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Development of an interdisciplinary educational resource to foster active and motivated learning

FRANCISCO JAVIER SAINZ MUÑOZ[1]
https://orcid.org/0009-0006-1013-248X
SALVADOR BAENA MORALES[2]
https://orcid.org/0000-0002-6722-3714
ALBERTO FERRIZ VALERO[3]
https://orcid.org/0000-0001-8206-4152

University of Alicante, Spain
Corresponding author: alberto.ferriz@ua.es

Abstract

This article presents the design and implementation of *Kahbom*, a low-cost, game-based device intended to foster active and motivated learning. The study follows a descriptive qualitative design with 53 upper-secondary students (16–17 years old) from a public school in Spain. The device combines physical levers, light and sound feedback, and time-limited semantic challenges in which small groups must identify an impostor word to "defuse the bomb." Data were collected through an open-ended questionnaire and analysed using ATLAS.ti. Five main categories emerged from students' perceptions: positive acceptance, motivation, exploration, interest, and innovation. Results show high levels of enjoyment, cooperative engagement, and curiosity, as well as sustained attention during the activity. The discussion highlights the potential of hybrid ludic-technological resources for formative assessment, inclusive practice, and interdisciplinary learning, and outlines future lines of research to examine long-term motivational and learning effects.

Introduction

The importance of information and communication technologies (ICTs) in education is increasingly evident in the daily life of classrooms, both as a vehicle for learning and in specific subjects such as computer science or technology that are responsible for providing students with learning situations based on emerging digital tools (Balalle, 2024; Getenet et al., 2024). In Physical Education, however, teachers do not always know how to put ICTs at the service of education and make good use of them in the classroom, thereby failing to take full advantage of the benefits of these tools (Díaz Barahona, 2012). In addition, technological tools often do not introduce substantial innovations in Physical Education classes, even though teachers perceive that their implementation would be highly beneficial (Fernández-Espínola & Moreno, 2015).

Game-based learning and gamification are resources that teachers are increasingly using, and this is also seen in the growing number of studies in recent years with this theme (Kim & Castelli, 2021; Li et al., 2023; Manzano-León et al., 2021). In addition, this gamification coupled with ICTs results in greater motivation in students and greater involvement in the proposed activities (Kim & Castelli, 2021; Li et al., 2023; Quintero González et al., 2018). Although physical education is a subject where the game is present in the classes, the same does not happen with ICT tools, since in physical education classes we find handicaps to make use of them, this is due to the use of outdoor tracks or pavilions, where there is not always internet connectivity and also in the yard we cannot connect to the electricity network, therefore, the use of ICTs in the subject is limited to ICT tools that do not depend on either internet connection or electricity connection for their use. In addition to these requirements, the tools must also be inclusive, so that students with disabilities can use them like any other student and not only as assistance tools (Fernández Batanero et al., 2021; Lynch et al., 2024; Samaniego López et al., 2025; Zárate-Rueda et al., 2025).

To introduce these tools, teachers have an ally, novelty. Some authors seek to adhere novelty as a basic psychological need, joining the already established Competence, Autonomy and Relatedness (González-Cutre et al., 2016). It has been shown that proposing novel methodologies and materials in physical education could cause an increase in students' intrinsic motivation (Fernández-Espínola et al., 2019). Teachers should be in constant search and learning about materials that students can visualize as novel and thus improve the learning experience of students, this work is not always well received by the teaching staff, where the older the age, the greater the disinterest and negative attitudes towards the use of ICT tools compared to younger groups of teachers (Díaz Barahona et al., 2018).

The satisfaction of basic psychological needs should be the focus of attention when planning, organizing and selecting educational experiences and materials in order to promote intrinsic motivation in the subject of physical education (Salazar-Ayala & Gastélum-Cuadras, 2020). This intrinsic motivation in students in the face of sports practice contributes to create an intentionality in the adolescent to be physically active in the future (Almagro Torres et al., 2011; García Soler, 2016).

Evaluation is a very important aspect of education—although not the only one—and it should not be used solely as an element of grading, but also endowed with a pedagogical purpose (Schunk & Zimmerman, 1998; Coll & Onrubia, 2002) so that the student can develop in all educational areas and thus see their basic psychological needs fulfilled at the time of evaluation being present. This evaluation process seeks to be formative and collaborative, where students are part of the evaluation process and can through evaluative practice produce improvements in student learning, providing them with autonomy and reflection in the process (Bizarro et al., 2019). One way to involve students in evaluation is to present them with evaluation tools that they can manipulate, use and learn about. ICTs, in addition to innovative elements, can provide evaluation situations that differ from what has been seen so far in a more traditional evaluation and can make the student more aware (Fernández-Espínola et al., 2019) of the evaluation process by having an instantaneous response giving rise to a reflection at the same time. The objective of this descriptive study is to present a proposal for educational material that is inclusive and facilitates a novel learning experience, as well as to offer suggestions for use and activities with this device as an axis in physical education classes for all educational stages.

