

Development of Biology Podcast-Based Learning Media (Bee O Podcast) on Environmental Change Material

Iwan Ridwan Yusup^a, and Desi Widiya Astuti^b

^{a,b}Department of Biology Education, Faculty of Tarbiyah and Teacher Training, UIN Sunan Gunung Djati Bandung, Indonesia

ABSTRACT

The digitisation of 21st-century learning media, which knows no distance, time, or space and can be accessed anywhere and anytime, is rapidly developing to clarify the concept of lifelong learning. As a result, the quality of education increases, and learning becomes effective, interesting, and innovative. This study aims to develop products and determine students' responses to biology podcast learning media (Bee O Podcast) on environmental change material. The development of biology podcasts uses the Research and Development (R&D) research method of the 4D model from Thiagarajan, simplified to 3D (Define, Design, and Develop). The Define stage is a preliminary study of biology learning through teacher interviews, analysis of student characteristics through survey questionnaires, and task-concept-objective analysis of learning environmental change material in class X MIPA. The Design stage is the preparation of research instruments, selection of media formats, and media design according to the analysis of the previous stage. At the Development stage, the media were validated by experts and tested with 15 students. The results of the validity of biology podcasts from material experts were 87.50% (very valid), media experts 76.36% (valid), and biology teachers 84.21% (very valid). The average validity value of the biology podcast was 82.69% (very valid), and the students' response to the biology podcast was 82.25% (very feasible). This shows that the biology podcast media product (Bee O Podcast) is feasible to use in learning environmental change material, especially environmental pollution material.

ARTICLE HISTORY

Received 30th November 2024

Accepted 10th February 2025

KEYWORDS

Learning Media, Research and Development, Biology Podcast, Bee O Podcast, Environmental Change, Biology Learning Media Validation.

Introduction

The characteristics of 21st-century education, which know no distance, space, or time, can be accessed anywhere and anytime, changing the previous education paradigm. The teacher-oriented education paradigm is now shifting to students. Especially since March 2020, Indonesia has been hit by the COVID-19 pandemic. The spread of the virus has affected various aspects of people's lives in Indonesia, one of which is the aspect of education. Distance Learning (PJJ) online (in the network) is inevitably chosen to break the spread/transmission of the COVID-19 virus in schools. According to Indriastuti & Saksono (2014), the development of distance education and the growth and development of learning resources clarify the concept of lifelong learning.

Learning media is a means of transferring knowledge to students, and one of the emerging media is the podcast. According to Faradinna (2020), podcasts have developed in Indonesia since 2017 and compete with audiovisual content like YouTube. Despite the dominance of online videos, podcasts remain attractive due to their unique characteristics and potential impact on the future knowledge society. Cheta & Eberechukwu (2018) categorize podcasts into two types: audio podcasts and video podcasts (vodcasts), with the former requiring less storage space (Bolliger et al., 2010). Brown and Green (2007) define podcasts as audio/video content uploaded online that can be accessed via subscription, listenable or viewable through computers or portable media players. Hutabarat (2020) notes that podcasts serve as digital learning supplements, not replacements for textbooks or other materials.

Podcasts also offer emotional engagement and social presence. Lee & Chan (2007) found that online podcasts reduce feelings of isolation among learners. Rane (2018) adds that audio is the most familiar communication medium, with personalized content capable of emotionally connecting with listeners. Determann (2020) highlights the accessibility of podcasts, which often use simpler language than academic texts and can be consumed while multitasking. Nonetheless,

CONTACT Iwan Ridwan Yusup. email: iwanyusup@uinsgd.ac.id, UIN Sunan Gunung Djati, Faculty of Tarbiyah and Teacher Training, Department of Biology Education, Jl. AH. Nasution No.105, Cibiru, Bandung, West Java, Indonesia © 2024 The Author(s). Published by Pena Ma'sum Suja'i Foundation's

This is an Open Access article distributed under the terms of the Creative Commons Attribution NonCommercial-NoDerivatives, which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

issues such as poor audio quality, speaker accents, and mismatches with student learning styles can hinder effectiveness. These limitations can be mitigated by integrating podcasts with text, visuals, or other media. Overall, podcasts are generally free and accessible, making them valuable lifelong learning tools even after formal education ends.

