

Plug in, listen in, rise up: Climate change education through podcast-based learning in English pre-service teacher education

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ABSTRACT

This study investigates the use of educational podcasts to support climate change awareness and twenty-first-century competencies among pre-service English teachers. Specifically, the study examines changes in students' climate change awareness before and after engaging in podcast-based learning activities, as well as their perceptions of podcast effectiveness, perceived challenges, and self-reported podcast themes in relation to twenty-first-century skills. The participants were 75 undergraduate students enrolled in English Language Education programs at multiple universities in Indonesia. Data were collected using a structured Likert-scale questionnaire administered before and after students participated in podcast-based learning activities, including listening to and producing educational podcasts on climate change. Quantitative data were analyzed using the Wilcoxon signed-rank test and descriptive statistics. The results after participating in podcast-based learning indicate a statistically significant increase in students' self-reported climate change awareness ($W = 0.00$, $Z = -7.52$, $p < .01$). Students also reported positive perceptions of podcasts as a learning medium, particularly in supporting understanding of complex concepts, contextualizing environmental issues in English learning, and developing professional competencies as prospective teachers. Reported challenges included the need for technical and pedagogical training, difficulties with collaboration, technical constraints, and adapting climate-related content to English-language teaching contexts. Students further reported addressing themes such as environmental impacts, the role of education, and climate change mitigation and adaptation. Overall, the findings suggest that podcast-based learning represents a promising pedagogical approach for integrating climate change education into English language teacher education while supporting the development of essential twenty-first-century competencies.

Keywords: Educational podcast; awareness; climate change education; English language teaching; 21st-century competencies

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INTRODUCTION

Climate change is one of the most pressing global challenges of the twenty-first century. In response to this urgent issue, Sustainable Development Goal 13 (SDG 13) calls for immediate action to combat

climate change and its impacts through global cooperation and sustainable practices. Established as part of the United Nations' 2030 Agenda for Sustainable Development in 2015, SDG 13

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underscores the severe consequences of climate change for the environment, human health, and global economies. Its mission, to “take urgent action to combat climate change and its impacts,” highlights the need for collective efforts across sectors, including education (United Nations, 2015, p.1).

Within this context, the education sector is expected to play a critical role in fostering environmental awareness and sustainability-oriented mindsets among younger generations, as educational experiences are central to shaping learners’ values, attitudes, and sustainability orientations (Tan et al., 2023). One strategic entry point lies in pre-service teacher education, as pre-service teachers will eventually mediate sustainability-related issues in classrooms across different educational levels. Beyond developing environmental awareness, future teachers are also expected to possess essential twenty-first-century competencies aligned with the Sustainable Development Goals, including critical thinking, creativity, communication, collaboration, and digital literacy (Carletti, 2025; Mundaca & Mundaca, 2024). These competencies are increasingly indispensable in contemporary educational contexts.

Digital literacy, one of the key challenges in integrating technology into academic courses (Blau et al., 2020), has been widely discussed in the literature. The term was first introduced by Gilster (1997), who defined digital literacy as the ability to derive meaningful information from various internet-based sources (as cited in Spante et al., 2018). Expanding this notion, Martin (2006) conceptualized digital literacy as encompassing not only technical skills but also attitudes and awareness that enable individuals to use digital tools responsibly, manage digital resources, create new knowledge, and engage in meaningful communication and social action. Accordingly, digital literacy extends beyond technical or operational competence and should be understood as a holistic, multidimensional capacity that supports critical, ethical, creative, and meaningful uses of technology in education, work, everyday life, and civic participation (Carretero et al., 2017; Falloon, 2020). This broader conceptualization positions learners not merely as consumers of digital content but also as active creators of digital artifacts, thereby opening opportunities for pedagogical practices that integrate higher-order thinking, creativity, and social engagement.

One digital technology that has gained significant attention in recent years within educational contexts is the podcast. Levy (2009, p. 775) defines a podcast as “an audio/video file distributed via the Internet, often delivered automatically to subscribers at regular intervals.” In education, podcasts enable learners to access instructional content through mobile devices,

offering flexibility in time and place while supporting autonomous learning (Ikram & Bahloul, 2024; Oraif & Alrashed, 2025; Randive, 2023; Yang, 2025). Empirical evidence indicates that podcasts positively contribute to learning outcomes and learner motivation in EFL settings, particularly by enhancing oral language development (Chaves-Yuste & de-la Peña, 2023; Indahsari, 2020; Peng et al., 2025; Son, 2018; Yang, 2025; Zou et al., 2018). Accordingly, podcasts have been increasingly recognized as a viable and efficient pedagogical innovation in English language teaching. At the same time, integrating podcast production into higher education is not without challenges. One commonly reported concern relates to ensuring content quality, particularly when students are expected to independently engage with complex topics such as sustainability and climate change (Cerez & Amezcua, 2025). Without adequate instructional scaffolding, podcast projects risk remaining descriptive rather than fostering critical engagement.