This work seeks to make a quality proposal where, from the teacher's point of view, students are more motivated to engage in sports practice through a material that promotes cooperation, teamwork and adapts to multiple gamifications to be carried out in the classroom. It also aims to be environmentally friendly, fulfilling the Sustainable Development Goal (SDG) number 12, corresponding to reduction and responsible consumption, of the 2030 agenda of sustainable development goals proposed by the United Nations (UN) among others such as SDG 4, quality education; SDG 5, gender equality and SDG 9, industry, innovation and infrastructure (UN, 2015).

In recent years the study of gamification in education has become increasingly relevant among researchers, defining the search with the terms gamification and education, for the last 5 full years and we find an upward trend in the number of publications collected by these search terms, which implies a greater interest in the scientific community for this area of knowledge in the world of education (Cavus et al., 2023; Li et al., 2023; Manzano-León et al., 2021).

Gamification is an active methodology that consists of introducing playful elements in the classroom by means of some innovative solution where students are actively involved in their learning. The subject of physical education is an environment in which games are present and it is easy to introduce them into the sessions. The aim of this teaching technique is that students perceive an improvement in the satisfaction of their basic psychological needs and an increase in intrinsic motivation while at the same time there is a decrease in demotivation (Ferriz-Valero et al., 2023; Mo et al., 2024; Sotos-Martínez et al., 2022). However, in the literature we also find studies reporting that, at the university level, intrinsic motivation is not modified by the use of gamification, but the grades obtained with respect to a control group are (Ferriz-Valero et al., 2020).

However, gamification not only increases student motivation and grades, but also requires cooperation between group members to achieve common goals. This supports the use of interactive groupings in the context of gamification, where students cooperate with each other for a common goal and dialogue is encouraged in physical education classes. This type of grouping also increases the degree of satisfaction of basic psychological needs, intrinsic motivation and level of theoretical knowledge (Cuartero et al., 2020; Ferriz-Valero et al., 2023). Additionally, it also brings benefits in disruptive situations that occur in the classroom by the students, as behavioural variables such as aggressiveness, irresponsibility, disobedience and disruption of classroom climate are significantly reduced (Ferriz Valero et al., 2019).

Currently, the UN has proposed an agenda for sustainable development, called Agenda 2030. In the creation of the device, some Sustainable Development Goals have been taken into account so that this innovative material complies with and brings this reality closer to the students. Specifically, the SDGs developed are SDG 4, quality education, since through this device the education that students will receive will be improved in vital aspects such as motivation or the satisfaction of basic psychological needs, among others; SDG 5, gender equality, thanks to the groupings and cooperative learning that the material promotes, gender equality will be promoted in physical education classes; (Bofill-Herrero et al., 2022) and SDG 9, industry, innovation and infrastructure; innovation of materials in the classroom helps in the classroom by working on novelty, which can be picked up as a basic psychological need. Moreover, in physical education, self-constructed material is used on numerous occasions and these practices related to SDG 12, sustainable consumption and production, are encouraged in physical education classes.

Therefore, the teachers involved have a high awareness of sustainable development (Baena-Morales et al., 2021; Bofill-Herrero et al., 2022; Ruiz-Navas et al., 2024).

Methods and Materials

Study design

This study follows a descriptive qualitative design aimed at analysing students' perceptions of an educational game-based device (Kahbom) and examining its potential to enhance motivation, engagement, exploration, and active learning within Physical Education lessons. The intervention was implemented in real teaching conditions and integrated into regular class sessions, allowing the analysis to reflect authentic educational dynamics.

Participants

The sample consisted of 53 students enrolled in the first year of Upper Secondary Education (1st Baccalaureate) at a public high school in the province of Alicante (Spain). Two intact groups of the subject Physical Education participated, selected through convenience sampling according to their availability during the study period. Participants were approximately 16 to 17 years old and had previously completed compulsory Physical Education during lower secondary education, ensuring a relatively homogeneous level of experience in group dynamics and cooperative learning tasks. The intervention took place during regular school hours in the sports facilities of the centre, reproducing realistic classroom conditions.

