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# Optimizing differentiated podcasts to promote students' self-regulation and engagement, self-efficacy and performance in asynchronous learning

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## Abstract

**Purpose** – Our study focuses on providing empirical evidence regarding the optimization of podcasting in asynchronous learning. This action research aimed to innovate the delivery of asynchronous classes using differentiated podcasts.

**Design/methodology/approach** – We utilized action research as the research design for the study. Participating in action research entails developing practical knowledge to improve educational practices through specific methods and critical perspectives (Sáez Bondía and Cortés Gracia, 2022). According to Burns (2007), action research involves deliberate interventions usually prompted by identified issues, mysteries or inquiries that individuals in the social setting seek to improve or change. Implementing changes to enhance individuals' actions and understanding within their context is the focus of action research (Kemmis, 2010). The study's approach is ideal for examining new practices and gaining enhanced theoretical insights (Altrichter *et al*., 2002). Engaging in action research helps enhance understanding and empowers us to impact and enhance practices through continuous reflection, exploration and action. Through this iterative process, we can continuously enhance our comprehension and make substantial strides toward fostering positive transformation.

**Findings** – The study findings showed an apparent rise in student regulation and engagement and remarkable enhancements in learning outcomes, as demonstrated by differences in pre-test and final exam scores. These results highlight the actual effect of specialized podcasts on self-paced inducing students' self-efficacy in learning. Our research provides valuable insights on effectively incorporating podcasts into education, offering innovations and improvement of practice among educators and institutions adapting to the ever-changing landscape of the educational environment while catering to the diverse needs of the learners. This research is pioneering research catering to the various learning styles of asynchronous learning environments.

**Research limitations/implications** – Although our current sample offered valuable insights, upcoming studies could gain from more extensive and more diverse participant groups to strengthen the reliability of our results and guarantee broader applicability across various demographics and contexts. Moreover, the length of our intervention may have been relatively brief, which could have limited our ability to evaluate the long-term impact of customized podcasts on learning results. Continued investigation into the long-term effects of these interventions could provide valuable insights into their effectiveness over time and help shape the creation of more lasting educational approaches.



We express our sincere appreciation for the invaluable contributions of the students in this study. We also thank the members of the professional learning community who helped us with the preparation of the intervention. We greatly valued their expertise, insights and support throughout this intervention.

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**Practical implications** – Innovation in asynchronous learning differentiated teaching attuned to the diverse learning styles of the students.
**Social implications** – The study promotes equitable education, which eventually promotes learning outcomes of the students.
**Originality/value** – We created differentiated podcasts tailored to the learning styles of the students. This research is pioneering research catering to the various learning styles of asynchronous learning environments.

**Keywords** Asynchronous learning, Student's self-efficacy, Engagement, Regulation, Podcasts
**Paper type** Research paper

## Introduction

Education institutions experience a remarkable shift, marked by seamless information sharing and enhanced connectivity. This shift is becoming increasingly popular as it promotes unique and individualized learning experiences (Wang, 2022). Asynchronous learning emerged as a vital platform for delivering essential knowledge (Kositanurit *et al.*, 2022) due to the intermittent interaction (Carr, 2012). It expands physical distance between teachers and students, allowing learners to study at their convenience (Gaur *et al.*, 2020). According to Van der Keylen *et al.* (2020), this approach enhances accessibility of educational materials, regardless of geographical and time constraints.

Media richness theories (Daft and Lengel, 1984; Blau *et al.*, 2017) form the foundation of asynchronous learning, which investigates the efficacy of various communication channels in transmitting knowledge while accommodating diverse communication styles and preferences. This approach emphasizes the significant impact of media-based learning on knowledge transfer (Weiß and König, 2023). Using appropriate media to improve interaction and social presence, it substantially impacts users' learning experiences in virtual environments (Guo *et al.*, 2021). A recent study has focused on the importance of media richness in affecting user retention on online learning platforms, revealing a high association between users' willingness to continue using these platforms and the level of media richness provided (Wang, 2022).

However, there is a need for more comprehensive information in the existing body of literature regarding the specific role of media richness in asynchronous learning to support inclusive education. There is a notable need for improvement in implementing media-driven innovations that simultaneously enhance self-directed learning. Furthermore, we require more empirical evidence to substantiate the advantageous impacts of these strategies in asynchronous learning environments.

The present study highlights the capacity of podcasting as a cutting-edge tool for augmenting asynchronous learning. Podcasting has demonstrated its efficacy and ability to captivate learners by employing media richness theories (Fabriz *et al.*, 2021). It has broadened the scope of knowledge sharing, going beyond the confines of traditional academic boundaries (Brehm, 2022). Additionally, it promotes the development of "virtual communities," which are valuable sources of learning support (Berk *et al.*, 2020) to establish stronger ties between students, knowledge, teachers and the greater community (Kendrick *et al.*, 2023). Although podcasts are gaining recognition as innovative tools, Hanafi *et al.* (2022) noted that further research must determine the most influential podcast structures for learning to explore their integration into formal curricula. Essentially to investigate the impact of consumption on learning outcomes and behavioral changes using this tool (Hanafi *et al.*, 2022).

### *Background of the study*

Podcasts have grown from audio storytelling to media that allows seamless streaming and downloading of content over the internet and mobile devices (Hanafi *et al.*, 2022). These

improvements demonstrate the capacity of audio media, such as traditional broadcast radio and podcasts, to captivate and enlighten people about scientific fields (Sanchez and Granado, 2024). Recent research demonstrates podcasts' diverse applications and growing acceptance as innovative instructional media.

