenced by teacher philosophy and school resource availability. Feedback is another area that has been proven to improve learning outcomes in PE through the use of wearable technology. For instance, Lin *et al.* [22] used the watching, imitating, self-examining, enhancing, and repeating or WISER model in badminton classes and found that students who received multiple types of feedback through wearable technology significantly performed better compared to those who used traditional teaching methods. Research on wearable monitoring systems has shown that real-time physiological feedback can enhance responsiveness and effectiveness, as demonstrated in a study where a neck-worn sensor detected critical changes in vital signs 12.6 seconds earlier than a traditional system [23]. User acceptance is another critical factor in the success of wearable technology in PE. Another research on wearable soft robotics highlights the importance of designing systems that accommodate human movement and ensure comfort, which can enhance adoption and engagement in educational settings [24]. Another study by Xu *et al.* [25] also investigated how college students' acceptance of wearable devices, such as smart bracelets, mediates their effectiveness in improving physical performance [25]. His findings indicated that acceptance significantly boosted the devices' effectiveness, enhancing improvements in metrics such as speed and endurance [25]. This study seeks to bridge that gap by investigating how a programmable device can improve learning outcomes in PE through active enhancement of motivation and efficiency.

2. METHOD

For this study, a preliminary exploratory method was used to assess the role of physical computing in enhancing motivation in PE. The experiment was conducted on three students who were randomly picked from a PE class during a scheduled lesson. The reason for only three participants being used for this study is because this is only a preliminary experiment and three is enough for observation and testing the efficiency of micro:bit in real-life situations.

The major instrument used was the micro:bit, a programmable microcontroller equipped with an accelerometer for tracking and counting exercises. Completion times for each exercise were measured using a stopwatch, with shorter times indicating greater motivation. Both the stopwatch data and micro:bit activity counts were reviewed to ensure that only valid completed sets of motions were included in the analysis. Table 1 lists all instruments used during the experiment. No surveys or self-report instruments were employed, focusing solely on objective, observable measures of performance.

Table 1. List of instruments

Instrument	Description	Quantity
micro:bit	The main instrument for detecting and counting physical activity	3
Stopwatch	Instrument for recording the time taken to complete the exercises	1

The low sample size also makes it easier to control the conditions, thus allowing the study to concentrate on the micro:bit technology and the effect on the performance of the individuals [26]. Furthermore, the choice of using three participants in the study strikes the right balance between the data that can be obtained and the logistics of conducting the experiment during the PE lesson [12]. Lastly, the use of the small group also helps the participants interact and collaborate with each other during the physical activities, which has been proven to increase the level of motivation through social support and competition [6], [10]. Small sample sizes are common and acceptable in exploratory studies, especially in the context of the classroom due to the constraints that are involved [27].

The physical activities included hula hoop jumping, shuttle run, and sit-ups. These activities were chosen based on the suitability of the activities for school-going children and the relevance of the activities to the major components of physical fitness. The micro:bit device was used to create a program that could act as a motion sensor and a counter, which could identify the movement patterns of the activities and provide real-time feedback to the participant. The participant was asked to perform the exercise of choice with and without the micro:bit device, and the time taken to complete the exercise was noted by the researcher.

2.1. Plyometric exercises-jumping through hula hoops

In this activity, the micro:bit was pre-programmed to show the number of jumps made by the participants, similar to how a pedometer works. The micro:bit counted the number of times the participant jumped by using its built-in accelerometer. The micro:bit was attached firmly to the ankle of the participant, ensuring accurate detection of the up-and-down movement along the Y-axis. A threshold was also set for the micro:bit to detect the acceleration, thus ensuring accurate counting of the number of jumps made by the participant and giving feedback by making a beep sound after each count. Plyometric activities are known to improve the performance of the human body, as they are used to increase the power of the muscles [28]. The main objective of the activity was to measure the time taken by the participants to complete the predetermined 24 hula hoop jumps. Figure 1 shows the pattern of the jumping hoops.