Materials and device description

The central material of the intervention was a teacher-designed game-based device, hereafter referred to as Kahbom (Figure 1). The device consists of:
- A physical base equipped with four levers (representing "cables"),
- Velcro-attached words placed on each lever,
- A light and sound system that activates when the device "explodes".

Among the four words placed on the levers, three belong to the same semantic field, while one acts as the "impostor word". When the incorrect lever is activated, the device produces a symbolic "explosion" using lights and sound feedback. The system also includes a configurable time limit, after which the device activates automatically if the group has not completed the task. The device is portable, low-cost, and does not require an internet connection or external power source, making it suitable for outdoor or non-digital learning environments.

Figure 1. *Material used for the development of the activity*

Procedure

Students were organised into four cooperative groups, each assigned one Kahbom device. The activity required them to identify the impostor word and deactivate the device correctly within a limited time. To achieve this, students searched the space for dispersed word cards, identified those belonging to the same semantic field, determined which word on the device did not appear in the collected set, and avoided activating the lever associated with the impostor word. Activating the correct three levers resulted in successful deactivation, whereas selecting the incorrect word triggered a light-and-sound "explosion".

The activity was designed to promote the active use of an innovative teacher-created device for formative assessment, encourage movement and physical activity through a search-based task, increase engagement and playful involvement, reinforce semantic-field learning across different curricular subjects, and foster cooperative work, shared decision-making, and peer communication. The task took place in the school gymnasium or sports court. Before the session, teachers prepared the devices and distributed ten word cards around the space (Figure 2). Each card derived from or related to the others, forming a coherent semantic network, while one of the words attached to each Kahbom device served as the distractor.

Figure 2. *Two examples of track leaves distributed by space (gym or track)*

Without receiving explicit instructions at the outset, students approached the challenge from a problem-solving perspective, collecting the distributed cards and recording them on a provided sheet (Figure 3). After identifying the complete semantic field, they returned to the device and selected the lever corresponding to the impostor word. A correct selection deactivated the Kahbom, whereas an incorrect one activated the symbolic explosion.

Figure 3. *Two examples of cards provided to students to complete the series of words*

This methodological proposal can be adapted to different educational levels by modifying the number of words and the complexity of the semantic categories. It is grounded in active learning, cooperative work, formative assessment, and problem-solving approaches. Teachers acted as facilitators throughout the process, activating the devices at the start of each round but refraining from intervening in students' decision-making. The spatial search component naturally integrated motor activity into the learning process, reinforcing the physical dimension of the task.

Evaluation instruments

To evaluate students' perceptions, an open-ended ad hoc questionnaire was administered on paper at the end of the third session. The questionnaire included five open items designed to explore:
- The perceived motivational value of the device,
- Its impact on learning and engagement,
- Elements of design that stimulated exploration or interest,
- Students' views on its potential applicability for future gamified activities.

No personal or sensitive data were collected. Each response sheet was assigned a numerical code to preserve anonymity. Paper questionnaires were later digitised for systematic analysis.

The tool was originally created with a specific use in mind, but during its development the broad potential of the device in education became evident, particularly its transversality, as it is applicable to all subjects and open to aesthetic modifications to adapt it to any educational context.

The main operation of the instrument is detailed below and a flowchart of the operation is shown in figure 4.

Figure 4. *Flow diagram of device operation*
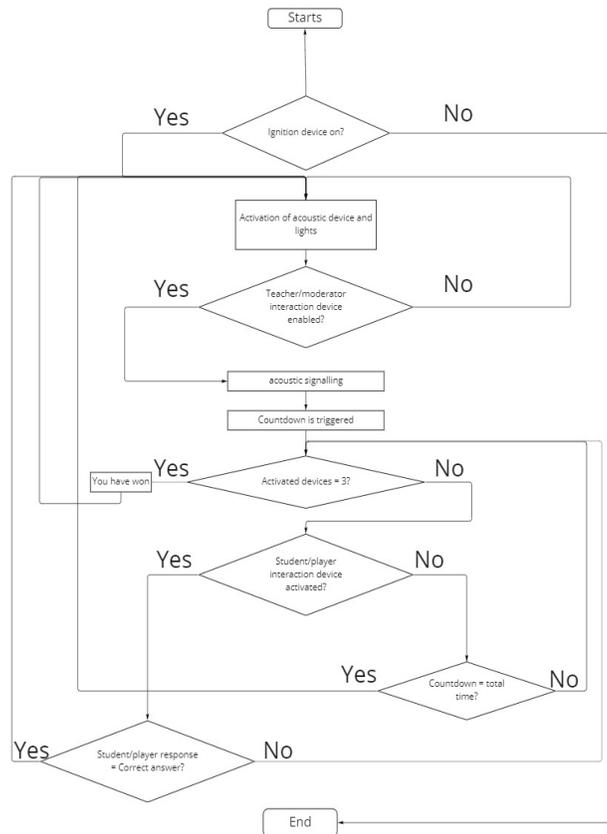
Data Analysis