Podcasts provide an adaptable learning experience based on individual preferences (Chapa *et al.*, 2022; Kelly *et al.*, 2022; Matava *et al.*, 2013; Jalali *et al.*, 2011). They come in various formats, from audio-only to vidcasts, combining video and audio and even improved audio files with visual elements such as PowerPoint presentations. Scholars such as Rosell-Aguilar (2007) and Supanakorn-Davila and Bollinger (2014) provide significant insights into various educational applications and ways for engaging users effectively. Thus, have a multitude of capabilities toward self-directed learning (Broadbent and Poon, 2015; Broadbent *et al.*, 2021).

Podcasts are a contemporary method of students' learning. Extensive research has examined their impact to enhance critical thinking by reviewing classroom content and instruction (Shumack and Gilchrist, 2009). Recent studies have shown that podcasts promote narrative learning and empathy (Crooks *et al.*, 2023; Davidson *et al.*, 2019; Hatfield, 2018). It enhances storytelling abilities, hence promoting logical thinking (Vandenberg, 2018). Similar research highlights podcasts to advance speaking and listening abilities (Chaves-Yuste and de-la Peña, 2023) and deliver audio-based instructions effectively (Koehler *et al.*, 2022). These findings contribute to a more comprehensive understanding of the role of podcasts in education.

Podcasts demonstrate the broadening of digital technology in education. The widespread acceptance of digital audio and video formats is highly valued for their effectiveness in enhancing instructional delivery and supporting student learning (McGarr, 2009) and valuable tools for teaching (On Tam, 2012). Gurran (2018) and Sen *et al.* (2017) have thoroughly explored the positive effects of podcasts on student interaction, integration of inquiry methods and facilitation of innovative communication.

*Research questions.* This study aims to enhance asynchronous learning delivery through personalized podcasts. We proposed using tailored podcasts based on students' learning preferences to complement online learning. We sought to explore the following research questions:

*RQ1.* What is the students' regulation and engagement in differentiated podcasts?

*RQ2.* What is the effect of podcasting on students' regulation and engagement, self-efficacy and long exam gains?

*RQ3.* Is there a significant difference in the long exam performance of the students throughout the intervention?

### *Theoretical framework*

The current study has its theoretical grounding in the cognitive theory of multimedia learning (CTML). According to Cavanagh and Kiersch (2023), CTML provides valuable insights for instructional designers in various crucial areas. It recommends utilizing slide-sharing programs to develop succinct, narrated animation segments, thereby improving the clarity and engagement of instructional content. Additionally, CTML suggests integrating questions and prompts between these segments, fostering generative learning activities. Furthermore, it advises making use of video-sharing platforms to empower learners with control over specific aspects of the instructional experience, thus creating a more personalized and engaging learning environment Cavanagh and Kiersch (2023).

In CTML, the introduction of multimedia into the learning process fits with human cognition (Almasseri and AlHojailan, 2019). It addresses how educational multimedia designs

assist human understanding of the load on the verbal/auditory and graphics/visual channels, akin to memory models (Paivio, 1990; Baddeley, 1997; Mayer, 2017). CTML originates mental cognition and learning paradigms from Pavio's dual coding theory as well as Sweller's cognitive load theory with its purpose of developing instructional design principles that enhance learners' active processing and create meaningful representations of learning material (Trypke *et al.*, 2023).

One theory that explores the relationship between verbal and nonverbal representations and their impact on human action and experience is Clark and Paivio's (1991) dual coding theory. According to this theory, cognition integrates visual and verbal information to encode and represent knowledge. It is important to note that the human mind processes these two types of information through different channels, resulting in distinct representations for each modality. In addition, the connection between verbal and nonverbal systems has been shown to enhance memory recall and learning results (Paivio, 1991; Al-Seghayer, 2001).

Paivio (1986) and Clark and Paivio (1991) have identified three forms of processing in verbal and nonverbal/visual systems: representational, referential and associative. The representational processing involves the identification of verbal or visual representations through stimuli. Verbal expressions and visual representations affect our perception. For example, the process begins by activating logos and images through stimulus recognition, similar to the template-matching process in stimulus recognition (Paivio, 2014). Referential processing is a cognitive process that involves the activation of words or visuals. This activation helps recognize objects and recall mental images, leading to improved comprehension. The associative processing using representational or referential systems enables the establishment of connections between linguistic units and visual images. Rieber (1994) suggests using pictures and visuals alongside unfamiliar words can be a powerful teaching technique. It enhances memory tests by going beyond words alone, enabling learners to recall and retain words more efficiently.

Then, the cognitive load theory, expanding on the coding theory, tackles cognition on human working memory during learning and problem-solving (Trypke *et al.*, 2023). The concept of cognitive load is essential in creating practical learning experiences and instructional designs (Sweller, 1994). Mayer (2009) categorized this cognitive loading as intrinsic, germaine and extraneous. The *intrinsic cognitive load* is an essential factor in acquiring new information. It plays a crucial role in selecting and organizing the information that needs to be stored in the working memory (Mayer, 2009). According to Clark *et al.* (2006), various factors can impact cognitive loading, such as the type of material, schema and contextual framing.

Furthermore, the relevant cognitive loading is what Mayer (2009) described as *germaine* processing. The *germaine* cognitive loading involves understanding new information by reconfiguring the framework and incorporating previous knowledge. Mayer (2008) asserts that complex learning tasks and deep cognitive engagement are closely linked to an intrinsic cognitive load. The *extraneous* processing relates to irrelevant materials in the lesson. Mayer (2009) stated that this could hinder cognitive processing without adding to the learning experience. These encompass various visual elements that lack a clear purpose, excessive details and unnecessary animation.