According to Stanley Alten (2013), cited in Zellatifanny (2020), the visual component in audio podcasts is the creation of images in the minds of people who listen, also known as the theatre of the mind. Making podcasts can be done by paying attention to the important points or conclusions of the material to be conveyed, with the addition of relevant information. In addition, the duration of the podcast is kept short (Laila, 2020). The short duration ranges from 10–15 minutes (Best Practice in Educational Podcasting, KUMC, 2016).

Based on the explanation above, podcast media can be used as learning media. This is interesting because educators are creative and innovative, utilizing technological developments that are quite familiar to students. This is reinforced by the survey data in class X MIPA 1–2; those students are quite familiar with podcast media. As many as 83.8% of students have listened to podcasts. The platforms used to access podcasts are YouTube and Spotify. The types of podcasts in demand are podcasts with casual discussions as much as 57.4%, monologue podcasts 20.6%, and interview podcasts 14.7% (Personal Data, 29/04/2021).

Some of the reasons students prefer to listen to podcasts include 42.6% feeling they understand better by listening (auditory learning type), 32.4% not really liking reading, and 23.5% feeling podcasts are more interesting than visual content (books, articles, electronic magazines, etc.). The rest think podcasts save more data to get information and like them because they are fun (Personal Data, 29/04/2021).

The development of podcast-based learning media is a researcher's idea to support distance learning (PJJ) during the pandemic. For this reason, the delivery of learning materials is increasingly varied; apart from using visual media, delivery in audio is also important. This is done to increase one's understanding and critical thinking after listening to podcast media so that students can be encouraged to study independently, find out the truth of the information they have listened to, and then develop the willingness to discuss it with their teachers or peers. The material presented in the podcast can be played repeatedly, anytime and anywhere. According to Determann (2020), one can learn and be productive through different media, not necessarily books. With podcasts, one can listen outside of class time and revisit the material through discussion during class.

Methods

This research uses qualitative and quantitative data types. Qualitative data comes from the results of the podcast media development process, validator critiques, open interviews, and documentation. Quantitative data comes from validator validation scores, student interest questionnaire scores, and student response questionnaire scores. Product development of biology podcast learning media (Bee O Podcast) uses the Research & Development research method of Thiagarajan's 4D model, which is simplified into 3D (Define, Design, and Development).

Define

The define stage consists of the results of preliminary studies (observation) and analysis of students in the Biology learning class X MIPA at MAN 2 Bandung City. In addition, there are also data from the results of task analysis, concept analysis, and specification of biology learning objectives in the material of environmental change in the environmental pollution subchapter.

Design

The design stage involves preparing several research instruments, including learner survey questionnaires, expert validation sheets, and response questionnaire sheets. It also consists of selecting learning media, media formats, and designing the initial media.

Development

The development stage includes expert appraisal and developmental testing on target students (Thiagarajan, 1974). The Bee O Podcast was validated by material experts, media experts, and biology teachers, whose feedback served as input for revision. Limited trials were then conducted with Class X MIPA 2 students at MAN 2 Bandung to obtain feasibility scores and student responses. The expert appraisal results were quantified using a specific formula to determine the feasibility percentage of the biology podcast media.

$$\text{Score} = \frac{\text{Validator's validation score}}{\text{maximum expected score}} \times 100\% \quad (1)$$

The results of the validity percentage of the biology *podcast* learning media were analysed to assess the content of the material with the eligibility criteria. The percentage of media feasibility can be seen in Table 1 below.

Table 1. Score Interpretation Categories (Arikunto, 2006)

Validity Criteria	Validity Level
85.01% - 100.00%	Very valid , ready to be used as learning media
70.01% - 85.00%	Valid , can be used as learning media
50.01% - 70.00%	Moderately valid , or can be used but needs minor revisions
30.01% - 50.00%	Less valid , recommended not to be used because it needs major revisions

The population in this study consisted of 216 Class X MIPA students at MA Negeri 2 Bandung City. The Bee O Podcast was tested on a small group of 15 students from Class X MIPA 2 using purposive sampling, based on recommendations from the Deputy Head of Curriculum and a biology teacher. This technique was chosen to reflect the transition from adaptive to normal learning conditions (Sugiyono, 2015). The percentage of student responses in the limited media trial (developmental testing) was calculated using a specific formula and interpreted based on Table 2.

$$\text{Score} = \frac{\text{Sum of response scores}}{\text{Maximum possible scores}} \times 100\% \quad (2)$$

Table 2. Learner Response Score Interpretation Categories (Ridwan, 2010)

Score range	Category
Figures 0-20%	Very unfit
Figure 21-40%	Not worth it
Figure 41-60%	Decent enough
61-80%	Worth
81-100%	Very worthy

Results and Discussions

This research on developing biology podcasts on environmental change material was carried out from April 2021 to August 2022. It started with distributing survey questionnaire sheets to observe students' interests and biology teacher interview sheets related to the use of learning media in Class X MIPA for the 2020/2021 academic year at MA Negeri 2 Bandung City. After that, a biology podcast product (Bee O Podcast) was developed.