Data were uploaded to ATLAS.ti and analysed using a systematic qualitative coding protocol. Responses were segmented into units of meaning and categorised using a predefined coding tree structured into dimensions such as motivation, learning, and challenge. Associations between codes were examined through query tools, frequency counts, and co-occurrence analyses, allowing for the identification of recurrent patterns and emerging subthemes. This approach enabled a nuanced interpretation of students' experiences and perceptions.

Results

The qualitative analysis of student responses revealed five main categories, representing the most salient aspects of their experience with the Kahbom device: positive acceptance, motivation, exploration, interest, and innovation.

These categories emerged from the frequency of citations in the coded dataset and reflect the students' perceptions of both the pedagogical value and the emotional impact of the activity. The distribution of categories is presented in Table 1.

Table 1. *Reference records in the category-ordered questionnaire replies*

Category	Frequency (n)	Percentage (%)
Positive acceptance	46	86.79%
Motivation	42	79.25%
Exploration	27	50.94%
Interest	26	49.06%
Innovation	23	43.40%

Positive Acceptance (46 references)

A total of 86.79% of the students positively evaluated the acceptance of the Kahbom device. Some of the highlighted statements included:

- "Yes, having to pull the levers and the lights really catch your attention, yes, because it has been entertaining to use something totally different from what we normally use."
- "I think what I liked the most could be the lights, but also the levers. Yes, because the fact of having to go and pull the levers and that it might explode makes it more competitive."
- "Yes, because it is very fun, and it is good for the groups to have more confidence and work more as a team, not individually."
- "The sound, since it is a sound that attracts me and works in an easy way. Because it is a game where you are active and also bond with people."
- "It is something new for us and very practical due to its wide variety of options, yes, because you can mix physical activity with general-knowledge questions."

In summary, a large proportion of students described the device as fun, engaging, and different from typical classroom materials. Many highlighted the lights, levers, and sound effects as elements that immediately captured their attention and fostered group cohesion. Remarks such as "the lights and levers make it much more exciting" or "it helps the group work as a team rather than individually" illustrate this strong positive reception.

Motivation (42 references)

A total of 79.25% of the students highlighted the motivational aspect of the activity, emphasising its capacity to generate positive tension and a spirit of healthy competition. Its similarity to a television game show and the challenge of "defusing the bomb" increased adrenaline and encouraged the group to stay involved until the very last second. Some participants expressed:

- "Yes, the fact that it has levers makes me feel like I am playing one of those games that appear on television."
- "The lights motivate quite a lot. If we had done the activity without the device, it would not have been as entertaining."
- "The similarity to the TV show Boom, because what draws our attention the most are the switches that looked like those on an airplane."

- "Sharing different opinions with classmates to reach the solution, and the device made the activity more intense."

In sum, students frequently mentioned feeling highly motivated, emphasising the tension and excitement associated with the ticking timer and the challenge of preventing the "explosion." Several compared the device to television game shows, noting that these features increased adrenaline and sustained engagement throughout the task.

Exploration (27 references)

A total of 50.94% of the students highlighted the exploratory component of the activity, noting how the simple mechanism of switches sparked their curiosity and motivated them to try different strategies. The adaptability of the device allowed for the creation of varied narratives and tailored exercises, promoting collective solutions and the creative exchange of ideas. This spirit of experimentation strengthened group collaboration, as reflected in comments such as:

- "Yes, because it is something new for us and very practical due to its wide variety of options, because you can mix physical activity with general-knowledge questions."
- "The fact that it was entertaining to have to develop any technique to retrieve the puzzle."
- "Attractive and also different from what we usually do in class; it looked like a treasure, which awakened more curiosity."
- "It contributed to teamwork simply through the simple mechanism of switches."
- "In a way it grabs your attention, yes, like creating new activities, because with a simple bomb you can do many activities."

Overall, half of the participants valued the exploratory dimension of the activity. The simplicity of the mechanical system encouraged experimentation, creativity, and strategic thinking. Students reported that the device invited them to "try different techniques," "develop strategies," and "figure out the puzzle," reinforcing collaborative problem-solving.

