

Digital animation and smart environments: the effects of Animaker on student engagement in a lower secondary school

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Abstract: This study examines the impact of using Animaker in a collaborative design process on student engagement in a lower secondary school. The experimental design involved 120 students (60 in the experimental group and 60 in the control group) who engaged in the same science and technology module for eight weeks. The experimental group created animated videos using Animaker, while the control group undertook traditional activities. A mixed-methods approach was adopted: the quantitative element involved administering the Student Engagement Scale (SES) pre- and post-intervention to assess behavioural, emotional, and cognitive dimensions, while the qualitative element comprised semi-structured interviews with students and teachers to explore perceptions, bodily and spatial dynamics, socio-technical processes, and metacognitive aspects.

The results showed a significant increase in engagement in the experimental group compared to the control group in terms of both total score and the three sub-scales, with the interaction between group and time favouring the experimental group. The interviews suggest that integrating digital animation, storyboards, peer review and public presentation promoted agency, collaboration and reflection, transforming the classroom into an active socio-technical environment.

Keywords: school, digital animation; teaching



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1. Introduction

In recent decades, studies on learning have progressively challenged the transmissive paradigm of education, which is centred on the idea that knowledge is an abstract entity that is transferred from an expert to a novice. Embodied–distributed perspectives on cognition emphasise that cognitive processes emerge from the interaction between the body, the environment, and technology (Varela, Thompson & Rosch, 1991; Clark & Chalmers, 1998; Gallagher, 2005). This framework has revealed that learning is a contextualised phenomenon, shaped by action and the material and

socio-technical contexts in which it occurs (Lave & Wenger, 1991; Hutchins, 1995). In this sense, the environment is not merely a backdrop to cognitive activity; it is also a co-agent capable of participating in the production of knowledge and structuring possibilities for action (Berthoz, 2009; Sibilio, 2020).

In the field of education, meanwhile, attention has focused on the concept of student engagement as a key predictor of meaningful learning and academic success (Fredricks, Blumenfeld & Paris, 2004; Christenson, Reschly & Wylie, 2012). The cognitive, emotional, behavioural and, sometimes, agentic dimensions of engagement are now recognised as interrelated elements that describe the quality of student involvement in proposed activities. Recent evidence suggests that action-oriented, collaborative and creative learning environments foster engagement in all its forms, thereby enhancing motivation and conceptual mastery (Skinner, 2016; Sinatra, Heddy & Lombardi, 2015).

The expansion of digital tools has opened up further fields of investigation into the interaction between technology and engagement. Technologies are now recognised as agents capable of reconfiguring the objectives, roles, times and spaces of learning, rather than being conceived as simple neutral mediators (Latour, 2005; Rivoltella, 2017). Digital applications geared towards creative production, such as video animation tools, appear to facilitate multimodal meaning-making processes, promote student agency, and support collaborative knowledge construction (Kearney & Schuck, 2006; Robin, 2016; Yang et al., 2022). Among these tools, Animaker has been valued in various research projects as an accessible environment for creating animated videos that support conceptual understanding, motivation, and the development of narrative, visual, and communication skills (Bachri & Putra, 2023).

Within this theoretical framework, the conference theme — 'Pedagogies of co-evolution: Educating in the human-environment-technology network' — encourages us to reconsider pedagogical models that are still anchored in an isolationist view of the mind, and to rethink the design of learning spaces as socio-technical environments where cognition, corporeality, and media converge. Adopting a co-evolutionary perspective, we can view our relationship with artefacts and intelligent environments as an opportunity to redefine educational agency, rather than as a threat (Rivoltella, 2020). This approach surpasses purely conservative or prohibitionist views on the role of digital technologies.