Essentially, CTML explores how individuals gain knowledge from various types of media and presentations. As a fundamental concept, learners can acquire knowledge through visual aids like static images, GIFs, videos and written and spoken words (Almasseri and AlHojailan, 2019). Together, they function more effectively than alone (Clark and Mayer, 2016). Highlighting the significance of creating strong connections between words and visuals and actively processing these connections to remember information effectively in the long run (Mayer, 1997, 2005). In Mayer's (2014) study, sensory information processes two channels: auditory and verbal elements and visual and pictorial elements. The auditory/

verbal channel is responsible for processing spoken words, narrations or sounds received through the ears. On the other hand, people perceive and interpret images, graphs, videos/animations and other visual stimuli through the visual/pictorial channel using their eyes. However, working memory limits learners' capacity to process information in multiple channels. When a learning task becomes too challenging for the learner, it can result in cognitive overload.

Furthermore, it is essential to acknowledge that the verbal channel of working memory has a restricted capacity, as it can only retain a specific amount of information at any given moment (Mayer, 2014). CTML entails a dynamic process in which individuals choose and organize words and images, blending them with their prior knowledge retrieved from long-term memory and transferred to short-term memory to enhance processing. The process entails choosing appropriate words and images to process in the relevant working memory channels, arranging these elements into verbal and pictorial models and integrating them with relevant past information to improve comprehension and memory retention (Mayer, 2014).

## Method

### *Research design*

We utilized action research as the research design for the study. Participating in action research entails developing practical knowledge to improve educational practices through specific methods and critical perspectives (Sáez Bondía and Cortés Gracia, 2022). According to Burns (2007), action research involves deliberate interventions usually prompted by identified issues, mysteries or inquiries that individuals in the social setting seek to improve or change. Implementing changes to enhance individuals' actions and understanding within their context is the focus of action research (Kemmis, 2010). The study's approach is ideal for examining new practices and gaining enhanced theoretical insights (Altrichter *et al.*, 2002). Engaging in action research helps enhance understanding and empowers us to impact and enhance practices through continuous reflection, exploration and action. Through this iterative process, we can continuously enhance our comprehension and make substantial strides toward fostering positive transformation.

### *Research strategy*

The study utilized a plan-do-study-act (PDSA) to optimize the intervention's utilization. The PDSA cycles provide a rigid structure for the iterative testing and refinement of changes to improve the system's quality (Knudsen *et al.*, 2019; Taylor *et al.*, 2014). It is particularly effective in promoting active learning sessions, increasing student satisfaction and facilitating learning outcomes (Rose *et al.*, 2021).

The goal of the *plan* phase was to improve asynchronous learning by using personalized podcasts for delivery. Personalization recognizes a variety of learning preferences to accommodate students' varied learning requirements and cultivate an encouraging atmosphere that nurtures scholastic achievement and development (Ojeh *et al.*, 2017). Although learning preference reflects students' learning styles and approaches (Liew *et al.*, 2015), in the context of CTML, students use learning preferences to engage in cognition and actively create meaningful representations. Learning preference, as part of our framework, explores media processing such as representation (i.e. verbal or visual), referential (i.e. activation or words) and associative (i.e. words and images). Thus, we determined three fundamental learning preferences in asynchronous learning, namely – audio, visual and audio–visual or combined audio and visual.

First is audio learning preference. We argue that the students can listen while doing other tasks, allowing them to engage without constantly looking at a screen (Condayan, 2008). *High-quality audio* is a motivational method that effectively supports autonomy and relatedness, which are basic psychological requirements (Weinstein *et al.*, 2022). Second is the visual learning preference. Visual and textual elements convey the information in video format without accompanying audio components. Videos can enhance learning motivation and interest by providing authentic learning settings, opportunities for multi-perspective observation and learning opportunities (Rosendahl and Wagner, 2024). Finally, audio–visual preference offers a valuable opportunity for students to immerse themselves in authentic language and gain a deeper understanding of cultural and situational contexts (Shaojie *et al.*, 2022). This approach subsequently enhances their understanding, maintaining engagement throughout auditory task input, the type of video and the interaction between audio and visual elements (Shaojie *et al.*, 2022).

The *do* phase refers to the podcasts' development phase. In this context, our goal is to innovate our podcasts by acknowledging the channel of working memory. In the intervention materials, we integrated generative processing (i.e. voice and embodiment) and reduced extraneous processing (i.e. audio or visual). We further managed the essential processing through a micro-lecture format. Our podcasts were developed coherently with synchronous learning to reinforce cognition. As we curated our podcasts, we segmented the content to engage, explain and elaborate essential discussion on the same topic to cater to the learning preferences.

In the first two (e.g. audio or visual), we eliminated extraneous cognitive processing to strengthen the connections between media processing and later storage in long-term memory. We designed a purely audio podcast as the simplest form of micro-lecture listening and voice-over as materials. Through the audio podcasts, the students can actively participate in the discussion using their playlists and audio, as Oslawski-Lopez and Kordsmeier (2021) recommended for improving focus and understanding. On the other hand, the visual podcast is a unique variation of the micro-lecture, featuring a combination of text and graphics in a video podcast (vidcast) format. According to Kalludi *et al.* (2015), vidcasts significantly enhance the educational experience by providing a reliable source of information amid the vast amount of online content. Instructors can enhance the use of vidcasts by considering cognitive load, student engagement and practical strategies for active learning (Brame, 2016).

Finally, combining the first two (e.g. audio and visual), also known as audio–visual podcasts, enables higher levels of personalization, accommodating diverse learner needs and preferences. The integration of auditory and visual elements in audio–visual media facilitates the seamless exchange of information, creating an environment conducive to deep understanding (Errabo *et al.*, 2024). O'Bannon *et al.* (2011) found that integrating audio–visual podcasts into educational environments enhances the learning experience by offering adaptable learning opportunities. It incorporates credibility, relevance and legitimacy (Chivers *et al.*, 2023) while effectively disseminating knowledge and fostering a clear sense of purpose (Weiß and König, 2023).