Define

Based on the results of a survey of students in Classes X MIPA 1 and 2 with 68 respondents, the learning media used by biology teachers are quite diverse and make it easier to understand biological material. In addition, the learning media used are still friendly to students' data quota. Students' learning experiences included voice note media (88.2%), material modules (70.6%), mind maps (55.9%), PowerPoint (51.5%), and other media such as textbooks, YouTube videos, material images, and virtual meetings. However, during learning in the last semester, some students still experienced problems accessing learning media. Learning obstacles experienced by students include 66.2% complaining that their device's memory is often full because teachers often send material through WhatsApp, often as voice notes. Another obstacle is that 50% often experience network disruptions, while 38.2% experience quota limitations. Meanwhile, 17.6% of students did not experience significant obstacles when accessing biology learning media (Personal Data, 29/04/2021).

Therefore, the researchers developed biology podcast learning media products in audio form tailored to students' needs. According to Dalila & Ernungtyas (2020), although still considered an alternative audio medium to radio, podcasts have developed quite rapidly because the audience easily accepts them. Four characteristics of podcasts compared to other audio media are episodic, downloadable, streamable, and having segmented themes.

The enthusiasm of respondents (students of Classes X MIPA 1–2) who have listened to podcasts is quite high, reaching 83.8% (Personal Data, 29/04/2021). Quoting data from Eka (2018), a survey of podcast users in Indonesia conducted by DailySocial & Jakpat (2018) shows that 68% of 2,032 respondents feel familiar with podcasts. Respondents found podcasts interesting because the content is varied, flexible, and more enjoyable than visual content. According to Dalila & Ernungtyas (2020), podcasts are more easily accepted by listeners; the delivery of information is natural like chatting with friends, includes elements of everyday life that listeners also experience, the content is original because it involves personal experiences or those of others, podcasts are interesting because there is an entertaining element, and they are of course easy to access online.

MA Negeri 2 Bandung City used the COVID Emergency Curriculum in the biology learning process, which simplified the 2013 Curriculum. Based on the analysis of Core Competencies (KI) and Basic Competencies (KD) in Class X MIPA Biology, the environmental change material includes two KDs which were then used as references in formulating Competency Achievement Indicators (IPK/ GPA) and Learning Objectives (TP) in the development of biology podcast media on environmental change material, as shown in Table 3. According to Wahyuni (2021), the material in the podcast

is prepared according to the lesson plan, includes some information about the material, and questions about the material to be discussed.

Table 3. KD, GPA and TP on Environmental Change Material

KD	3.6	Analyse data on environmental change, its causes and impacts on life.
	4.6	Formulate ideas for solving environmental change problems that occur in the neighbourhood.
	3.6.1	Being aware of soil and water pollution activities in daily life, even small ones.
GPA	3.6.2	Concluding that organic waste can also cause the GHG (Greenhouse Gas) Effect.
	3.6.3	Differentiate between organic, inorganic and residual waste groups.
	4.6.1	Formulate ideas for solving environmental change problems in the neighbourhood.
	3.6.1	Learners can realise the existence of soil and water pollution activities in daily life, even small ones.
TP	3.6.2	Learners can conclude that organic waste can cause the GHG (Greenhouse Gas) Effect.
	3.6.3	Learners can differentiate between organic, inorganic and residual waste groups.
	4.6.1	Learners can formulate ideas for solving environmental change problems in their neighbourhood.

Design

The data used at this stage came from several research instruments, including the learner survey questionnaire, expert validation sheet, and response questionnaire sheet. This stage also consists of learning media selection, media format selection, and initial media design see Table 4.