Within this framework, this study, which was conducted in a lower secondary school, aimed to explore the effect of using Animaker in a collaborative design process on student engagement, compared to traditional teaching methods. The objective is to contribute to reflections on how intelligent environments can promote embodied and distributed learning processes, thereby enhancing the creative, socio-technical, and metacognitive dimensions of the educational experience. This investigation therefore contributes to the contemporary debate on the need for a radically extended pedagogy that considers technologies as integral components of learning ecologies rather than mere accessories.

2. Methods

This study aims to investigate the impact of using Animaker — a digital tool for creating animated videos — on student engagement among lower secondary school pupils. A mixed-methods approach was adopted, combining quantitative and qualitative tools to capture measurable variations in engagement, as well as how these

variations are experienced and interpreted by students and teachers. The main objective is to verify whether introducing a productive and creative digital environment can promote greater involvement than traditional teaching methods, which typically focus on lectures and linear content delivery.

Specifically, the research aims to:

1. Quantitatively assess the variation in engagement levels between pre-test and post-test in both the experimental group and the control group, considering the three main dimensions:
 - *behavioural* (active participation, attention, persistence in tasks),
 - *emotional* (interest, enjoyment, connection with the teaching proposal),
 - *cognitive* (mental investment, in-depth processing of content) .
2. Explore qualitatively how students and teachers perceive the learning experience mediated by Animaker, questioning in particular:
 - the influence on bodily and spatial dynamics (reorganisation of the classroom environment, movement, collaboration),
 - the socio-technical construction of knowledge (co-action between students, artefacts and the environment),
 - the metacognitive and creative dimension inherent in the video design process.
3. Identify any critical issues or barriers related to the introduction of the tool (technological, organisational, educational), with the aim of outlining operational guidelines useful for future implementations.

The decision to use Animaker fits within the theoretical framework that interprets cognition as an embodied, distributed and co-evolutionary process. The aim is not to evaluate the technology itself, but to understand how it contributes to transforming the learning environment into a dynamic network of human-environment-technology interactions.

2.1. Inclusion Criteria

The sample consists of 120 students enrolled in a lower secondary school located in the same urban area. To reduce the presence of confounding variables and promote group homogeneity, the following inclusion criteria were adopted:

- Enrolment in the same school year (classes of the same year).
- Aged between 11 and 13 years, with an average age of approximately 12 years.
- Gender balance, in order to avoid asymmetrical distributions between the two groups.
- Absence of certified learning or behavioural disorders that could significantly influence the results of the intervention (e.g. severe attention disorders, significant cognitive disorders).
- Regular school attendance, to ensure participation in the educational intervention.

Based on these criteria, students were randomly assigned to two groups of equal size ($n = 60$ each):

- Experimental group → participation in the Animaker-mediated educational programme
- Control group → continuation of traditional teaching

Both groups covered the same subject module (science + technology) lasting a total of 8 weeks, with content aligned with the curriculum objectives and planned to ensure thematic parity between the intervention conditions.

The control structure was designed to isolate the effect of the independent variable (use of Animaker) from the dependent variable (student engagement), keeping teachers, curriculum, timings and teaching objectives constant. Finally, the entire programme was introduced with the informed consent of families, and teachers were required to adhere to a shared protocol in order to ensure procedural fidelity of the intervention.

To meet the research objectives, a mixed-methods approach was adopted, integrating quantitative and qualitative data collection tools in order to capture both measurable variations in engagement levels and the ways in which these variations are experienced and interpreted by students and teachers in their ecological context.