The *study* phase involved the optimization and monitoring of students' use of the podcasts. We used a quasi-experimental design and a time-series approach to evaluate the optimization of podcasts. Quasi-experimental research strategies strive to recreate experimental conditions by allocating individuals to receive treatment (Gopalan *et al.*, 2020). Therefore, it offers an understanding of the cause-and-effect outcomes of various educational interventions (Campbell, 1957). It then delves into how an intervention has led to a notable shift in the observed result and measures the magnitude of this shift. This strategy provides an unbiased estimate of the average treatment effect and is a benchmark for upcoming evaluations of causal impact (Campbell, 1957; Gopalan *et al.*, 2020).

In addition, a time-series approach explores the connections and interdependencies between data points gathered at various times (Diebold *et al.*, 2010). A time series methodology allows researchers to pinpoint trends accurately (McCleary *et al.*, 1980; Hyndman and Athanasopoulos, 2014). This approach is advantageous for capturing variability and ensuring an accurate data representation. The trends derive from consistent patterns identified through interventions (Jebb *et al.*, 2015). Likewise, it is essential for identifying patterns, trends and seasonal variations in time-ordered data, enabling more precise forecasting and comprehension of dynamic processes over time (Casolaro *et al.*, 2023). Hence, we can discover hidden structures and accurately predict future behavior for refining the intervention.

Finally, in the act phase, we took the opportunity to expand our analysis and incorporate valuable feedback to enhance the implementation of our intervention. Using a two-round quasi-experimental design, we examined how the integration of podcasting as an instructional tool affected temporal changes and variations in response. After receiving feedback from student users, we implemented instructional improvements. This cycle included batches 1 and 2 of our data analysis.

### *Research participants*

The study involved three cohort groups with a total of 92 first-year students taking a fully online Botany class. A learning preference inventory helped them determine a personalized approach toward this intervention. The students fully participated in the activity and extended their consent for the data usage.

### *Research materials*

Our research has led us to develop personalized podcasts ($N = 39$). These podcasts explore essential Botany topics, covering everything from the detailed aspects of plant organs like fruits to the broader understanding of system-level concepts such as the shoot system. Every podcast is carefully crafted as a micro-lecture, following the 3 Es instructional model – engagement, explanation and elaboration – to enrich the learning experience for our listeners.

First *engages* students in learning using a podcast of their choice. Second, the podcasts *explains* relevant concepts using clear, concise and practical media to aid comprehension. Finally, the third underscores detailed *elaborations*. Elaboration encourages students to delve deeper and discover more grasp and mastery of the material.

### *Research instruments*

To ensure the robustness and reliability of our research methodology, we integrated established psychometric tools alongside innovative assessment techniques. Specifically, we employed the Academic and Self-Regulation Scale, initially developed by Akhtar and Mahmood (2013), which encompasses five pivotal dimensions of self-regulation: self-planning, self-monitoring, self-instruction and self-reaction. This scale has demonstrated strong internal consistency, with an alpha coefficient of 0.83, indicating its reliability in measuring the constructs of interest. Additionally, we incorporated the Self-Efficacy Inventory by Muris (2001), which assesses three critical domains: social self-efficacy, academic self-efficacy and self-regulation, further substantiated by its internal consistency (alpha = 0.88).

To examine the effects of podcasting on student learning and knowledge acquisition, we designed and implemented teacher-made tests. These assessments included two phases: conducting an initial test to determine students' baseline knowledge before exposure to the podcast content and administering a final test to assess their learning outcomes after the

intervention. Each test comprised 80 questions aligned with the core topics and principles disseminated through the podcasts. By employing a parallel test structure, we ensured a reliable and consistent evaluation of our intervention.

*Data collection*

Prior to integrating podcasts into our curriculum, we implemented a pre-test as an additional assessment in addition to the final evaluation. This pre-test aimed to gauge students' understanding and establish a baseline for future comparisons. Throughout the study, students engaged in synchronous learning sessions twice a week and independent and asynchronous learning activities. The asynchronous component spanned eight weeks within the 14-week course, commencing in week six and concluding in week 14.

Two comprehensive examinations occurred during this intervention period: one in week 10 and the other in week 14. We utilized Canvas®'s built-in exam feature to facilitate both asynchronous and simultaneous student participation. In the final two weeks of the intervention, we distributed questionnaire inventories to gather data on participants' utilization and confidence in using the podcast for their learning. Self-reported self-regulation, engagement and self-efficacy surveys were dispersed via Google Forms®, enabling efficient data collection and analysis.

*Data analysis*

We assessed the students' regulation, enagagement and self-efficacy by analyzing the feedback from their self-reported questionnaires. We analyzed the data using the interval scale and generalized the scores using mean and standard deviation. We presented a comparison of data between batches 1 and 2 to illustrate the implementation's effectiveness and highlight the trends of our intervention over time. Additionally, we compared the results across learning preferences.

Subsequently, we conducted a thorough analysis of the student's performance by examining the results of the long exam using statistical measures such as mean and standard deviation. We also calculated the gains score to measure performance improvement from the pre-test to the post-test and explored normalized gains for deeper insights into how student performance improved relative to each other. A *t*-test was used to determine the statistical significance of the differences between pre-test and post-test results.

## Results

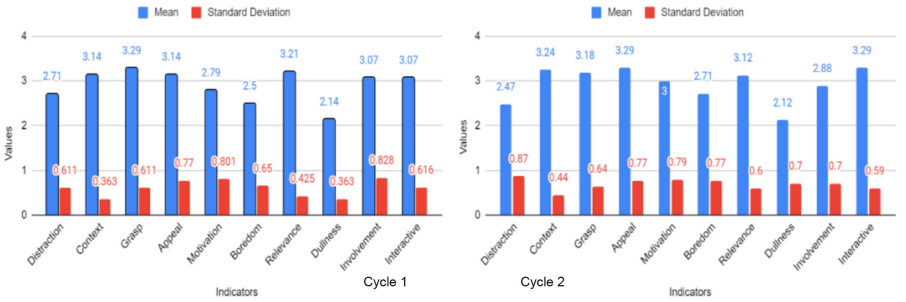
Figure 1 presents the students' regulation and engagement of the audio podcasts.