Interest (26 references)

A total of 49.06% of the students highlighted the level of interest the game generated, emphasizing the curiosity to discover which lever had to be pulled next and the desire to get it right before it "exploded." This dynamic mechanic kept attention high throughout the entire session. As one student mentioned:

- "Yes, it is a way of doing several fun activities and learning by playing. Yes, I find it interesting how the device knows which lever to pull so that it does not explode as the objectives change."
- "The fact that it has buttons to pull and that it might explode if you make a mistake, I think that makes it more interesting."
- "It made it a very dynamic game, because without the tension of defusing the bomb, it would not be the same."
- "Yes, because having the device and being able to pull the levers increases the interest in finding the correct answer."
- "Yes, because it increases the interest and the desire to carry out the activity."

To summarize, nearly half of the responses highlighted that the constant decision-making process—combined with the risk of triggering the explosion—maintained their interest and focus. Comments referred to the activity as "dynamic," "attention-grabbing," and "stimulating," with the device serving as a central element in maintaining engagement.

Innovation (23 references)

A total of 43.40% of the students highlighted the innovation of the device, valuing especially its novel combination of technology and play in the Physical Education environment. This element of originality not only broke traditional patterns but also encouraged collective creativity when proposing alternative dynamics. Several participants stated:

- "The joystick, you can choose the answer; yes, because it is something innovative in class, that it lights up and makes noise when you make a mistake."
- "The novelty, because it was a new object; yes, because you had the tension of whether the option would be the correct one or not."
- "Yes, because with it the situation is more realistic; I can make the activity more entertaining due to its originality and realism."
- "Yes, since I would have liked to see how it works and see all the work behind it. Of course, it is something innovative that people do not know they can learn with, and it is very motivating."
- "Because it is innovative and we are not used to this type of game; it attracts the attention of the class and you compete to complete the game correctly in the shortest possible time."

In essence, students recognised the device as innovative, noting the novelty of integrating physical mechanisms with playful dynamics in Physical Education. The originality of the tool sparked curiosity about its internal functioning and encouraged discussion about how it could be used in other subjects.

Discussion

The results of this study demonstrate that the Kahbom device generated a substantial pedagogical impact on student motivation, engagement and participation in Physical Education settings. The notably high level of positive acceptance (86.79%) indicates that multisensory and game-based stimuli function as effective mediators for initiating group involvement, lowering the entry barrier to participation and establishing a supportive social climate. This finding is consistent with Self-Determination Theory, which posits that the fulfilment of basic psychological needs fosters intrinsic motivation and long-term engagement (Almagro Torres et al., 2011; Manzano-León et al., 2021; Salazar-Ayala & Gastélum-Cuadras, 2020). In particular, the device's novelty—the combination of physical manipulation, sound effects and time pressure—appears to satisfy the need for novelty proposed by González-Cutre et al. (2016), reinforcing the idea that innovative materials can stimulate students' interest and willingness to participate (Ferriz-Valero et al., 2023).

Motivation emerged as a central dimension, with 79.25% of students describing heightened activation, emotional tension and sustained engagement. The resemblance of the activity to a television game show—a familiar and culturally recognised format—may have contributed to increasing students' enjoyment and sense of challenge, an effect previously reported in studies on gamification in Physical Education (Ferriz-Valero et al., 2023; Kim & Castelli, 2021; Li et al., 2023; Quintero González et al., 2018; Sotos-Martínez et al., 2022). The combination of countdown, uncertainty and collective decision-making appears to have triggered a playful competitive environment that promoted meaningful group interaction.

This aligns with findings indicating that gamified challenges can enhance both motivational processes and social competencies in school-age learners (Ferriz Valero et al., 2019; Mo et al., 2024).

The exploratory nature of the activity—highlighted by 50.94% of participants—supports the idea that educational technologies can serve as "creative platforms" enabling experimentation, strategy development and adaptive task design. Students used the device to engage in problem-solving processes, draw semantic connections and construct collaborative narratives, aligning with pedagogical models based on active learning and project-based methodologies (Cavus et al., 2023; Manzano-León et al., 2021). This result is consistent with Cuartero et al. (2020), who emphasise that interactive group tasks enhance cooperative dialogue, shared responsibilities and collective reasoning within Physical Education.

Sustained interest (49.06%) further demonstrates that the dynamic nature of the task—particularly the sequential manipulation of levers and the anticipation of the "explosion"—maintains attention and reduces disengagement, a recurrent challenge in practical subjects. The combination of time constraints, embodied action and immediate feedback may have facilitated states of focused involvement similar to flow, reinforcing the relationship between challenge, perceived competence and enjoyment (García Soler, 2016; Fernández-Espínola et al., 2019). These findings suggest that well-designed ludic mechanisms can be harnessed to improve attentional regulation in environments characterised by movement and spatial dispersion (Fernández-Espínola et al., 2019; García Soler, 2016; Mo et al., 2024).