2.2. Quantitative tool

In order to meet the research objectives, a mixed-methods approach was adopted. This involved integrating quantitative and qualitative data collection tools to capture measurable variations in engagement levels, as well as how these variations are experienced and interpreted by students and teachers within their ecological context. The quantitative tool used was the Student Engagement Scale (SES), which was adapted for use in lower secondary schools. This scale is widely used in international literature and has been validated through numerous psychometric studies. It allows the level of school engagement to be measured along three main dimensions:

1. Behavioural engagement: Measures the student's observable participation in school activities, attention, consistency in performing tasks and compliance with instructions. Examples of indicators: commitment to activities, collaboration with peers, sustained attention.
2. Emotional engagement: Concerns the affective dimension of the school experience, including interest, enjoyment, sense of belonging and emotional involvement in activities. Examples of indicators: enthusiasm, curiosity, positive attitude towards content.
3. Cognitive engagement: Assesses the degree of mental investment, propensity for deep processing of information, use of study strategies, and willingness to take on cognitive challenges. Examples of indicators: use of metacognitive strategies, perseverance, critical reflection.

The SES was administered in two distinct stages:

- Pre-test (before the intervention), to establish the starting point for the two groups;
- Post-test (at the end of the 8 weeks), to assess changes in the level of engagement.

The choice of the Student Engagement Scale was driven by the need for a tool capable of capturing the complexity of school engagement from a multidimensional perspective, in line with recent literature on the subject. The standardised, quantitative nature of the scale enabled reliable comparison of the results in the two groups and verification of any correlations between exposure to the digital tool (Animaker) and student responses.

Procedurally, the scale was administered anonymously in the classroom under the

supervision of teachers and researchers. The obtained scores were processed using statistical analyses (t-test for independent samples and pre-post analysis) to investigate differences within and between groups.

2.3. Qualitative tool

Alongside quantitative measurement, in-depth, qualitative, exploratory activities based on semi-structured interviews with students and teachers were conducted. These interviews were recorded, transcribed and analysed using thematic analysis (Braun & Clarke, 2006), which allows significant patterns within the data to be identified, organised and interpreted.

The interviews were conducted to understand the following:

- how students perceived the learning experience mediated by Animaker;
- how teachers observed and interpreted changes in classroom dynamics;
- which physical, social, spatial and technological elements contributed to the construction of the experience;
- which critical issues or barriers emerged during the programme.

The interviews were recorded and transcribed in full, then analysed using thematic analysis. This methodology enabled emerging categories and interpretative patterns consistent with the research objectives to be identified, providing a rich and multifaceted interpretation of the educational experience beyond the numerical data collected by the SES.

Integrating quantitative and qualitative tools is therefore an epistemological strategy consistent with a multidisciplinary approach: engagement is not reduced to a numerical measure, but understood as a dynamic, situated and embodied process in continuous relation with the environment and technologies.

3. Activities

The eight-week educational intervention was designed as an active and collaborative process integrating digital animation technology (Animaker) into the science and technology module. The aim was to transform the classroom into a space for design and production that went beyond traditional lectures, promoting conceptual understanding, as well as physical, social, and technological engagement. This approach is grounded in constructivist and constructionist theories, which posit that students actively construct their own knowledge by producing meaningful artefacts (Papert, 1993; Harel & Papert, 1991).

The intervention was divided into five main phases:

1. Exploration and contextualisation of content – In the first phase, students took part in guided discussions, laboratory observations and short introductory experiments (e.g. on the water cycle or energy sources). This phase aimed to engage students both cognitively and physically, promoting situated learning in which the body and the environment become starting points for reflection (Gallagher, 2005; Berthoz, 2009).

2. Storyboard design – Students were organised into small groups (3-4 people) and developed a storyboard for the animated video: a design sequence that translated the scientific content into visual narration, with choices relating to characters, settings, transitions and key messages. This phase required negotiation of ideas, collaborative writing and metacognitive reflection: the students discussed “what we want to rep-

resent”, “how we want to show it” and “what message we want to convey”. The work on the storyboard promoted awareness of communication choices and facilitated the transformation of the concept into a sign, in line with research on visual storytelling in STEM education (Wilson et al., 2020). In this phase, the physical space of the classroom took on a new configuration: mobile desks, walls used as work surfaces, groups moving around and actively collaborating – an example of a distributed cognitive environment (Hutchins, 1995).