From an EFL perspective, these challenges are especially salient, as learners must simultaneously manage content accuracy, language use, and communicative clarity. When carefully designed, however, podcast-based tasks can function as a form of digital literacy practice that supports the development of twenty-first-century competencies. Recent studies highlight the pedagogical value of positioning students not merely as consumers of podcasts but as active producers of digital content. Although Kenna’s (2022) study is situated outside English language education, her work provides an important pedagogical foundation by conceptualizing student-generated research podcasts as an action-oriented approach that supports deep learning and education for sustainable development. Engaging students in researching, scripting, and producing podcasts positions them as active knowledge creators rather than passive recipients of information, fostering critical thinking, creativity, communication, collaboration, and digital fluency (Abimbade, 2025; Kenna, 2022). These affordances align with broader conceptions of digital literacy as multimodal, reflective, and socially situated knowledge production (Martin, 2006; Pegrum, 2015). In EFL contexts, podcasts also offer accessible and engaging ways to mediate complex and abstract issues, such as culture and values, through meaningful language use (Chaves-Yuste et al., 2023). Taken together, these insights suggest that student-produced podcasts hold considerable potential for integrating sustainability issues such as climate change into pre-service English teacher education, provided that sufficient pedagogical scaffolding is in place.

However, despite the growing body of research on podcast-based learning in EFL contexts, existing studies have tended to emphasize linguistic

outcomes or the mediation of cultural content, with relatively limited attention to the integration of sustainability-related issues, particularly climate change, as a pedagogical content focus within EFL teacher education (e.g., Chaves-Yuste et al., 2023; Putri et al., 2023). While recent work has begun to conceptualize student-generated podcasts as a meaningful pedagogical practice for education for sustainable development (Kenna, 2023), such research has largely been situated outside language education and pre-service English teacher preparation. This gap appears especially pronounced in Southeast Asian contexts, where empirical research at the intersection of digital literacy, sustainability education, and EFL teacher education remains limited in the international literature. Building on this body of research, the present study seeks to extend existing scholarship by introducing climate change as the focal issue mediated through podcast-based learning in pre-service English teacher education. Situated within the framework of the Sustainable Development Goals of the 2030 Agenda, this study positions environmental awareness as its central theme. By engaging pre-service teachers not only as listeners but also as producers of educational podcasts, the study aims to promote digital literacy, foster critical engagement with climate change, and support the development of twenty-first-century competencies. In doing so, the study contributes to the preparation of future English teachers who are both environmentally conscious and digitally competent. To address these aims, the study focuses on four interrelated areas: (1) changes in students' awareness of climate change before and after engaging in podcast-based learning activities in English education; (2) students' perceived effectiveness of podcast-based learning in supporting the development of twenty-first-century competencies; (3) the challenges students face in understanding and producing educational podcasts on climate change; and (4) the themes addressed by students in their educational podcasts and their relevance to twenty-first-century competencies.

Accordingly, this research expands the limited national literature on podcast-based learning and sustainability in English education. It contributes to the international discourse by providing pre-post survey evidence from a relatively underexplored context: pre-service English teacher education in Indonesia within the broader Southeast Asian context.

Based on these aims, the research questions guiding this study are as follows:

1. What is the level of students' awareness of climate change before and after engaging in podcast-based learning activities?
2. How do students perceive the effectiveness of educational podcasts in enhancing their understanding of climate change?

3. What challenges do students face in understanding and producing educational podcasts related to climate change?
4. What themes do students address in their educational podcasts on climate change, and how are these themes related to twenty-first-century competencies?

METHOD

Research Design

This study employed a one-group pretest-posttest format. This design is appropriate for examining participants' self-reported perceptions and awareness without manipulating variables or establishing causal relationships (Creswell, 2014).

The design was used to examine pre-service English teachers' awareness of climate change and their perceptions of podcast-based learning activities in English language education. Specifically, the study focused on self-reported knowledge, attitudes, behavioral intentions, reflective perceptions, perceived effectiveness of podcasts, perceived challenges, and perceived relevance to twenty-first-century competencies in the context of climate change education mediated through podcast listening and production.

Rather than employing a controlled experimental design, the study relied on repeated survey measures administered before and after students participated in podcast-based learning activities. Accordingly, the findings reflect changes in students' self-reported awareness and reflective perceptions of learning experiences, rather than objectively measured learning gains or causal effects. This approach is consistent with prior survey-based research in EFL teacher education that documents perceived learning outcomes and pedagogical experiences (Deda, 2023).

Participants and Research Sites

The participants were 75 undergraduate students enrolled in English Language Education programs at 20 state-owned higher education institutions across five regions of Indonesia: Sumatra, Java, Kalimantan, Sulawesi, and Maluku. Participants were selected using convenience sampling, based on their availability and participation in podcast-based learning activities within their courses.