Innovation (43.40%) was also frequently mentioned, indicating that Kahbom was perceived as a disruptive and original component within a subject where technological integration remains limited (Balalle, 2024; Díaz Barahona, 2012; Fernández-Espínola & Moreno, 2015; Karabin et al., 2024). The hybrid nature of the device—combining tactile mechanics with game-based dynamics—aligns with recent calls for sustainable, low-cost and scalable educational innovations capable of overcoming infrastructural barriers in Physical Education (Baena-Morales et al., 2021; Bofill-Herrero et al., 2022; Lynch et al., 2024). Moreover, the device's modularity and adaptability open possibilities for interdisciplinary use, reinforcing its potential to support learning across curricular areas.

The activity also revealed implications for formative assessment. The problem-solving structure of the task required students to articulate decisions, justify their reasoning and collaborate under pressure—elements aligned with contemporary perspectives on formative assessment that emphasise autonomy, reflection and shared evaluation processes (Bizarro et al., 2019; Cavus et al., 2023; Coll & Onrubia, 2002). The device offers an accessible means of transforming assessment into an interactive and participatory experience, reducing its association with purely summative or individual forms of measurement.

Nonetheless, these findings must be interpreted considering several limitations. The study was conducted with a relatively small and homogeneous sample from a single institution, limiting external validity. The short duration of the intervention does not allow us to determine whether the high levels of motivation and interest reflect sustained engagement or a novelty effect. Moreover, the activity was implemented in Physical Education only; its interdisciplinary potential remains theoretical and requires empirical validation. Future studies should incorporate longitudinal designs, comparison groups and objective indicators of learning and performance to better understand the long-term impact of the device.

Overall, the results provide strong support for the pedagogical viability of hybrid ludic-technological tools in Physical Education. The convergence of positive acceptance, motivation, exploration, interest and innovation establishes a solid foundation for integrating such devices into active and collaborative methodological frameworks.

Conclusions

The present study demonstrates that Kahbom is a highly promising pedagogical resource capable of transforming learning dynamics in Physical Education through game-based mechanisms, multisensory cues and collaborative problem-solving. The consistently high levels of positive acceptance and motivation observed suggest that the device effectively satisfies key psychological needs identified by Self-Determination Theory—particularly competence and novelty—while simultaneously fostering group cohesion and enjoyable engagement. These features position Kahbom as more than a motivational add-on: it operates as a structural enhancer of active learning environments.

The strong exploratory and interest dimensions reflect the device's versatility and creative potential. Its modular structure, adaptability to multiple narratives and capacity to integrate cognitive and motor tasks make it a powerful tool for interdisciplinary applications. Beyond its immediate use in Physical Education, the device holds potential for language learning, mathematics, science and humanities, where semantic reasoning, problem-solving and cooperative inquiry can benefit from ludic frameworks.

From an organisational perspective, Kahbom represents a scalable and cost-efficient innovation. Its ease of construction and maintenance allows for implementation in schools with limited resources, and its simplicity enables students themselves to participate in its assembly and improvement. This aligns with calls for sustainable and inclusive educational innovation, reflecting broader goals outlined in the Sustainable Development Goals—particularly SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption).

For sustained adoption, teacher training will be essential. Professional development programmes focusing on challenge-based instruction, formative assessment and inclusive pedagogies would allow educators to maximise the device's pedagogical potential. Establishing communities of practice could further support the sharing of scenarios, adaptations and evidence-based reflections.

While this study offers encouraging insights, further empirical research is needed. Longitudinal analyses should examine whether the motivational effects endure over time and whether Kahbom influences learning outcomes, physical engagement or socio-emotional development. Evaluating its impact in other curricular areas will also be necessary to fully validate its interdisciplinary value.

In sum, Kahbom represents an accessible and innovative contribution to the growing field of playful learning technologies. By merging low-cost engineering with evidence-based pedagogical principles, the device positions play as a central resource for active learning, instructional innovation and the creation of inclusive, participatory classroom communities.