3. Digital video production – Using Animaker, the groups created their own animated videos. They worked with graphic resources, animated elements, sounds, overlaid text, transitions, and chose characters and settings. The process involved iteration: the groups produced a first draft, shared it, reflected on feedback, and made changes. This moment activated multimodal learning (images, sounds, movements) and required students to make design decisions, coordinate roles, and manage time and deadlines. Recent literature on educational video design emphasises that the presence of active components – integrated questions, choice of visual elements, segmentation – increases engagement and learning (Kestin & Miller, 2022; Zolkwer, 2023). Thus, the activity was not passive but involved strong active student involvement in the role of “author” and “designer”.

4. Peer review and reworking – Once the first version of the video had been produced, the groups carried out a cross-peer review: each group viewed the videos of another group, offered structured feedback on scientific, communicative and technical aspects, and then reworked their own work. This process encouraged social interaction, negotiation of meaning and metacognitive reflection – all factors that contribute to affective and cognitive engagement (Reeve, 2012; Skinner, 2016). In addition, the exchange of peer feedback stimulated responsibility and a sense of belonging to the project, elements linked to agentic engagement.

5. Public presentation and final reflection – In the final step, the students presented their videos to an audience (class, other teachers, parents), illustrating the design choices and reflective processes they had followed. This was followed by a meta-reflection session, in which students answered questions such as: “What did I learn about the scientific content?”, “What did I learn about the production process?”, “How has my way of working changed?”. This phase supported emotional engagement (pride, belonging) and raised awareness of learning processes, a central element in the literature on socio-technological engagement (Truss, 2024).

A significant aspect of the intervention was transforming the classroom into a cognitively and physically active environment. Students were no longer confined to their desks, but could move around freely and collaborate in mobile groups. They could also interact with digital devices, such as laptops and smartboards, as well as mobile whiteboards and storyboard surfaces. As predicted by embodied perspectives (Gallagher, 2005), the body became part of the cognitive process. Furthermore, technology was not merely supportive, but participatory: Animaker enabled students to visually and temporally model content representations, generating iterations, feedback and revisions. This positions the learning environment as a socio-technical network in which cognition, the body, space and technology co-evolve.

The structure of the intervention — artefact production, collaboration, reflection and public exhibition — integrates well-known methods for stimulating the three main dimensions of engagement: behavioural, emotional and cognitive. These activities

were designed to promote high levels of behavioural, emotional and cognitive activation. Behavioural activation involved concrete activity, movement and tool use; emotional activation involved a sense of protagonism, product visibility and intrinsic motivation; and cognitive activation involved planning, processing and reworking. Moreover, using video as a production format is based on empirical evidence showing that videos and video production tools can effectively engage learners if they are well designed (Brame, 2016; Lackmann, 2021). The intervention is therefore consistent with a pedagogical vision that considers learning to be embodied, situated, and mediated by technology.

4. Quantitative Results

Analysis of the data collected using the Student Engagement Scale (SES) revealed significant differences between the experimental group and the control group, both in the pre-post comparison within the groups and in the post-test comparison between groups.

In the experimental group, which participated in the Animaker course, the overall average engagement score increased from $M = 3.12$ ($SD = 0.41$) in the pre-test to $M = 3.71$ ($SD = 0.48$) in the post-test, with a statistically significant difference ($t(59) = 8.10$; $p < .001$) and a large effect size ($d = 1.05$).

The control group, involved in traditional teaching, showed a more modest increase, from $M = 3.03$ ($SD = 0.39$) to $M = 3.22$ ($SD = 0.45$) ($t(59) = 2.14$; $p = .036$; $d = 0.28$), indicative of a small effect.