2.2. Short distance shuttle run

For short distance shuttle run exercises, the setting is the same as the previous activity. It was conducted by asking each participant to run a 30-meter sprint five times. This is equivalent to running 150 meters in total. The short distance shuttle run requires each participant to move back and forth between two points. Shuttle runs are often used as an instrument of measuring cardiovascular endurance as well as anaerobic fitness because they require rapid acceleration, deceleration, and directional changes over short distances [10]. In order to increase the motivation of each participant, it was required of them to compete with each other during the task. The layout of the short distance shuttle run is shown in Figure 2.

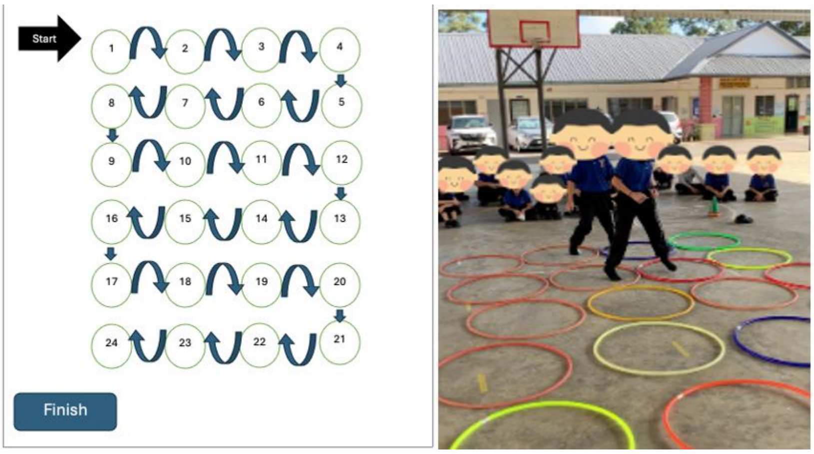

Figure 1. The sequence of jumping through hula hoops from the starting point to the finish line

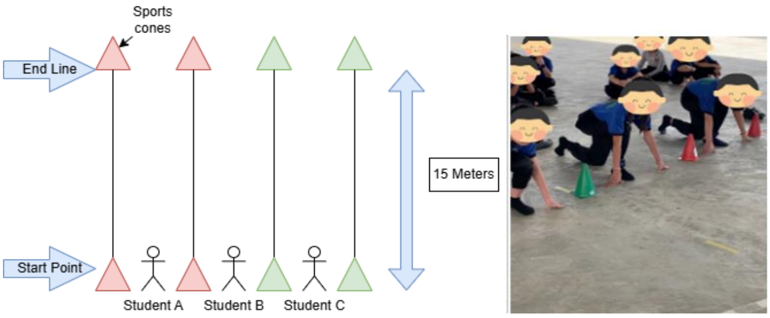

Figure 2. The pathway for Students A, B, and C involves performing a shuttle run

2.3. Conventional sit-ups

The third exercise required participants to perform proper form sit-ups, with the objective of completing 10 repetitions. Proper form in this exercise entails the participant lying on their back with their knees bent and feet flat on the ground, with hands placed on the chest or behind the head to prevent back strain [29]. The micro:bit device was strapped on the forehead, chest, or wrist of the participant and employed to detect changes in the orientation of the body. As the participant changes their position from lying down to sitting up and then back down, the micro:bit device, which has the capacity to detect angular motion using the accelerometer, records the complete motion of the participant in the sit-up exercise. A photo of students performing the sit-up exercise is presented in Figure 3.

Figure 3. The photo was captured while students were engaged in performing sit-ups

3. RESULTS AND DISCUSSION

This research studies the significance of physical computing in boosting the level of motivation and engagement of students in PE activities by using micro:bit as the main tool. The research was based on an experiment with three types of exercises, including plyometric, cardiovascular, and muscular endurance. From Table 2, it can be seen that the time spent on all three exercises decreased after the students used the micro:bit device. This shows that the device has a positive effect on the efficiency of exercises. This can be explained by the motivational factor of technology, which helps students finish exercises efficiently [30].