Acknowledgments

References

Almagro Torres, B. J., Sáenz-López Buñuel, P., González-Cutre Coll, D., & Moreno Murcia, J. A. (2011). Clima motivacional percibido, necesidades psicológicas y motivación intrínseca como predictores del compromiso deportivo en adolescentes. *RICYDE. Revista Internacional de Ciencias Del Deporte, ISSN-e 1885-3137, Vol. 7, Nº. 25, 2011 (Ejemplar Dedicado a: "Teoría de La Auto-Determinación y Adherencia Al Ejercicio Físico"), Págs. 250-265*, *7*(25), 250–265. https://doi.org/10.5232/ricyde2011.02501

Baena-Morales, S., Ferriz-Valero, A., Campillo-Sánchez, J., & González-Víllora, S. (2021). Sustainability awareness of in-service physical education teachers. *Education Sciences*, *11*(12). https://doi.org/10.3390/EDUCSCI11120798

Balalle, H. (2024). Exploring student engagement in technology-based education in relation to gamification, online/distance learning, and other factors: A systematic literature review. *Social Sciences & Humanities Open, 9*, 100870. https://doi.org/10.1016/j.ssaho.2024.100870

Bizarro, W., Sucari, W., & Quispe-Coaquira, A. (2019). Evaluación formativa en el marco del enfoque por competencias. *Revista Innova Educación*, *1*(3), 374–390. https://doi.org/10.35622/j.rie.2019.03.r001

Bofill-Herrero, A., Morales, S. B., & Ferriz-Valero, A. (2022). Cooperative learning and SDG 5 . An intervention for physical education in secondary schools secondary schools. *Journal of Physical Education and Sport*, *August*. https://doi.org/10.7752/jpes.2022.07198

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education, 17*, Article 2. https://doi.org/10.1186/s41239-019-0176-8

Cavus, N., Ibrahim, I., Ogbonna Okonkwo, M., Bode Ayansina, N., & Modupeola, T. (2023). *The effects of gamification in education: A systematic literature review.* BRAIN: Broad Research in Artificial Intelligence and Neuroscience, 14(2), 211–241. https://doi.org/10.18662/brain/14.2/452

Coll, C., & Onrubia, J. (2002). Evaluar en una Escuela para Todos. *Cuadernos de Pedagogía*, *50*, 50–54. http://www.psyed.edu.es/prodGrintie/articulos/CC_JO_EvaluarEscuelaTodos_02.pdf

Cuartero, J. O., Jaén, M. G., Martínez, S. G., & Valero, A. F. (2020). Los grupos interactivos en Educación Física: Una experiencia docente en Educación Secundaria (Interactive Groups in Physical Education: A Teaching Experience in Secondary Education). *Retos*, *38*(38), 369–374. https://doi.org/10.47197/RETOS.V38I38.74606

Díaz Barahona, J. (2012). La enseñanza de la Educación Física implementada con TIC. *Educación Física y Deporte*, *31*(2), 1047–1056. https://revistas.udea.edu.co/index.php/educacionfisicaydeporte/article/view/14409

Díaz Barahona, J., Molina-García, J., & Monfort-Pañego, M. (2018). Estudio de las actitudes y el interés de los docentes de primaria de educación física por las TIC en la Comunidad Valenciana (Primary Physical Education teachers' attitudes and interests towards ICT in the Valencian Community). *Retos*, *35*, 267–272. https://doi.org/10.47197/retos.v0i35.63355

Fernández Batanero, J. M., Rueda, M. M., Cerero, J. F., & Tadeu, P. (2021). Impacto de las TIC en el alumnado con discapacidad en el área de Educación Física: una revisión sistemática. *Retos*, *2041*(39), 21–28. https://dialnet.unirioja.es/servlet/articulo?codigo=7595362

Fernández-Espínola, C., & Moreno, L. L.-G. (2015). El uso de las TIC en la Educación Física actual. *E-Motion: Revista de Educación, Motricidad e Investigación*, *5*, 17–30. https://doi.org/10.33776/REMO.V0I5.2740

Fernández-Espínola, C., Almagro, B. J., & Tamayo Fajardo, J. A. (2019). Prediction of physical education students' intention to be physically active: A model mediated by the need for novelty. *Retos*, *40*(9), 442–448. https://doi.org/10.47197/RETOS.V37I37.70946

Ferriz Valero, A., García Martínez, S., & Arroyo Botella, J. M. (2019). Cooperative methodologies for the decrease disruptive attitudes in physical education. *Revista Internacional de Medicina y Ciencias de La Actividad Fisica y Del Deporte*, *19*(76), 599–615. https://doi.org/10.15366/RIMCAFD2019.76.002

Ferriz-Valero, A., Agulló-Pomares, G., & Tortosa-Martínez, J. (2023). *Benefits of gamified learning in physical education students: A systematic review.* Apunts Educación Física y Deportes, 153, 39–51. https://doi.org/10.5672/apunts.2014-0983.es.(2023/3).153.04