All participants were pre-service English teachers, making them a relevant population for examining the integration of climate change issues, digital media, and twenty-first-century competencies in English language teacher education. Participation in the study was voluntary, and informed consent was obtained before data collection.

Research Instrument

Data were collected using a structured self-report questionnaire administered online via Google Forms. The questionnaire was developed based on a

review of literature on climate change education, digital literacy, podcast-based learning, and twenty-first-century competencies. Rather than being adapted from a single existing instrument, the items were conceptually informed by established frameworks in climate literacy (UNESCO, 2017) and survey-based research on podcast use in EFL contexts that informed the design of items related to learners' perceptions, experiences, and challenges of podcast-based learning (Son, 2018; Deda, 2023; Inderawati, 2024).

The initial pool of questionnaire items was then subjected to expert validation to ensure content relevance, clarity, and alignment with the study's objectives. The validation process involved experts from related fields, including science education and English language education, all of whom have experience in curriculum development and educational research. Based on their feedback, items were refined, revised, or removed to improve conceptual clarity and construct validity.

As a result of this iterative development and validation process, the final instrument consisted of seven thematic dimensions, which reflect key constructs commonly addressed in climate change education and podcast-based learning research:

1. *Knowledge of Climate Change*
Items in this dimension measured students' self-reported understanding of climate change concepts, including causes, impacts, carbon emissions, and distinctions between climate change and extreme weather.
2. *Attitudes and Concern toward Climate Change*
This dimension captured students' affective responses, including concern, sense of responsibility, and beliefs about the seriousness of climate change as a global issue.
3. *Willingness to Act and Pro-Environmental Behavior*
Items explored students' self-reported intentions and behaviors related to environmental action and sustainability-oriented practices.
4. *Contextualized Reflective Statements*
This dimension included reflective items prompting students to relate climate change issues to broader social, educational, and personal contexts, including their future roles as English teachers.
5. *Perceptions of the Effectiveness of Educational Podcasts*
Items examined students' perceptions of podcasts as a learning medium, focusing on attention, comprehension, vocabulary understanding, conceptual clarity, and overall effectiveness for learning about climate change in English.

6. *Challenges in Understanding and Producing Educational Podcasts*

This dimension addressed challenges encountered during podcast-based learning, particularly in podcast production, including technical difficulties, time constraints, difficulties simplifying scientific terminology, locating reliable English-language sources, confidence in speaking English, and collaboration within groups.

7. *Themes Addressed in Student-Produced Podcasts and Their Relevance to Twenty-First-Century Competencies*

Items captured students' self-reported descriptions of the main themes addressed in their podcasts and their perceptions of how podcast production supported competencies such as critical thinking, creativity, communication, collaboration, digital literacy, and problem-solving.

All questionnaire items were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), unless otherwise stated.

Instrument Validation and Reliability

Before final data collection, the questionnaire underwent expert validation with six experts from diverse academic and professional backgrounds, including Science Education, English Literature, English Language Education, Educational Technology, and educational practice and entrepreneurship. Expert feedback focused on item clarity, construct alignment, and wording, resulting in revisions such as standardizing items as declarative statements, refining item structure, and clarifying research variables.

Following expert validation, the revised questionnaire was piloted with 41 undergraduate students who shared characteristics similar to those of the target participants. Item validity was assessed using Pearson's correlation coefficient; items were considered valid when $r > 0.30$. Three items that did not meet this criterion were removed. Reliability was assessed using Cronbach's Alpha, with $\alpha > 0.70$ indicating acceptable internal consistency. Further revisions were made to improve the reliability of constructs with lower reliability before administering the final questionnaire.

Data Collection Procedures

Data collection in this study was integrated with the implementation of podcast-based learning activities within English language education courses. The finalized questionnaire was administered twice: before students participated in the podcast-based learning activities, and after students had completed both podcast listening and podcast production tasks.

The pre-survey captured baseline levels of students' awareness of climate change, while the post-survey examined students' perceptions, reflections, and self-reported changes following their engagement in podcast-based learning. All responses were completed independently and collected anonymously via Google Forms.

The instructional intervention adopted a production-oriented learning approach. At the initial stage, students were introduced to climate change issues aligned with Sustainable Development Goal 13 (SDG 13) through selected English-language educational podcasts. One of the main examples used in the learning activities was "What is Climate Change?" from *The Climate Question series produced by the BBC World Service* (2024). This podcast was selected because it presents climate change concepts in accessible language, combines expert perspectives with real-world examples, and models effective audio-based communication suitable for EFL learners.

Following the listening phase, students were required to design and produce their own educational podcasts addressing climate change-related topics. Student-produced podcasts were typically about 10 minutes long and focused on issues such as climate awareness, everyday environmental practices, and the local impacts of climate change. For example, a two-student podcast titled *From Awareness to Action: Student Voices for Climate* featured student hosts discussing climate issues through interview-style dialogue and reflective commentary. These student podcasts served as learning artefacts within the instructional process rather than as objects of textual analysis.