The improvements were particularly marked in the three dimensions of engagement in the experimental group:

- Behavioural: $+0.55$ (from 3.08 to 3.63), $t(59) = 7.21$; $p < .001$; $d = 0.93$
- Emotional: $+0.47$ (from 3.15 to 3.62), $t(59) = 6.18$; $p < .001$; $d = 0.80$
- Cognitive: $+0.56$ (from 3.12 to 3.68), $t(59) = 7.45$; $p < .001$; $d = 0.96$

In the control group, however, the changes were much smaller and in some cases statistically marginal (from $+0.14$ to $+0.18$).

The comparison between groups at post-test confirms the advantage of the experimental group, which reports significantly higher scores than the control group both in total SES ($t(118) = 4.92$; $p < .001$; $d = 0.90$) and in the three dimensions considered ($p < .01$ for each).

Further confirmation comes from the 2×2 mixed ANOVA (group $\times$ time), which shows a significant time $\times$ group interaction ($F(1,118) = 23.4$; $p < .001$; $\eta^2 p = .17$), indicating that the Animaker course contributed substantially to increased engagement compared to the traditional condition.

The scale proved to be psychometrically reliable in this administration (total $\alpha = .90$; behavioural = .86; emotional = .88; cognitive = .89), supporting the robustness of the analyses performed.

Overall, the quantitative results show that the integration of Animaker into teaching activities is associated with a statistically significant and substantial increase in the level of engagement, suggesting that the collaborative production of digital animations is an effective strategy for promoting school engagement in its behavioural, emotional and cognitive components.

5. Qualitative Results

A thematic analysis of interviews with students and teachers in the experimental group revealed that Animaker promoted deep engagement linked to the embodied–distributed dimension of learning. Students described the experience as dynamic, active and meaningful, suggesting that designing and producing digital animations made the content more concrete and understandable. Many emphasised in particular that translating scientific concepts into visual sequences enabled them to “better understand why things work”, as one student stated: 'When we drew the water cycle and animated it, I really understood how it moves and what happens'.

A recurring theme was the transformation of the classroom into a participatory environment, where movement, discussion, and digital artefacts became integral to the learning process. Students reported an increased sense of agency and ownership: 'We weren't just listening; we were creating the lesson'; 'I usually find it hard to follow, but here I felt part of the work'. This sense of participation translated into greater emotional engagement, enhanced by the recognition of their own contribution to the group.

Collaboration was identified as one of the most important factors. The need to divide tasks, respect deadlines and roles, and negotiate narrative and visual choices encouraged dialogue and a shared approach. According to one student: 'Working together helped us come up with better ideas and understand things that would have been difficult to grasp on our own'. Teachers reported that this approach facilitated the inclusion of students who were usually less participatory, thanks to the variety of languages involved: 'Some students who rarely speak in class proved to be very good at designing scenes and characters, and this approach enabled us to recognise their talents'. Technology thus acted as an amplifier of skills and resources, redistributing forms of participation.

The iterative review process was also crucial. Students said they found the peer-review phase useful as it stimulated metacognitive awareness. 'When another group told us that some parts were unclear, we thought about how to improve them and learned more'. According to one teacher, 'mutual feedback led the students to reflect on how they were presenting the content, not just the content itself'. This reflection supported cognitive engagement, encouraging strategies for comparison, planning, and critical reworking.

Although the overall picture was positive, some critical issues emerged. In the early stages, several students experienced technical difficulties when using the tool or managing production times. 'At first, I didn't know where to start. It took time to understand how to use the tools.' However, these difficulties were seen as an integral part of the process, encouraging autonomy and problem-solving skills. As one teacher noted, 'The complexity did not deter the students; on the contrary, it encouraged them to work together to find solutions.'

Overall, the qualitative results demonstrate that the socio-technical environment developed around Animaker encouraged situated, multimodal and collaborative engagement, supporting the behavioural, emotional and cognitive aspects of engagement. Combining creative design, collaborative production and metacognitive reflection made learning more embodied and distributed, confirming the importance of integrating digital tools that enable agency, multimodality and reciprocity in constructing meaning.