Figure 1 shows audio learners' regulation and engagement levels in podcast activities in two groups. Audio learners in cycle 1 show a consistently high level of engagement in the podcasting activity. The engagement levels show improvement in the second administration batch, with enhancements in critical factors such as context, grasp, appeal, motivation, relevance, involvement and interactivity.

Furthermore, in cycle 1, audio learners raised issues regarding the podcast content, possibly leading to distraction (mean = 2.47; sd = 0.87) and boredom (mean = 2.12; sd = 0.7), indicating a somewhat engaged position. Cycle 2 shows an apparent reduction in perceived distraction and dullness.

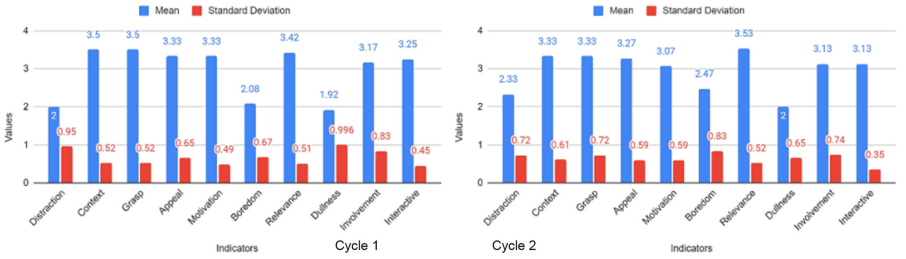
Figure 2 presents the students' regulation and engagement of the visual podcasts.

Figure 2 shows the regulation and engagement levels of visual learners involved in podcast activities in two groups. In cycle 1, visual learners show significant engagement with podcasting activities. This engagement demonstrates a decrease in cycle 2, especially in




**Note(s):** 3.50-4.00 – Highly regulated and engaged; 2.50-3.49 – Regulated and engaged; 1.50-2.49 – Moderately regulated and engaged; 1.00-1.49 – Disregulated and disengaged
**Source(s):** Figure by the authors

**Figure 1.**
Students' regulation and engagement of audio podcasts




**Note(s):** 3.50-4.00 – Highly regulated and engaged; 2.50-3.49 – Regulated and engaged; 1.50-2.49 – Moderately regulated and engaged; 1.00-1.49 – Disregulated and disengaged
**Source(s):** Figure by the authors

**Figure 2.**
Students' regulation and engagement of visual podcasts

essential aspects like context, grasp, involvement and interactivity. Relevance has significantly increased from moderate to high engagement levels (mean = 3.53; sd = 0.52).

The data shows consistent results regarding appeal (mean = 3.27; sd = 0.59) and motivation (mean = 3.07; sd = 0.59), suggesting an regulated and engaged stance. Furthermore, there have been positive changes noted in boredom (mean = 2.47; sd = 0.83) and distraction (mean = 2.33; sd = 0.72) as well as a decrease in perceived dullness (mean = 2.00; sd = 0.65), keeping a moderately regulated and engaged stance.

Figure 3 presents the students' regulation and engagement of the audio–visual podcasts.

Figure 3 shows the regulation and engagement levels of audio–visual learners involved in podcast activities. Audio–visual learners in cycle 1 show an early interest in the podcasting activity, which remains consistent and steady in cycle 2. The metrics related to essential aspects like context, grasp, appeal, motivation, relevance, involvement and interactivity show steady levels of engagement with means ranging from 2.8 to 3.4 and standard deviations from 0.32 to 0.74.

Moreover, audio–visual learners have decreased perceived distraction (average = 2.3; standard deviation = 0.67) and a lower level of boredom (average = 2.4; standard deviation = 0.52) while utilizing the podcasts. There is a moderate level of engagement in response to perceived dullness, with a mean of 2.0 and a standard deviation of 0.67.

Figure 4 provides a comprehensive overview of the student's self-regulation and engagement.

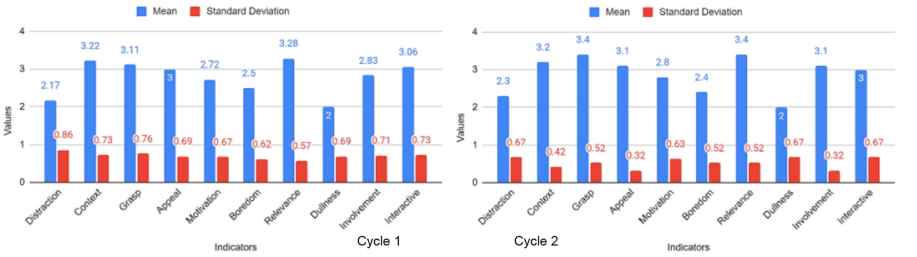



**Figure 3.**
Students' regulation and engagement of audio–visual podcasts

**Note(s):** 3.50-4.00 – Highly regulated and engaged; 2.50-3.49 – Regulated and engaged; 1.50-2.49 – Moderately regulated and engaged; 1.00-1.49 – Disregulated and disengaged
**Source(s):** Figure by the authors