Ferriz-Valero, A., Østerlie, O., Martínez, S. G., & García-Jaén, M. (2020). Gamification in physical education: Evaluation of impact on motivation and academic performance within higher education. *International Journal of Environmental Research and Public Health*, *17*(12), 1–16. https://doi.org/10.3390/ijerph17124465

García Soler, S. (2016). *Percepción de utilidad, diversión y motivación en la asignatura de Educación Física y su relación con el nivel de actividad física habitual en escolares de 10-12 años de la Región de Murcia*. https://digitum.um.es/entities/publication/a33faae1-edee-4412-9432-f19d2bdb81a7

Getenet, S. T., Beswick, K., & Callingham, R. (2024). *Students' digital technology attitude, literacy and self-efficacy and their relationship with online learning engagement.* International Journal of Educational Technology in Higher Education, 21, 19. https://doi.org/10.1186/s41239-023-00437-y

González-Cutre, D., Sicilia, Á., Sierra, A. C., Ferriz, R., & Hagger, M. S. (2016). Understanding the need for novelty from the perspective of self-determination theory. *Personality and Individual Differences*, *102*, 159–169. https://doi.org/10.1016/J.PAID.2016.06.036

Karabin, O., Bielova, V., Hladun, T., Makarenko, L., & Bozhkov, A. (2024). *The role of digital technologies in increasing the students' involvement in the educational process.* WSEAS Transactions on Information Science and Applications, 21, 77–89. https://doi.org/10.37394/23209.2024.21.8

Kim, J., & Castelli, D. M. (2021). *Effects of gamification on behavioral change in education: A meta-analysis.* International Journal of Environmental Research and Public Health, 18(7), 3550. https://doi.org/10.3390/ijerph18073550

Li, M., Ma, S., & Shi, Y. (2023). *Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis.* Frontiers in Psychology, 14, 1253549. https://doi.org/10.3389/fpsyg.2023.1253549

Lynch, P., Singal, N., & Francis, G. A. (2024). *Educational technology for learners with disabilities in primary school settings in low- and middle-income countries: A systematic literature review.* Educational Review, 76(2), 405–431. https://doi.org/10.1080/00131911.2022.2035685

Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). *Between level up and game over: A systematic literature review of gamification in education.* Sustainability, 13(4), 2247. https://doi.org/10.3390/su13042247

Mo, W., Yang, W., Pan, X., & Zhou, G. (2024). *Effects of game-based physical education program on enjoyment in children and adolescents: A systematic review and meta-analysis.* BMC Public Health, 24, 517. https://doi.org/10.1186/s12889-024-18043-6

ONU. (2015). *Agenda 2030 para el Desarrollo Sostenible:* (Vol. 17, Issue 1). https://doi.org/10.54114/revanlisis.v17i1.17556

Quintero González, L. E., Jiménez Jiménez, F., Moreira, M. A., & Quintero González, L. E. (2018). Más allá del libro de texto. La gamificación mediada con TIC como alternativa de innovación en Educación Física. *Retos: Nuevas Tendencias En Educación Física, Deporte y Recreación, ISSN 1579-1726, Nº. 34, 2018, Págs. 343-348*, *34*(34), 343–348. https://dialnet.unirioja.es/servlet/articulo?codigo=6736340&info=resumen&idioma=ENG

Ruiz-Navas, S., Ackaradejraungsri, P., & Dijk, S. (2024). *Are there literature reviews about gamification to foster inclusive teaching? A scoping review of gamification literature reviews.* Frontiers in Education, 9, 1306298. https://doi.org/10.3389/feduc.2024.1306298

Salazar-Ayala, C. M., & Gastélum-Cuadras, G. (2020). Teoría de la autodeterminación en el contexto de educación física: Una revisión sistemática. *Retos*, *38*, 838. www.retos.org

Samaniego López, M. V., Campos Soto, M. N., & Paz-Maldonado, E. (2025). *Technologies in inclusive education: Solution or challenge?* Education Sciences, 15(6), 715. https://doi.org/10.3390/educsci15060715

Sotos-Martínez, V. J., Ferriz-Valero, A., García-Martínez, S., & Tortosa-Martínez, J. (2022). *The effects of gamification on the motivation and basic psychological needs of secondary school physical education students*. https://doi.org/10.1080/17408989.2022.2039611

Zárate-Rueda, R., Lésmes Peralta, J. C., & Beltrán Villamizar, Y. I. (2025). *Technological tools and inclusive pedagogy for students with disabilities in higher education: A systematic review.* Revista de Investigación Educativa, 43, 590831. https://doi.org/10.6018/rie.590831