Table 2. Time taken for 3 exercises without and with wearing micro:bit

Aerobic exercises	Evaluation method	Without micro:bit	With micro:bit
Plyometric exercise- hula hoop jump	Time taken to finish the jumping 24 hula-hoops	Student A: 2 mins 54 sec Student B: 2 mins 31 sec Student C: 2 mins 38 sec	Student A: 2 mins 32 sec Student B: 2 mins 18 sec Student C: 2 mins 21 sec
Short distance shuttle run	Times taken to finish 5 rounds 30 m shuttle run	Student A: 1 min 43 sec Student B: 2 mins 3 sec Student C: 1 min 53 sec	Student A: 1 min 21 sec Student B: 1 min 45 sec Student C: 1 min 32 sec
Conventional sit-up	Times taken to get 10 times sit-up with (TICK) correct posture	Student A: 1 min 35 sec Student B: 1 min 56 sec Student C: 1 min 4 sec	Student A: 1 min 21 sec Student B: 1 min 39 sec Student C: 1 min 2 sec

From Figure 4, it is clear that the time taken to complete 24 hula hoop jumps is reduced for students wearing the micro:bit. All three students showed a reduction in time taken to complete the task after wearing the micro:bit. For instance, Student A showed a reduction of 12.64%, while Student B showed an 8.61% reduction, and Student C showed a reduction of 10.76% in time taken to complete the task. This shows that the integration of the micro:bit in the activity not only helped students track their performance but also motivated them to complete the exercise efficiently. The reduction also suggests that there is an element of gamification that motivates students to perform better. Gamification is known to be effective in motivating students to perform better in educational and physical activities because of its elements of game design that include points and competition and use of feedback to improve learning and engagement [31].

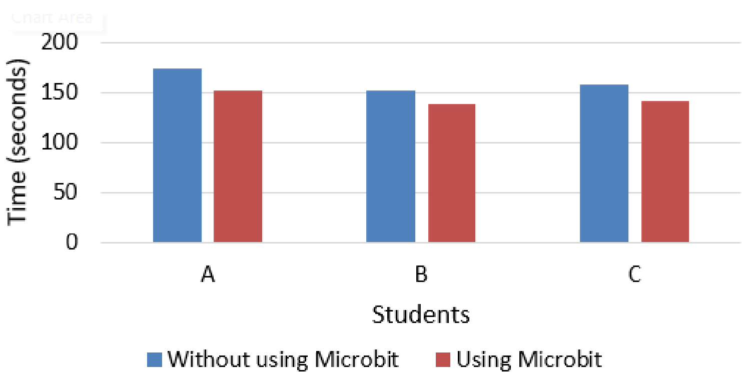

Figure 4. Time taken for plyometric exercise (hula-hoops)

Figure 5 shows that participants using the micro:bit completed their shuttle runs in a shorter time. From the results obtained using the shuttle run, it is clear that there is an improvement in performance when using the micro:bit. Student A shows a notable improvement in performance. In this case, Student A shows a 21.36% improvement in performance. On the other hand, student B shows a 14.63% improvement. In addition, Student C shows an 18.58% improvement.

The real time feedback given by micro:bit during exercise helps students push themselves to their physical limits, as they are aware of their performance at every given time. This awareness helps students regulate their performance during the shuttle run, allowing them to adjust their pace, stamina, and strategy, which leads to faster completion times [30]. This continuous feedback also strengthens students' desire to improve with each trial, which can be linked to the gamification features of the micro:bit, as it transforms physical activities into measurable and goal-oriented tasks [32].