The podcast production process involved several stages, including selecting relevant information, organising ideas, scripting content, recording audio, and, in some cases, editing recordings. These stages reflect commonly reported practices in podcast-based and project-based learning in EFL contexts (Serini et al., 2025; Yang, 2025). The activities were designed to support English language development while simultaneously fostering students' engagement with global sustainability issues.

Although students produced podcasts as part of the learning activities, the present study did not

conduct qualitative content analysis of the podcast artefacts. Instead, data collection focused on students' learning experiences, perceptions, and reflections related to podcast listening and production, as captured through structured pre- and post-survey responses. This approach enabled the study to examine the perceived pedagogical value of podcast-based learning without analysing the podcasts' linguistic or multimodal features.

Data Analysis

Data analysis was conducted using descriptive and inferential statistical techniques. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize students' responses across the seven questionnaire dimensions. Assumption testing indicated that the data did not meet the normality assumption. The Shapiro–Wilk test was significant for the pretest–posttest comparison ($W = 0.89, p < .01$), suggesting a deviation from normality. Given that the normality assumption was not met, we decided to compare the pretest and posttest scores using a Wilcoxon signed-rank test.

Furthermore, this analysis identified statistically significant differences in students' self-reported awareness between the two measurement points. All findings reported in this study are based on self-reported survey data. Reported themes and competencies reflect students' perceptions rather than results from qualitative content analysis of podcast artifacts or interview data.

FINDINGS AND DISCUSSION

Students' Awareness of Climate Change Before and After Listening to Educational Podcasts

This section presents quantitative findings on changes in students' awareness of climate change following their engagement with educational podcasts. To examine whether participation in podcast-based learning, through listening to and producing podcasts, was associated with changes in awareness, a Wilcoxon signed-rank test was conducted. This analysis compared students' pretest and posttest scores to identify within-subject differences over time. Table 1 presents the result of the Wilcoxon signed-rank test.

Table 1

Wilcoxon signed-rank test results

Measure 1	Measure 2	W	z	df	p	Rank-Biserial Correlation	SE Rank-Biserial Correlation
Pretest	- Posttest	0.00	-7.52		< .01	-1.00	0.13

The posttest scores (Median = 129, IQR = 18.00) were higher than the Pretest scores (Median = 119, IQR = 15.50). The difference was compared using a Wilcoxon signed-rank test with a significant result, $W = 0.00, z = -7.52, p < .01$, and a very large

effect ($r_{rb} = -1.00, SE = 0.13$), indicating a statistically significant increase in students' self-reported awareness of climate change following their engagement with educational podcasts. These findings suggest that podcast-based learning may

support students' perceived internalization of climate change-related knowledge. From a constructivist learning perspective, this increase in awareness can be understood as the result of learners engaging with meaningful, contextually relevant learning experiences, specifically climate-related narratives presented in an accessible audio format. This finding is consistent with Goldman (2018), who argues that podcasts can enhance conceptual understanding, learner engagement, and information retention, particularly when learning materials are aligned with relevant and contemporary issues.

Furthermore, these results align with previous research highlighting the role of education and media in shaping environmental awareness among younger generations (Liu & Zhang, 2024; Tan et al., 2023). The observed increase in awareness suggests that students were not merely exposed to climate change concepts but also able to relate them to broader social and sustainability contexts. This finding indicates that podcast-based learning can help learners make meaningful connections between environmental knowledge and real-world issues.

Students' Perceptions of the Effectiveness of Educational Podcasts in Enhancing Their Understanding of Climate Change

This section presents students' self-reported perceptions of the effectiveness of educational podcasts in supporting their understanding of climate change. The findings are based on responses to questionnaire items measuring attention, comprehension, perceived usefulness, and relevance to competency development.

Item 16 indicates that most respondents reported high levels of attention when listening to educational podcasts on climate change ($M = 3.9$, $Md = 4$, $Mo = 4$). A total of 73% of students agreed with this statement, while 26% were neutral and 1% disagreed, suggesting that the podcast format was perceived as engaging. Similarly, item 17 shows that students perceived podcasts as effective in broadening their understanding of environmental issues within English language learning contexts ($M = 4.1$, $Md = 4$, $Mo = 4$), with 81% agreement and no disagreement.

Regarding language-related aspects, responses to item 18 indicate that students generally found podcasts helpful for understanding foreign vocabulary and terminology, with a mean score of 3.9. Most respondents (73%) agreed that English-language podcasts did not pose a barrier to comprehension, while 26% remained neutral. These findings reflect students' perceived accessibility of audio-based input rather than objectively measured vocabulary gains.