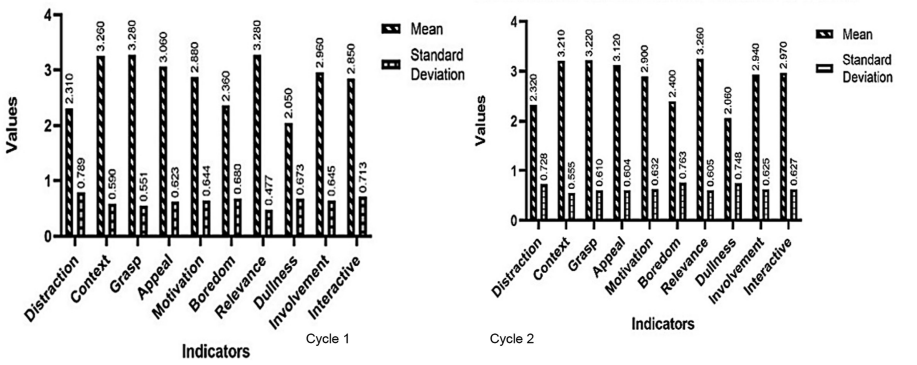



**Figure 4.**
Students' regulation and engagement

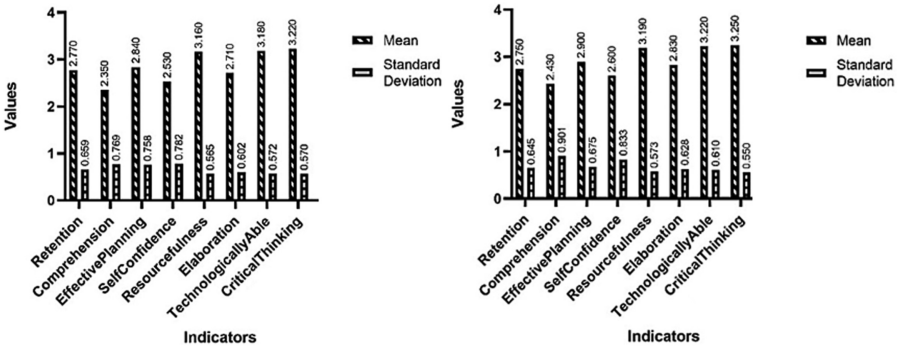
**Note(s):** 3.50-4.00 – Highly regulated and engaged; 2.50-3.49 – Regulated and engaged; 1.50-2.49 – Moderately regulated and engaged; 1.00-1.49 – Disregulated and disengaged
**Source(s):** Figure by the authors

Figure 4 shows consistent trends in behavior for both study groups. In cycle 1, 70% ($n = 7$) of the metrics showed active student participation. Our indicators covered contextual relevance (mean = 3.260; sd = 0.590), content comprehension (mean = 3.28; sd = 0.51), material appeal (mean = 3.06; sd = 0.62) and perceived content significance (mean = 3.28; sd = 0.47).

In cycle 2, we found consistent results, showing that 70% ($n = 4$) of the indicators demonstrated continued interest. Students were highly interested in aspects such as contextual relevance (mean = 3.26; sd = 0.59), knowledge of content (mean = 3.22; sd = 0.61), material appeal (mean = 3.12; db = 0.60) and relevance of content (mean = 3.26; sd = 0.60). The consistent results indicate a steady level of involvement in both groups.

Moderate engagement was consistently seen, especially in aspects like distraction (mean = 2.31; sd = 0.78), boredom (mean = 2.36; sd = 0.68) and dullness (mean = 2.05; sd = 0.67). In the second cycle, distraction had a mean of 3.20 with a standard deviation of 0.72, boredom with a mean of 2.40 with a standard deviation of 0.76 and dullness with a mean of 2.60 with a standard deviation of 0.74, all showing moderate levels. The results indicate that negative factors did not directly impede students' overall regulation and engagement despite occasional interruptions or feelings of boredom.

Figure 5 provides a comprehensive view of students' self-efficacy.




**Note(s):** 3.50-4.00 – Very High; 2.50-3.49 - High; 1.50-2.49 - Moderate; 1.00-1.49 - Low
**Source(s):** Figure by the authors

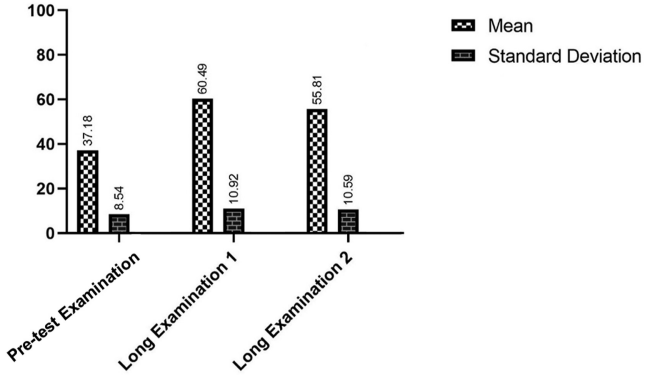
**Figure 5.**
Self-efficacy results

Figure 5 reveals remarkably comparable trends in both cohorts. In cycle 1, we observed that 88% ($n = 7$) of the indicators showed significantly high levels of self-efficacy in pupils. The indicators included retention (mean = 2.77; sd = 0.65), effective planning (mean = 2.60; sd = 0.75), self-confidence (mean = 2.53; sd = 0.60), resourcefulness (mean = 3.16; sd = 0.56), elaboration (mean = 2.71; sd = 0.57), technological adeptness (mean = 3.18; sd = 0.57) and critical thinking (mean = 3.22; sd = 0.57).

In cycle 2, 88% ($n = 7$) of the indicators consistently showed sustained high levels of efficacy. Retention, effective planning, self-confidence, resourcefulness, elaboration, technological adeptness and critical thinking showed substantial levels of self-efficacy, with means ranging from 2.53 to 3.25 and standard deviations ranging from 0.55 to 0.67. The consistent results indicate a sustained level of effectiveness in both batches, demonstrating high confidence and proficiency among students in many academic areas.

Figure 6 comprehensively compares the students' academic achievement on a set of long exams.

Figure 6 shows that the average scores for the first long exam (mean = 60.49; sd = 10.92) and the second long exam (mean = 55.81; sd = 10.59) were higher than those of the pre-test (mean = 37.81; sd = 8.54). This vast difference in performance shows a notable improvement




**Source(s):** Figure by the authors

**Figure 6.**
Long exam performance

in long exam performance, with students making substantial progress before the intervention.