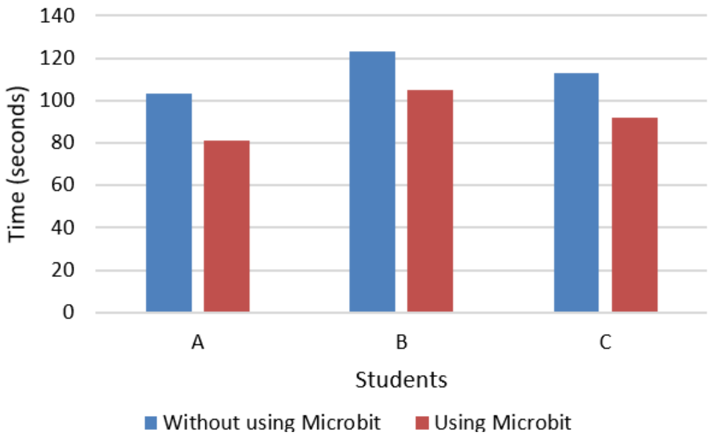

Figure 5. Time taken for a short-distance shuttle run

Figure 6 illustrates the time taken for the conventional sit-up exercise. In the conventional sit-up exercise, it is observed that the time reduction for completing 10 repetitions in correct posture shows a positive trend for all the students after wearing the micro:bit. The time taken by Student A has improved by 14.74%. Similarly, for Student B, it is observed that the time has improved by 14.66%. In contrast, for Student C there is only improvement of 3.12%, possibly due to different physique capabilities. The results from this research study validate the findings by Gu [30] regarding the efficiency and accuracy achieved by students while using sensor-based physical computing tools in PE. Similarly, Liu [5] and Cao [32] emphasized the importance of physical computing tools in increasing the level of enjoyment in PE settings. The findings from this research study also validate the importance given by Barkley *et al.* [33] regarding increasing efficiency in PE settings by using digital tools for scoring and providing feedback to the students, as observed in this research study through the beeps produced by step count and accelerometer.

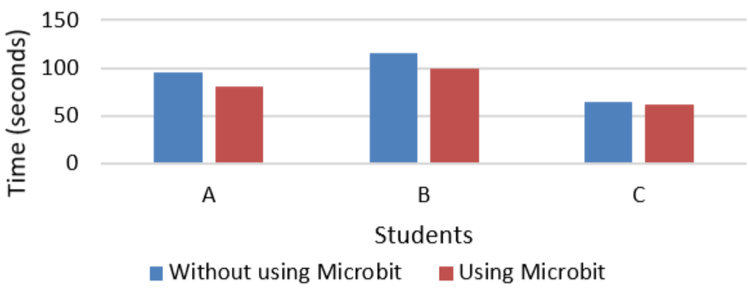

Figure 6. Time taken for conventional sit-ups

Moreover, the research adds to the emerging line of research arguing that autonomy and competence, as proposed by Deci and Ryan's self-determination theory [34], are promoted by the provision of instant and personalized feedback. In terms of the research methodology, it is accepted that the sample size is relatively small. However, as Bakker [35] argues, small-scale design-based research is particularly appropriate in the investigation of the feasibility of educational technology studies, even if the sample size is small. Not only that, this research approach is underpinned by simulation studies in high-dimensional research, which validate the statistical validity of small-scale experiments using repeated measures or multivariate statistical analysis. Finally, this research approach also illustrates the practical viability of the micro:bit in real-life educational settings without the need for significant infrastructure, which supports the research by Marra *et al.* [36] on the flexibility of wearable sensor technology in educational settings.

In terms of its contribution to the larger picture, the study contributes to the field in a very practical sense in terms of its potential to improve physical engagement and reduce sedentary behaviors in students. This is especially relevant in schools where resources are limited, making more sophisticated fitness trackers less feasible. This study resonates with Sun *et al.* [37], where it emphasized the importance of using more scalable and affordable technologies in the PE curriculum. The use of feedback technologies like beep sounds and motion count displays also resonates with the use of formative feedback in PE, as emphasized in the assessment for learning approach in PE [38].