Item 19 further suggests that students perceived podcasts as a potential source of pedagogical ideas for integrating global issues such

as climate change into English language learning ($M = 4.0$). Most respondents (79%) agreed with this statement, indicating positive perceptions of podcasts as a contextualized instructional resource. In addition, item 20 shows that students perceived podcast use as relevant to their professional competency development as prospective English teachers ($M = 4.1$), with 80% agreement.

Item 21 reveals that a large proportion of respondents (81%) agreed that podcasts helped them understand complex climate change concepts ($M = 4.0$). These responses indicate a consistent pattern of positive perceptions of podcasts' cognitive support in addressing abstract and multifaceted topics.

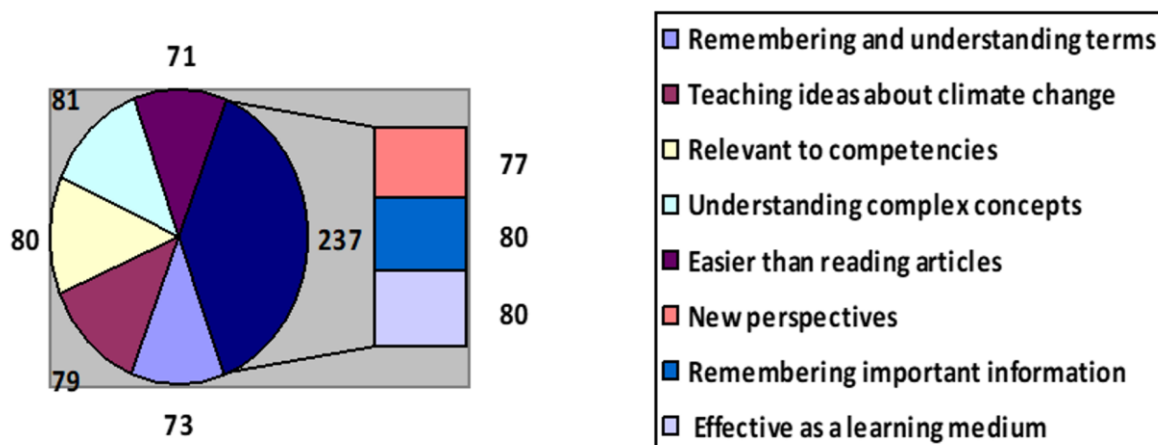
When asked to compare podcasts with other learning resources (item 22), 71% of respondents reported that they found climate change topics easier to understand through podcasts than through articles or books ($M = 3.9$). However, this finding reflects students' subjective perceptions rather than evidence from a controlled comparative design. Similarly, item 23 indicates that 77% of respondents perceived podcasts as providing new perspectives on climate change, suggesting that audio narratives may encourage reflective engagement with environmental issues.

Responses to item 24 indicate that students' overall evaluation of podcasts as a learning medium was consistently positive. With a mean score of 4.1, 80% of respondents agreed that podcasts are effective in supporting their understanding of climate change, while 20% remained neutral, and none disagreed. This overall assessment suggests that podcasts are a suitable medium for conveying complex, abstract content related to climate change.

Drawing on the results across all perception items, students' levels of agreement regarding the use of podcasts for climate change learning were analytically grouped into eight main categories: (1) remembering and understanding terms, (2) pedagogical ideas, (3) relevance to professional competencies, (4) understanding complex concepts, (5) ease of information processing, (6) gaining new perspectives, (7) facilitating recall of essential points, and (8) overall effectiveness. Figure 1 summarizes these categories and provides an overview of students' perceptions of podcasts as a learning medium for raising awareness of climate change issues.

Students reported listening attentively to the podcasts and relating the content to the development of their professional competencies as prospective English teachers, particularly in conveying global issues in context. The high level of agreement across survey items related to perceived understanding and ease of learning suggests that students found climate change topics more straightforward to comprehend through podcasts than through written materials, and that podcasts supported their understanding of complex climate change concepts.

Figure 1
Level of agreement on using podcasts as a learning medium



These responses indicate that students perceived audio-based learning as cognitively accessible and personally engaging. This perception aligns with the characteristics of contemporary learners who tend to prefer flexible, mobile, and narrative-based media. Previous studies similarly report that podcast-based learning is associated with increased student engagement, conceptual understanding, and information retention (Abdallah & Nassour, 2025; Bajrami et al., 2026; Craig et al., 2023; Gardiakos et al., 2025). Students' responses regarding the effectiveness of podcasts also support existing literature emphasizing the pedagogical affordances of audio-based learning. Chaves-Yuste and de la Peña (2023) demonstrated that podcasts can enhance social relevance and active participation in EFL contexts, while Craig et al. (2023) highlighted that student motivation is supported through flexible, personalized, and accessible audio formats. In collaborative learning settings, these findings are consistent with Pratiwi et al. (2024), who found that podcast creation fosters communication, teamwork, and technology integration in language education. Moreover, students' creative processes, such as searching for information, writing scripts, and recording and editing audio, align with Mayer's (2001) principles of multimedia learning and Bandura's (1977) theory of observational learning, which holds that learning occurs through modelling, social interaction, and reflection.