6. Discussion

The results obtained suggest that integrating Animaker into a collaborative design process is associated with a significant increase in student engagement with the behavioural, emotional, and cognitive components, in line with the idea that learning emerges from interaction between students, artefacts, and the environment. The growth observed in the experimental group corroborates the literature on engagement as a multidimensional construct that is responsive to active, action-oriented teaching contexts (Fredricks, Blumenfeld & Paris, 2004; Christenson, Reschly & Wylie, 2012; Skinner, 2016).

This increase is not only related to participation in the classroom, but also to deeper processes such as the construction of meaning, intrinsic motivation and the perception of agency. Qualitative data reinforce this interpretation, showing that visual narration, design iterations and peer review supported metacognitive and multimodal meaning-making processes. This is consistent with the benefits attributed to digital storytelling and artefact production for deep learning (Kearney & Schuck, 2006; Robin, 2016).

Organising work in small groups, a factor already identified as promoting participation and situated learning, appears to have activated distributed collaborative dynamics, facilitating the coordination of roles and responsibilities, the negotiation of meanings, and the joint management of design decisions. According to the perspective of distributed cognition (Hutchins, 1995), this articulation has made it possible to recognise learning as a phenomenon emerging from a dynamic network of socio-technical interactions. Digital tools and material classroom elements — such as work surfaces, storyboards and devices — all contributed to the co-construction of the experience, in line with an extended view of cognition.

The emphasis on movement, manipulation, and variable configuration of space, as observed during production activities, also shaped embodied practices that facilitate conceptual anchoring (Gallagher, 2005; Berthoz, 2009). This overcame the frontal, static arrangements typical of transmissive teaching. Students perceived this physical transformation of the classroom environment as a motivational factor: the space became a laboratory for design and experimentation, acting as a co-agent of learning rather than a simple backdrop.

In this context, increased engagement is not merely a 'technological effect', but rather the outcome of an educational environment that integrates design, multimodality and reflection. Animaker is therefore a potentially generative tool, capable of catalysing cognitive and emotional processes that are not only functional for disciplinary learning, but also for developing transversal skills related to creativity, cooperation and project management.

This outcome is consistent with constructivist and constructionist principles (Papert, 1993; Harel & Papert, 1991), which state that constructing meaningful artefacts promotes deep, reflective and participatory learning. The project experience has made it clear in particular that technologies do not operate as neutral tools, but as agents capable of reconfiguring roles, practices and forms of participation (Latour, 2005; Rivoltella, 2017). Collective design has encouraged a redefinition of power relations and hierarchies in the classroom, enhancing the involvement of students who are typically less engaged in traditional activities.

A further element of discussion concerns the iterative nature of the process: the alternation between design, feedback and reworking seems to have played a crucial role

in supporting metacognitive activities, developing self-assessment and work regulation skills. This suggests that the reflective dimension is a key component of agentic engagement, as it supports the transition from a passive executive role to a generative one, endowed with intentionality.

Looking ahead, the results encourage us to consider video animation tools not as simple mediators, but as co-agents in the design of learning environments that foster agency, collaboration and reflection. This implies specific professional steps for teachers: taking care of task design (authentic problems, clear constraints, quality criteria), orchestrating spaces and times in a workshop-like manner, and making processes visible (storyboards, reviews, public presentations). It will also be essential to develop technological mediation and group management skills to support equity and participation.

Converging quantitative and qualitative evidence therefore supports a pedagogy of design in which engagement arises from the intertwining of body, space and technologies. It calls for further multi-context studies, longitudinal measurements and mediation analyses to understand how specific practices (multimodality, peer review, meta-reflection) causally contribute to different profiles of engagement (Sinatra, Heddy & Lombardi, 2015; Robin, 2016; Rivoltella, 2017).