For theoretical terms, the study expands the work on embodied learning in the context of digital self-regulation in education. The use of the micro:bit to track record of body movement in a visual form also resonates with theories of embodied cognition in learning [39]. The study also shows that wearable physical computing can also potentially support national initiatives in terms of national health and PE policies, like Malaysia's National Physical Fitness Standard, also known as SEGAK. Policymakers can potentially use the micro:bit to support national initiatives in terms of digital literacy and physical activity at the same time, which resonates with other national initiatives in terms of digital literacy in Malaysia, like the STEM4ALL movement [40], which combines computing, health, and environmental learning.

4. CONCLUSION

Other than all those benefits and impacts, this research has some limitations as well, particularly in terms of the small sample group and context. Future research will prepare an enough sample group and materials to explore diverse contexts and strengthen the research results. Schools can transform conventional physical exercises and activities into a more engaging experience through gamification concepts by using physical computing tools like the micro:bit. It is a promising factor to consider in order to address the growing concerns over childhood obesity while promoting a healthy lifestyle among students by increasing their interest in PE.

ACKNOWLEDGMENTS

We would like to express our gratitude to the Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka for supporting the publication of this paper.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Johny Ling Pik Neng	✓	✓	✓	✓	✓	✓		✓	✓				✓	
Nor Hafeizah Hassan	✓					✓				✓				
Raja Rina Raja Ikram	✓					✓	✓			✓		✓	✓	
Ivy Ting Wei Wei	✓			✓		✓				✓				
Noradilah Omar	✓				✓					✓				
Nurul A. Emran	✓					✓				✓				
Haw Yuan Kang	✓	✓				✓				✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

All data collected were limited to anonymized task completion times observed during the intervention and not publicly available, but summary results have been presented in this study.

REFERENCES

[1] A. Martín-Rodríguez and R. Madrigal-Cerezo, “Technology-enhanced pedagogy in physical education: bridging engagement, learning, and lifelong activity,” *Education Sciences*, vol. 15, no. 4, p. 409, Mar. 2025, doi: 10.3390/educsci15040409.

[2] K. T. Quyen, N. Van Bien, and N. A. Thuan, “Micro: bit in science education: a systematic review,” *Jurnal Penelitian dan Pembelajaran IPA*, vol. 9, no. 1, p. 1, 2023, doi: 10.30870/jppi.v9i1.19491.

[3] M. Cápay and N. Klimová, “Engage your students via physical computing!” in *2019 IEEE Global Engineering Education Conference (EDUCON)*, doi: 10.1109/EDUCON.2019.8725101.

[4] D. Mariana Lolowang, F. Ihsan, N. Piri, E. Emor Kumenap, and F. Alfrets Makadada, “Innovative teaching methods in physical fitness education: integrating technology and gamification to improve student engagement-a systematic review,” *Retos*, vol. 68, pp. 1148–1163, Jun. 2025, doi: 10.47197/retos.v68.116064.

[5] J. Liu, “Implementation of embedded microprocessor in optimal teaching of physical health in the internet era,” *Wireless Communications and Mobile Computing*, vol. 2022, no. 1, 2022, doi: 10.1155/2022/4193644.

[6] H. A. Jamhour, “Impact of peer-based cooperative learning in physical education on physical fitness and learning motivation among secondary school students,” *Retos*, vol. 76, pp. 421–435, Mar. 2026, doi: 10.47197/retos.v76.118352.

[7] R. Salway *et al.*, “Predicting higher child BMI z-score and obesity incidence in Malaysia: a longitudinal analysis of a dynamic cohort study,” *BMC Public Health*, vol. 24, no. 1, 2024, doi: 10.1186/s12889-024-18917-9.

[8] A. Carriedo, J. A. Cecchini, A. Méndez-Giménez, D. Sanabrias-Moreno, and C. González, “Impact of teachers’ autonomy support in students’ basic psychological needs, intrinsic motivation and moderate-to-vigorous physical activity,” *Children*, vol. 10, no. 3, p. 489, 2023, doi: 10.3390/children10030489.

[9] C. J. Culajara, “Enhancing students’ learning performance in physical education through the use of a mobile application with game-based learning approach,” *Physical Education and Sports: Studies and Research*, vol. 2, no. 1, pp. 1–9, 2023, doi: 10.56003/pessr.v2i1.178.