There was a minor decline of about 5 points in performance between the first and second long exams, but the performance in the second exam was still much more excellent than that of the pre-test. This slight decrease indicates a favorable result of the intervention's efficacy. The students maintained high performance levels consistently throughout the research, showing a steady improvement trend.

Table 1 displays the results of a paired *t*-test, in the long exams.

In Table 1, the first long exam results showed a statistically significant difference, with $t(83) = -16.697$, $p < 0.05$. The comparison between the pre-test and lengthy exam scores shows a significant improvement in student performance, with a mean difference of −23.30 and a standard deviation of 12.79. Similarly, the results of the second long exam showed a statistically significant difference, indicating $(t(83) = -14.249, p < 0.05)$. The average difference between the pre-test and long exam results was −18.63, with a standard deviation of 11.98.

Table 2 shows the paired effect sizes for the pre-test and long Exams 1 and 2.

In Table 2, the effect sizes computed for comparisons are notably large, suggesting a substantial influence of the intervention on students' academic achievement. The pre-test and long Exam 1 had a significant effect size of $d = 1.82$, signifying a notable enhancement in student performance between the initial and subsequent assessments. Similarly, a substantial effect size of $d = 1.55$ was found in comparing the pre-test and long Exam 2. The intervention had a solid and continuous favorable impact on students' academic achievement during the second long exam. Both effect sizes demonstrate a notable influence of the intervention on students' performance in the long examinations.

## Discussion

Asynchronous learning democratizes education. It opened up new possibilities for students to take charge and learn independently (de Brito Lima *et al.*, 2021; Jansen *et al.*, 2020) by

| | Mean | SD | Std Error | Lower | Upper | T | df | One sided p | Two sided p |
|---|---|---|---|---|---|---|---|---|---|
| Pre-test long Exam 1 | −23.30 | 12.79 | 1.39 | −26.08 | −20.53 | −16.69 | 83 | <0.001 | <0.001 |
| Pre-test long Exam 2 | −18.63 | 11.98 | 1.30 | −21.23 | −16.03 | −14.24 | 83 | <0.001 | <0.001 |

**Table 1.**
Paired *t*-test results

**Source(s):** Table by the authors

| | | | | 95% confidence interval | |
|---|---|---|---|---|---|
| | | Standardizer[a] | Point estimate | Lower | Upper |
| Pre-test – long Exam 1 | Cohen's d | 12.79493 | 1.822 | 2.169 | 1.470 |
| | Hedges' correction | 12.91202 | 1.805 | 2.150 | 1.457 |
| Pre-test – long Exam 1 | Cohen's d | 12.79493 | 1.822 | 2.169 | 1.470 |
| | Hedges' correction | 12.91202 | 1.805 | 2.150 | 1.457 |

**Table 2.**
Paired *t*-test results

**Note(s):** [a]The denominator used in estimating the effect sizes

**Source(s):** Table by the authors

promoting engagement (Schneider and Preckel, 2017) and developing self-regulation skills to thrive in independent learning settings (Jin *et al.*, 2023). Technology's rapid progress has opened up countless possibilities for independent and self-directed learning.

*Self-regulation and engagement*

Differentiated podcasts promote students self-regulation. We noted that self-regulation developed in the audio, visual and audio–visual podcasts. Russell *et al.* (2020) described self-regulation in managing and directing learning independently. It involves setting goals, creating plans, employing effective task strategies, managing time efficiently, reflecting on past learning experiences and adapting to learning methods (Nugent *et al.*, 2019). The social cognitive theory (SCT) illustrates how students acquire knowledge, beliefs and attitudes from their social environment (Bandura, 1986, 2005, 2006).

Moreover, SCT orchestrates vicarious learning. For instance, the feedback in the utilization of podcasts proved to enhance contextual understanding, content comprehension and interaction, resulting in an independent learning experience. Our design caters content specific to individuals' learning preferences, offering various interactive media to effectively boost student motivation. Podcast engagement centers on relevant cognitive processing, including generative processing, reduction of extraneous processing and development of essential processing alongside audio, visual and audio–visual learning preferences.

Differentiated podcasts co-regulate and boost engagement. In the same manner, a consistent engagement in the audio, visual and audio–visual podcasts. Rogat and Linnebrink-Garcia (2011) explained that this interaction enhances individuals' self-regulation and demonstrates co-regulation using collaborative classroom activities (Yarbro *et al.*, 2014). Students' self-regulation can transform into co-regulation as they participate in collaborative classroom activities, allowing them to meet the demands of the learning (Park and Kim, 2022). It involves adjusting individual strategies to fit the collaborative learning environment, as Hadwin and Oshige (2011) explained, while DiDonato (2013) stated that co-regulation is developing self-regulation skills through working with peers.

Podcasts are a valuable tool for students to enhance their comprehension of the material and increase their involvement in classroom activities (Park and Kim, 2022). Engagement in learning involves various dimensions, including cognitive, emotional and behavioral aspects (Christenson *et al.*, 2012; Handelsman *et al.*, 2005). The relationship between learning motivation, cognitive engagement and acquiring new knowledge and skills is closely intertwined, as highlighted by Yazzie-Mintz and McCormick (2012). Additionally, the notion of emotional engagement emphasizes the significant role of students' emotions and feelings, including their levels of interest or boredom, within the educational environment, as discussed by Wang and Holcombe in 2010. Behavioral engagement emphasizes the importance of students actively participating in their learning. This includes interacting with their peers in group work and seeking instructor help for assigned tasks and activities (Handelsman *et al.*, 2005). Research shows that giving students assignments that are authentic and meaningful engages them more (Wang and Eccles, 2013).