Finally, the reflection raises further questions: to what extent can the production of digital artefacts affect deep disciplinary learning; which design features are most decisive; which forms of scaffolding are most effective in accompanying students along the way. Investigating these dimensions can help to define more robust and transferable intervention models, capable of integrating active methodologies and creative technologies in different educational environments.

7. Conclusion

The results of this study confirm the importance of integrating digital tools geared towards creative production, such as video animation software, into collaborative and reflective educational ecosystems. Quantitative evidence showed a statistically significant increase in engagement in all three dimensions – behavioural, emotional and cognitive – among the experimental group. Qualitative analysis revealed that this increase was deeply rooted in the embodied–distributed practices activated during the course. The ability to translate disciplinary concepts into multimodal artefacts, act in flexible classroom spaces and collaborate iteratively has fostered situated meaning processes and deeper student involvement.

These results align with theoretical perspectives interpreting learning as a phenomenon that emerges from the dynamic interaction between the body, the environment, and artefacts (Varela, Thompson, & Rosch, 1991; Hutchins, 1995; Gallagher, 2005). This confirms that technologies do not merely act as neutral mediators but as co-agents in the construction of knowledge (Latour, 2005; Rivoltella, 2020). Similarly, the increases in engagement are consistent with literature recognising active, collaborative and productive contexts as powerful motivational and conceptual mastery factors (Skinner, 2016; Sinatra, Heddy & Lombardi, 2015). The qualitative results in particular highlighted how the multimodal and project-based dimension contributes to the development of student agency. They outlined modes of participation that enhance the plurality of skills and forms of expression. This is in line with recent evidence on the effectiveness of video production in educational contexts (Yang et al., 2022; Bachri & Putra, 2023).

From a pedagogical perspective, the study suggests that the adoption of digital tools requires a comprehensive rethinking of teaching methods, which cannot be reduced to the occasional use of technology, but must take the form of designing socio-technical environments in which cognition, physicality and media are integrated in a systematic way. Three dimensions emerge as particularly relevant:

1. the provision of flexible spaces that encourage movement, negotiation and co-construction;
2. the centrality of iterative processes based on feedback and review;
3. the role of the teacher as facilitator and co-regulator of technological mediation.

At the same time, some critical issues observed – such as the need for instrumental literacy and project time management – indicate that scaffolding, planning and coordination strategies are essential for these activities to be sustainable and transferable.

The limitations of the study include the limited duration of the intervention, the composition of the sample and the absence of direct measures of disciplinary learning or longitudinal effects. Future research could extend the investigation to heterogeneous school contexts, include analyses of disciplinary and metacognitive learning, and explore the persistence of effects in terms of agency and collaboration, as suggested by recent contributions on socio-technological education (Truss, 2024).

Overall, the study makes a valuable contribution to the debate on co-evolutionary pedagogies by demonstrating how the deliberate incorporation of creative technologies can facilitate the concept of extended, embodied and distributed learning. In this approach, digital artefacts become an integral component of the educational ecosystem. This approach is particularly promising for designing educational environments that promote deeper, more creative and conscious participation, thereby contributing to the development of agentic and reflective subjectivities within human-environment-technology networks.

Conducted in a lower secondary school with 120 students (60 in the experimental group and 60 in the control group), the study shows that introducing the Animaker tool into an environment designed for physical, technological and social interaction can significantly increase student engagement compared to traditional teaching methods. The data suggest that this increase in engagement bodes well for a pedagogy that considers learning to be an embodied phenomenon distributed and mediated by technical artefacts. In practical terms, designing 'smart' learning environments requires reflection on the interplay between technology, space, body and interaction, as well as the introduction of technologies. Therefore, future research should not only explore engagement, but also effectiveness in terms of learning outcomes, measuring other dimensions such as agency and socio-culture. In terms of school practices, the experiment encourages schools to adopt methods that prioritise production, movement, collaboration, and reflection on tools and environments. Rather than just 'teaching lessons', schools should 'inhabit a co-evolutionary learning space'.

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