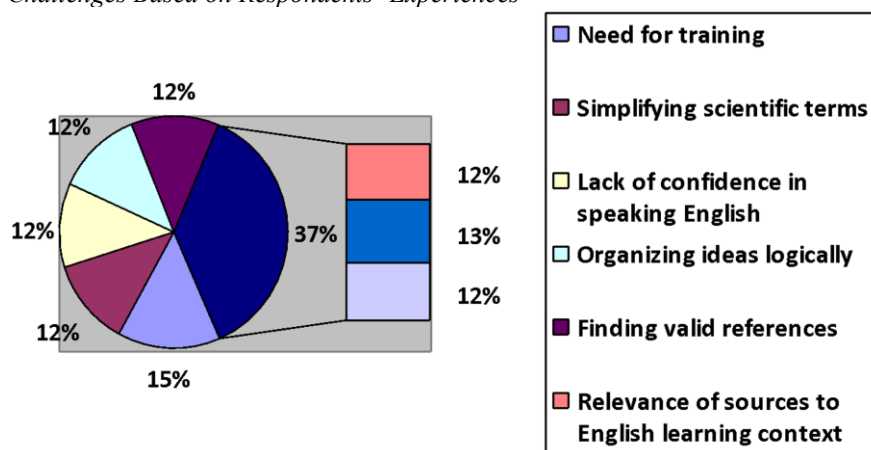
Overall, the positive responses across all indicators suggest that podcasts function as a complementary pedagogical medium alongside more conventional instructional resources, such as textbooks, academic articles, and lecture-based instruction, particularly in teacher education contexts. Rather than replacing existing approaches, podcasts offer an additional modality that supports environmental awareness, professional competency development, and the cultivation of twenty-first-

century skills, including digital literacy, critical thinking, and communication. Accordingly, this study highlights the potential of integrating digital audio media into higher education curricula to strengthen issue-based learning and to support the preparation of future teachers as reflective educators and agents of change aligned with the Sustainable Development Goals.

Challenges Faced by Students in Understanding or Producing Educational Podcasts on Climate Change

A total of 14% of respondents reported that they require training to implement podcasts in the learning process. Following that, other challenges mentioned were difficulties in working collaboratively with team members and experiencing technical problems during the process, 13% of respondents stated this. The remaining 12% of respondents identified challenges related to simplifying scientific terms, a lack of confidence when speaking English, organizing ideas logically, finding valid references, ensuring alignment between sources and content, and English language learning. When viewed from the average scores, the challenges experienced by each respondent occurred at a relatively similar frequency. Figure 2 presents a distribution of the challenges reported by respondents when engaging in podcast-based learning activities, highlighting the relative frequency of instructional, collaborative, linguistic, and technical difficulties experienced during the process. The challenges reported by students in the educational podcast production project indicate that difficulties emerged across several interrelated domains, particularly content-related, cognitive, linguistic, and technical aspects. From a content perspective, one of the primary challenges is simplifying scientific terms into clear, accessible language.

Figure 2
Challenges Based on Respondents' Experiences



This finding aligns with research emphasizing that the ability to represent complex concepts through coherent and straightforward narratives is essential for effectively conveying messages to audiences. Narratives help organize information, connect abstract ideas to concrete experiences, and enhance comprehension and meaning-making (Ramdayanti et al., 2023; Walsh et al., 2023). Ensuring content quality, therefore, becomes a critical concern, especially when students are expected to independently engage with complex topics such as sustainability and climate change. As noted by Cerez and Amezcua (2025), educational podcast production may risk superficial treatment of content or conceptual inaccuracies without sufficient guidance in managing complex subject matter.

Closely related to content challenges are cognitive difficulties, particularly in organizing ideas logically and constructing coherent arguments. Students' struggles to structure information reflect challenges in critical thinking and analytical reasoning, as transforming fragmented information into a clear, meaningful narrative requires careful synthesis and evaluation. These findings highlight the importance of supporting students' ability to manage information coherently, a skill widely recognized as essential in contemporary higher education.

In addition, students reported challenges in finding valid references and ensuring the relevance of sources to English language learning contexts. This points to limitations in information literacy, as previous research has shown that students often struggle to evaluate the credibility of digital sources and to relate them to academic and pedagogical purposes appropriately.

From a linguistic perspective, lack of confidence in speaking English emerged as a recurring challenge, particularly during audio recording. This finding is consistent with Yeh et al. (2021), who reported that students commonly experience anxiety related to pronunciation

accuracy, fear of making mistakes, and discomfort when speaking in recorded formats. Moreover, Yusof et al. (2025) described that the majority of ESL learners experienced moderate levels of speaking anxiety during recorded oral presentations. While podcasts provide opportunities for oral language use, they may also intensify affective barriers for learners who are not accustomed to speaking spontaneously or publicly.