In similar contexts, teachers can enhance students' active participation in a flipped learning setting by offering a variety of learning tasks, establishing an adaptable atmosphere and cultivating a student-focused environment (Chen *et al.*, 2014). Through the incorporation of podcasts and other technology-based tools, students have the opportunity to develop self-regulation skills before engaging in classroom activities.

*Students' self-efficacy*

Differentiated podcasts have been shown to significantly promote students' self-efficacy by demonstrating sustained effectiveness, which leads to increased confidence and proficiency.

This improvement in self-efficacy is vital for enhancing academic performance and personal well-being. Self-efficacy, a key component of Bandura's SCT, is an individual's belief in their ability to complete activities and accomplish desired results. This assumption affects their sense of task difficulty, effort level and persistence in confronting problems, eventually influencing their goal-setting behaviors and resilience (Bandura, 1978, 1997; Barnett, 2014). High self-efficacy is associated with establishing higher goals, enhanced diligence and perseverance, leading to improved academic success (Honicke and Broadbent, 2016). Furthermore, a high level of self-efficacy is associated with overall well-being.

Podcasting in this intervention has been demonstrated to improve and sustain students' self-efficacy, improving their academic context, grasp, appeal to learning, motivation, relevance, involvement and interaction significantly. Podcasts, due to their accessibility and repetition, help students grasp and retain complex course materials, increasing their confidence in their knowledge and skills (Lazzari and Burch, 2009). Furthermore, podcasts provide a versatile learning tool that allows students to interact with content at their own pace, supporting self-directed learning. This autonomy in learning improves students' management of their educational activities, deepens their comprehension and allows for meaningful linkages between concepts (Kidd, 2012; Lazzari and Burch, 2009).

Furthermore, Khechine *et al.* (2013) contend that podcasts' extensive explanations and insights boost students' understanding of complex subjects. Beyond academic content, listening to podcasts helps students improve their technological skills (Cane and Cashmore, 2008), an essential ability in today's digital landscape. Podcasts also promote critical thinking abilities by requiring active listening, information processing and critical analysis (Frydenberg, 2008; Lazzari and Burch, 2009).

### *Performance and learning gains*

Podcasting is an innovative strategy in asynchronous learning environments to positively impact academic performance and learning outcomes, enabling students to achieve their educational goals effectively. Academic performance involves success in reaching educational goals, influenced by various factors, including students' learning process, cognitive and non-cognitive attributes and the sociocultural context (Dubuc *et al.*, 2022). The SCT of agency strongly supports this argument. Academic self-efficacy plays a crucial role in determining students' success in academic environments and their general mental capacity (Hsieh *et al.*, 2007). Podcasting provides valuable insights into the complexities of education, offering a unique avenue for gaining a more profound acquisition of knowledge, which later translates to better understanding. It offers a chance to delve into the complex world of cognitive control, which is crucial for learning and academic achievement. According to Bandura (2006), individuals are active agents rather than passive participants. Students who demonstrate agency can effectively analyze their learning experiences and adapt their academic behaviors to achieve better results. It is an emerging technique for educators and researchers looking to impact asynchronous learning delivery. Podcasting enables educators and students to engage interactively, share knowledge and explore various learning opportunities in today's digital era. Podcasting is a valuable tool in educational strategies, helping to promote better understanding, increased engagement and higher academic achievement.

## Conclusion

Our study sought to revolutionize asynchronous learning delivery by optimizing personalized podcasts. Differentiated podcasts offered equitable and inclusive opportunities for students across learning preferences. Our investigation yielded compelling evidence that these podcasts

significantly enhanced students' self-regulation and engagement, improved self-efficacy and led to notable gains in long-exam performance. The substantial improvements in student performance, as demonstrated by the differences between pre-test and long exam results, underscore the positive impact of our intervention. Furthermore, our research caters to diverse learning preferences by applying the CTML principles to bolster self-regulation, engagement and self-efficacy. This study fills a critical void in educational research by offering empirical evidence supporting the efficacy of personalized podcasts as intervention materials. Our work makes a meaningful contribution to academic research and provides valuable insights for educators and institutions regarding the potential of innovative educational delivery models. We focused on creating an academic experience that enriches students' learning journeys, equipping them with vital skills and the adaptability needed to revolutionize their education. We aim to pave the way for a more inclusive and equitable educational experience by implementing a unique podcasting strategy.

*Limitations and implications of the study*

One of the drawbacks of our study is the small sample size, which could impact how applicable our findings are to larger populations. Although our current sample offered valuable insights, upcoming studies could gain from more extensive and diverse participant groups to strengthen the reliability of our results and guarantee broader applicability across various demographics and contexts. Upcoming research may explore comparative studies incorporating diverse effects of personalized podcasts in various learning set up. For instance, comparative studies may provide insights into the efficacy of varied podcasts compared to other asynchronous learning methods, like conventional online lectures or interactive multimedia modules.

Conversely, various avenues in future research could enhance our understanding of differentiated podcasts' effectiveness and long-term effects in asynchronous learning environments. Long-term studies could explore the lasting impact of specialized podcasts on student involvement, academic achievements and memory retention over prolonged durations. Educators can make well-informed choices about teaching techniques by identifying the most effective methods for involving students and improving learning results. In addition, upcoming research could explore potential moderating factors that impact the effectiveness of specialized podcasts. Various factors, including students' prior knowledge, learning preferences and technological proficiency, may influence the results of podcast-based learning experiences.

Given these research implications, educators and instructional designers can improve the implementation of differentiated podcasts in asynchronous learning environments. Creating guidelines for implementation can offer educators practical suggestions for developing, delivering and evaluating varied podcast content. Finally, professionals need to consider accessibility when creating unique podcasts. It is essential to ensure that content is inclusive and accessible to students with diverse learning needs. Offering transcripts, captions and alternative formats can support learners with disabilities and enhance access to educational resources, creating an inclusive learning environment for all students.

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