[10] I. Marwan, I. Wahidah, and N. Rohayati, “Development of the snake and leader game model to improve physical motor in early childhood,” *Journal of SPORT (Sport, Physical Education, Organization, Recreation, and Training)*, vol. 8, no. 1, pp. 297–312, 2024, doi: 10.37058/sport.v8i1.10289.

[11] M. Mılıć, D. Kukuljan, and E. K. Kurelovıć,, “Micro:bit immplementation in ICT education,” *The Eurasia Proceedings of Educational & Social Sciences (EPESS)*, vol. 11, pp. 128–133, 2018.

[12] S. Asare, S. A. Kyenkyehene, and M. K. Emmanuel, “Interactive technology in physical education classroom: a case of a Ghanaian College of Education,” *American Journal of Education and Information Technology*, 2023, doi: 10.11648/j.ajeit.20230702.11.

[13] P. Luarn, C. C. Chen, and Y. P. Chiu, “The influence of gamification elements in educational environments,” *International Journal of Game-Based Learning*, vol. 13, no. 1, pp. 1–12, 2023, doi: 10.4018/IJGBL.323446.

[14] M. Papastergiou, P. Natsis, N. Vernadakis, and P. Antoniou, “Introducing tablets and a mobile fitness application into primary school physical education,” *Education and Information Technologies*, vol. 26, no. 1, 2021, doi: 10.1007/s10639-020-10289-y.

[15] N. C. C. Brown, S. Sentance, T. Crick, and S. Humphreys, “Restart: the resurgence of computer science in UK schools,” *ACM Transactions on Computing Education*, vol. 14, no. 2, pp. 1–22, 2014, doi: 10.1145/2602484.

[16] A. C. Sousa, S. N. Ferrinho, and B. Travassos, “The use of wearable technologies in the assessment of physical activity in preschool- and school-age youth: systematic review,” *International Journal of Environmental Research and Public Health*, vol. 20, no. 4, p. 3402, 2023, doi: 10.3390/ijerph20043402.

[17] A. Ç. Seçkin, B. Ateş, and M. Seçkin, “Review on wearable technology in sports: concepts, challenges and opportunities,” *Applied Sciences (Switzerland)*, vol. 13, no. 18, p. 10399, 2023, doi: 10.3390/app131810399.

[18] H. A. Almusawi, C. M. Durugbo, and A. M. Bugawa, “Wearable technology in education: a systematic review,” in *IEEE Transactions on Learning Technologies*, vol. 14, no. 4, pp. 540–554, 2021, doi: 10.1109/TLT.2021.3107459.

[19] M. D. Ahmed and W. C. W. Leung, “Using wearable devices to enhance quality of physical education for students,” *Strategies*, vol. 34, no. 2, pp. 54–56, 2021, doi: 10.1080/08924562.2021.1867458.

[20] H. A. Almusawi, C. M. Durugbo, and A. M. Bugawa, “Innovation in physical education: teachers’ perspectives on readiness for wearable technology integration,” *Computers and Education*, vol. 167, p. 104185, 2021, doi: 10.1016/j.compedu.2021.104185.

[21] R. Marttinen, D. Landi, R. N. Fredrick, and S. Silverman, “Wearable digital technology in PE: advantages, barriers, and teachers’ ideologies,” *Journal of Teaching in Physical Education*, vol. 39, no. 2, pp. 227–235, 2020, doi: 10.1123/JTPE.2018-0240.

[22] K. C. Lin, H. C. Hung, and N. S. Chen, “The effect of wearable technology on badminton learning performance: a multiple feedback WISER model in physical education,” *Smart Learning Environments*, vol. 10, no. 1, 2023, doi: 10.1186/s40561-023-00247-9.

[23] S. Singh, M. Kozlowski, I. Garcia-Lopez, Z. Jiang, and E. Rodriguez-Villegas, “Proof of concept of a novel neck-situated wearable PPG system for continuous physiological monitoring,” in *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1–9, 2021, doi: 10.1109/TIM.2021.3083415.