Finally, technical challenges were also reported, including difficulties in using recording devices, editing software, and adjusting sound quality. These issues suggest that familiarity with digital technologies does not necessarily translate into competence in producing educational audio content. This finding aligns with Saragih et al. (2022), who demonstrated that technological readiness and experience with recording tools significantly influence the quality of podcast-based learning outcomes. This also relates to studies that reveal both lecturers and students still face challenges related to digital competence, technical skills, and the need for ongoing training to effectively adopt emerging learning technologies (Apriani et al., 2021; Inderawati et al., 2024)

Overall, these challenges indicate the need for systematic instructional support that addresses content accuracy, information organization, language confidence, and technical skills. Without such support, students may focus primarily on task completion rather than developing a deeper understanding and communicative effectiveness. Therefore, integrating educational podcasts into higher education should be accompanied by clear guidance and structured support to ensure students gain meaningful, high-quality learning experiences.

Themes Addressed by Students in Climate Change Educational Podcasts and Their Relevance to 21st-Century Competencies

This subsection reports the themes students addressed in their educational podcasts on climate

change, as identified through self-reported questionnaire responses. Rather than conducting a qualitative content analysis of podcast scripts, the study examined students' responses to multiple-choice and multiple-response survey items that asked them to indicate the main themes they addressed in their podcast projects. The unit of analysis was therefore defined as students' self-reported thematic selections, not podcast transcripts or audio artifacts. As respondents were allowed to select more than one theme, the total percentage exceeds 100%, reflecting the multidimensional nature of the topics addressed within a single podcast project.

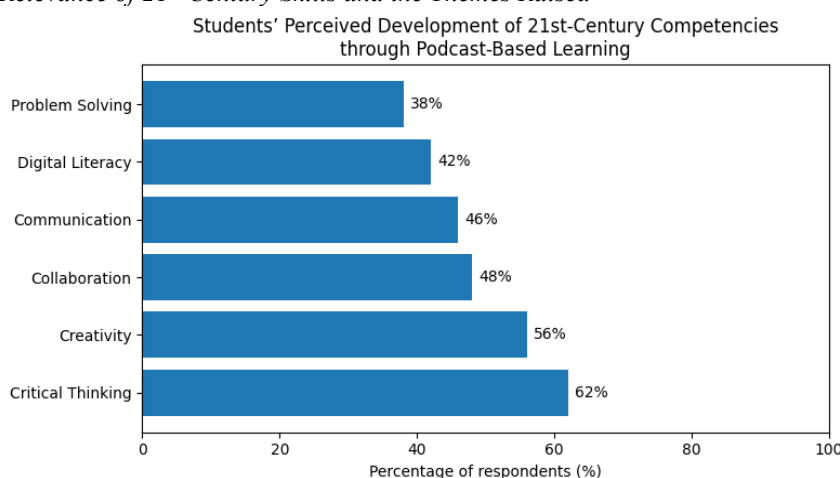
Based on students' survey responses, six major themes were identified. As shown in Figure 3, the most frequently reported theme was the impact of climate change on the environment, selected by 48 respondents (80%). This was followed by the role of education in addressing climate change (36 respondents; 60%) and social and economic issues related to climate change (24 respondents; 40%). In addition, 20 respondents (33%) reported climate change mitigation and adaptation efforts. Two response options were selected by only one respondent each (2%), namely, climate change as the root of global problems and not yet completing a podcast. These responses were treated as marginal or process-related indicators and were excluded from further interpretive analysis. The predominance of the environmental impact theme suggests that students primarily framed climate change in terms of its ecological consequences. At the same time, the relatively high frequency of the education theme indicates students' awareness of their prospective role as educators in addressing climate-related issues. The presence of socio-economic, mitigation, and adaptation themes further suggests that students' understanding extended

beyond environmental dimensions alone, reflecting an emerging recognition of climate change as a complex and multidimensional issue.

Survey responses indicate that critical thinking was the most frequently reported competency (95%), suggesting a high level of student awareness of the importance of analytical and evaluative skills when engaging with complex issues such as climate change. This finding aligns with Kenna (2023), who argues that student-produced podcasts function as an action-oriented pedagogy that requires learners to critically evaluate sources, synthesize information, and construct coherent narratives for public audiences. In this study, students were required to select, simplify, and organize scientific information into accessible educational podcasts, a process that inherently demands critical judgment and reflective decision-making.