[24] M. Zhu, S. Biswas, S. I. Dinulescu, N. Kastor, E. W. Hawkes, and Y. Visell, “Soft, wearable robotics and haptics: technologies, trends, and emerging applications,” in *Proceedings of the IEEE*, vol. 110, no. 2, 2022, doi: 10.1109/JPROC.2021.3140049.

[25] Y. Xu, J. Peng, F. Jing, and H. Ren, “From wearables to performance: how acceptance of IoT devices influences physical education results in college students,” *Scientific Reports*, vol. 14, no. 1, 2024, doi: 10.1038/s41598-024-75071-3.

[26] W. Wang, “Research on the current situation and countermeasures of the integration of information technology and physical education,” *Frontiers in Educational Research*, vol. 5, no. 14, 2022, doi: 10.25236/FER.2022.051418.

[27] E. van Teijlingen and V. Hundley, “The importance of pilot studies,” *Nursing standard (Royal College of Nursing (Great Britain) : 1987)*, vol. 16, no. 40, pp. 33–36, 2002, doi: 10.7748/ns2002.06.16.40.33.c3214.

[28] S. Sentance, L. Yeomans, J. Waite, and E. MacLeod, “Teaching with physical computing devices: the BBC micro:bit initiative,” in *Proceedings of the 12th Workshop on Primary and Secondary Computing Education*, 2017, doi: 10.1145/3137065.3137083.

[29] Z. Shi, Z. Zhao, J. Chen, and G. Cheng, “Research on sit-up counting method and system based on human skeleton key point detection,” *Quality in Sport*, vol. 24, p. 55408, 2024, doi: 10.12775/qs.2024.24.55408.

[30] Y. Gu, “Deep integration of physical education and multimedia technology using internet of things technology,” *Wireless Communications and Mobile Computing*, vol. 2022, no. 1, 2022, doi: 10.1155/2022/2556142.

[31] P. Luarn, C. C. Chen, and Y. P. Chiu, “Enhancing intrinsic learning motivation through gamification: a self-determination theory perspective,” *International Journal of Information and Learning Technology*, vol. 40, no. 5, pp. 413–424, 2023, doi: 10.1108/IJILT-07-2022-0145.

[32] T. Cao, “A review of research on the integration of information technology and physical education curriculum abroad,” in *2021 International Conference on Information Technology and Contemporary Sports (TCS)*, 2021, doi: 10.1109/TCS52929.2021.00033.

[33] J. E. Barkley, A. Lepp, A. Santo, E. Glickman, and B. Dowdell, “The relationship between fitness app use and physical activity behavior is mediated by exercise identity,” *Computers in Human Behavior*, vol. 108, 2020, doi: 10.1016/j.chb.2020.106313.

[34] L. Legault, "Self-determination theory," in *Encyclopedia of Personality and Individual Differences*, Springer International Publishing, 2017, doi: 10.1007/978-3-319-28099-8_1162-1.
[35] A. Bakker, *Design research in education: a practical guide for early career researchers*. Routledge, 2018, doi: 10.4324/9780203701010.
[36] F. Marra *et al.*, "Study, design and development of biocompatible graphene-based piezoresistive wearable sensors for human monitoring," *IEEE Sensors Journal*, vol. 24, no. 5, 2024, doi: 10.1109/JSEN.2023.3336518.
[37] Z. Sun, S. N. Kadry, and S. Krishnamoorthy, "Internet of things-assisted advanced dynamic information processing system for physical education system," *Technology and Health Care*, vol. 29, no. 6, pp. 1263–1275, 2021, doi: 10.3233/THC-213005.
[38] L. S. Chng and J. Lund, "Assessment for learning in physical education: the what, why and how," *Journal of Physical Education, Recreation and Dance*, vol. 89, no. 8, pp. 29–34, 2018, doi: 10.1080/07303084.2018.1503119.
[39] L. Foglia and R. A. Wilson, "Embodied cognition," *Wiley Interdisciplinary Reviews: Cognitive Science*, vol. 4, no. 3, pp. 319–325, 2013, doi: 10.1002/wcs.1226.
[40] R. Idris and J. Bacotang, "Exploring STEM education trends in Malaysia: building a talent pool for Industrial Revolution 4.0 and Society 5.0," *International Journal of Academic Research in Progressive Education and Development*, vol. 12, no. 2, 2023, doi: 10.6007/ijarped/v12-i2/16825.