In addition to critical thinking, creativity, and collaboration, these qualities also emerged with substantial frequency, reflecting the role of podcast production as a collaborative, design-oriented learning activity. Students were not only required to generate original scripts and audio formats but also to negotiate ideas, divide responsibilities, and provide peer feedback throughout the production process. Furthermore, the development of communication skills and digital literacy highlights students' attention to how messages are conveyed, rather than merely to the content delivered. It suggests that media-based learning projects such as podcasts can support the integrated development of multiple twenty-first-century competencies simultaneously, particularly when learners are positioned as content creators rather than passive recipients (Gudkova & Shadrina, 2025; Hernandez-Lopez & Mendoza-Jimenez, 2025; Kenna, 2023; Mbenza, 2025; Sager et al., 2025; Wijayanti et al., 2025).

Figure 3
Relevance of 21st Century Skills and the Themes Raised



The 21st-century themes and skills mentioned by the respondents were no coincidence. Regarding their desire for future podcast themes, the research team identified four major themes: the impact of climate change on the environment; the role of education; socio-economic issues; and mitigation

and adaptation. The associations presented in Table 4 reflect students' perceived relationships between podcast themes and twenty-first-century competencies, rather than empirically measured skill development.

Tabel 4
Theme Relationship Matrix and 21st Century Skills

Theme(s)	Most Frequently Associated 21st-Century Skills	Reason(s)
The impact of climate change on the environment	Critical thinking, Communication, Digital literacy	Students must analyze scientific data and present it in a simple and engaging way.
Socio-economic issues	Critical thinking, Problem solving	This topic sparks analysis of social and economic impacts, as well as real solutions.
Mitigation and adaptation	Creativity, Problem-solving	Requires innovative ideas such as renewable energy, urban farming, etc.
The role of education	Collaboration, Communication, Digital literacy	The podcast project requires teamwork, drafting the script, and using digital tools.

Students' aspirations for future podcast themes demonstrate that their interests extend beyond ecological concerns to strategic issues such as the role of education, socio-economic impacts, and climate change mitigation and adaptation strategies. This reflects a growing awareness of the complexity of climate issues, consistent with the IPCC's 2022 perspective, which emphasizes the importance of cross-sectoral understanding in addressing the climate crisis. Therefore, future development of podcast content needs to accommodate this diversity of themes.

The themes of the student-produced podcasts include the impacts of climate change on health, education, community resilience, and adaptation and mitigation measures in Indonesia, aligning with the climate stories approach proposed by Moser (2021) and Jordan et al. (2023), which emphasizes the use of personal narratives and local context to help students understand climate issues holistically and more meaningfully. The relevance of these themes to 21st-century competencies is also evident, as Almazroa and Alotaibi (2023) recommend that higher education must address the complex challenges of equipping students with creativity, critical thinking, communication, and collaboration. These findings are also supported by Kireitseva et al. (2025), who demonstrated that eco-podcasts are an innovative tool that can enhance ecological literacy and sustainability awareness. Furthermore, the findings emphasize the importance of integrating climate change and educational technology, as Faizah et al. (2025) also note.

Overall, this study demonstrates that educational podcasts serve not only as a medium for conveying information but also as a means of knowledge production, critical reflection, and the strengthening of 21st-century competencies. This approach positions students as active, creative, and sustainability-focused content creators.

CONCLUSION

The results of this study indicate that educational podcasts are perceived as an effective and promising learning medium for raising climate change awareness among prospective English teachers, while simultaneously supporting the development of essential twenty-first-century competencies. The findings show a statistically significant increase in students' climate change awareness following their engagement with climate change-themed podcasts. In addition, students reported positive perceptions of podcasts for broadening environmental knowledge, enriching thematic vocabulary, and strengthening their professional competencies as future educators concerned with sustainability. Overall, podcasts were perceived as practical learning aspects, including understanding complex concepts, processing information, gaining new perspectives, and supporting more contextualized learning experiences.

At the same time, the study identified several challenges students reported in understanding and producing educational podcasts. These challenges included the need for technical and pedagogical training, difficulties in simplifying scientific terminology, limited confidence in using English, organizing ideas coherently, locating and evaluating reliable sources, managing technical constraints, and navigating collaborative work dynamics. These findings suggest that podcast-based learning projects should be accompanied by systematic instructional scaffolding so that students can not only complete the tasks but also derive more profound, meaningful learning experiences.

In terms of content focus, students reported addressing themes that reflect an emerging understanding of the complexity of climate change, including environmental impacts, socio-economic issues, mitigation and adaptation efforts, the role of education, and climate change as a contributing

factor to broader global problems. This thematic distribution highlights the importance of designing future podcast-based learning activities that are more diverse, contextualized, and oriented toward sustainability literacy.

Overall, this study demonstrates that educational podcasts can serve not merely as supplementary learning media but also as strategic pedagogical platforms that support the integration of climate change education with the development of key twenty-first-century competencies, such as digital literacy, critical thinking, creativity, collaboration, and communication. Accordingly, integrating educational podcasts into English Language Education curricula represents a viable and innovative pedagogical strategy for connecting language learning with global sustainability issues, while supporting the preparation of future educators who are reflective, environmentally aware, and prepared to engage with sustainability challenges in their professional practice.

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