BIOGRAPHIES OF AUTHORS

Johny Ling Pik Neng is a primary school teacher with a master's degree in Educational Management, passionate about integrating sports into education. He has served as the master trainer for outdoor education at the district level. He currently serves as a ping pong or table tennis coach and participated as an assistant technical officer for the 2024 SUKMA Sarawak. In 2024, he was officially appointed as the contingent coach for the Sarawak boys' under-18 team during the Malaysian School Sports Council (MSSM) and Sarawak School Sports Council (MSSS) Table Tennis Championships. His commitment lies in nurturing young athletes and fostering their growth, instilling values of teamwork, personal well-being, and perseverance that extends beyond sports. He can be contacted at email: johnyling@gmail.com.

Nor Hafeizah Hassan is a dedicated senior lecturer and head of the Department of Software Engineering. With a Ph.D. in Computer Science and over 20 years of teaching experience, she is passionate about fostering an engaging learning environment that promotes critical thinking and innovation. Her focuses not only in software development matters but also have deep interest in community educational trends and technology. As a leader, her committed to enhancing the department's curriculum and supporting faculty and students alike in achieving their goals. She can be contacted at email: nor_hafeizah@utem.edu.my.

Raja Rina Raja Ikram is an accomplished academic and researcher with a deep interest in integrating technology into education, particularly in the fields of physical computing and STEM education. She has actively contributed to education technology in TVET and is passionately involved in knowledge transfer programs to the community. Her research spans multiple domains, including education technology in TVET, health informatics and software engineering. She can be contacted at email: raja.rina@utem.edu.my.

Ivy Ting Wei Wei is an educator specializing in teaching design and technology in primary schools, with a focus on programming such as micro:bit, MakeCode, and Scratch. She is deeply committed to promoting STEM education, actively encouraging students to participate in competitions like junior innovate competition. She has also conducted research on increasing teachers' knowledge in programming, helping to bridge the gap between educators and emerging technologies. Through her work, she empowers both students and teachers to engage with and explore the world of coding and technology. She can be contacted at email: ivypriscilla2022@gmail.com.

Noradilah Omar is an English teacher currently teaching at SK Durian Tunggal, Melaka. She has 12 years of teaching experience in primary school, as well as experience as Master Trainer for the primary school English CEFR-aligned syllabus. She also has a master's degree in TESL from UiTM and is passionate about finding innovative ways to improve the learning experience for her pupils. She can be contacted at email: noradilahomar@gmail.com.

Nurul A. Emran is an associate professor at the Universiti Teknikal Malaysia Melaka, specializing in the field of database systems. With a strong passion for education, she brings extensive expertise in teaching both undergraduate and postgraduate courses, including database administration, it and database security, database design, multimedia databases, and mobile databases. She also leads courses on advanced database principles, big data analytics, and current trends in database technology, ensuring that her students are equipped with the latest industry knowledge and skills. She is highly committed to pedagogical excellence, continuously integrating cutting-edge technologies and hands-on experiences in her teaching. She can be contacted at email: nurulakmar@utem.edu.my.

Haw Yuan Kang is a Ph.D. student specializing in software engineering. He completed both a diploma in computer science and a degree in Software Development at Universiti Teknikal Malaysia Melaka, achieving first-class honors for the degree. With a strong foundation in software engineering, his research interests focus on optimizing algorithms and advancing methodologies for test suite reduction, aiming to contribute valuable insights and innovations to the field. He can be contacted at email: hawyuankang11@gmail.com.