Table 4. Biology Podcast Development Instrument

Stages	Participants	Instrument
Preliminary Study	Biology Teacher MA Negeri 2 Bandung City 68 students of class X MIPA T.A 2020/2021 MA Negeri 2 Bandung City	Questions about learning Biology in class X MIPA <i>Gform</i> survey questionnaire
Validation of Research Instruments	Supervisor (Lecturer in Biology Education at UIN Sunan Gunung Djati Bandung)	Grid, validation sheet and questionnaire
Media Validation of Biology Podcasts	1. Material Expert (Lecturer in Biology Education at UIN Sunan Gunung Djati Bandung) 2. Media Expert (Lecturer in Biology Education at UIN Sunan Gunung Djati Bandung) 3. Biology Teacher X MIPA MA Negeri 2 Bandung City	Validation sheet (<i>print out</i>) Validation sheet (<i>print out</i>). Questionnaire <i>gform</i>
Media Product Trial	15 students of class X MIPA MAN 2 Bandung City	<i>Gform</i> response questionnaire

Biology Podcast (Bee O Podcast) is in the form of audio on the topic of the environmental change subchapter of environmental pollution. The reasons for choosing this media are as follows:

- Biology podcasts on environmental change and the environmental pollution subchapter in audio form are more quota-efficient to access than a vodcast (video podcast).
- Biology podcasts are on-demand. They can be accessed anytime and anywhere online on Spotify and listened to repeatedly. The Spotify app can be installed conveniently, but if students do not want to install it, they can use the Spotify website or Google by typing "Bee O Podcast." There are many alternatives for accessing the biology podcast.
- Biology podcasts in audio form help learners better understand environmental issues. They create images in listeners' minds (theatre of the mind), attract interest in self-learning both online and directly in class, and provide new learning experiences.
- Biology podcasts on environmental change and the environmental pollution subchapter use simple language, are easy to understand, and are not as rigid as printed books, giving the impression of discussing environmental problems with friends.
- Biology podcasts on environmental change, with material on the environmental pollution subchapter, can train students to be sensitive to environmental problems around them and to analyze various issues related to environmental change.

Biology podcasts (Bee O Podcast) on environmental change material for the environmental pollution subchapter are presented as on-demand audio that can be accessed online via the Spotify application, through the website at Anchor.fm, or even by using a Google search. The audio format used is a WAV or FLAC file, which is clearer than MP3 files.

Biology podcasts have cover art on each episode as a visual medium. In addition, there is a script/transcript in the episode description section that can be accessed if needed. Five genres (types) of biology podcasts have been developed: solo

podcast, multi-host/conversational/discussion podcast, drama podcast, non-fiction storytelling podcast, and interview podcast.

A biology podcast storyline describes the idea or content flow in bullet points that guide the host during recording. The storyline can be added to or shortened as needed, but still must consider the duration and target learning outcomes.



Figure 1. Biology Podcast Logo



Cover Art of the Biology Podcast

Kompetensi Dasar Materi Perubahan Lingkungan	
3.11	Menganalisis data perubahan lingkungan, penyebab, dan dampaknya bagi kehidupan
4.11	Merumuskan gagasan pemecahan masalah perubahan lingkungan yang terjadi di lingkungan sekitar.
Tujuan Pembelajaran	
3.11.1	Peserta didik dapat menyadari adanya kegiatan pencemaran tanah dan air dalam kehidupan sehari-hari, bahkan kegiatan kecil sekalipun
3.11.2	Peserta didik dapat menyimpulkan bahwa sampah organik ternyata dapat menyebabkan Efek GHN (Gas Rumah Kaca)
3.11.3	Peserta didik dapat membedakan kelompok sampah organik, anorganik dan residu
4.11.1	Peserta didik dapat merumuskan gagasan pemecahan masalah perubahan lingkungan pada lingkungan sekitar

Learning Media Usage Guide



Figure 2. A Collection of Biology Podcast Episodes; link Podcast: <https://spoti.fi/3GI77Hx>

Development

Material, media, and education practitioners expertly appraised the biology podcast media. Expert validators are Lecturers of Biology Education at UIN Sunan Gunung Djati Bandung and education practitioners of Biology Teacher MAN 2 Bandung City. The percentage is as in Table 5.

Table 5. Table of Validation Results and Recapitulation Per Assessment Aspect

No.	Aspects Assessment	Score Maximum	Validator			Average
			Expert Material	Expert Media	Teacher Biology	
1	Material	25	22 (88.00%)	-	21 (84.00%)	86.00%
2	Learning	15	13 (86.67%)	-	12 (80.00%)	83.33%
3	Language Design	10	-	7 (70.00%)	8 (80.00%)	80.00%
4	Visual Design	10	-	7 (70.00%)	9 (90.00%)	75.00%

5	Audio	10	-	8 (80.00%)	7 (70.00%)	80.00%
6	Presentation	25	-	20 (80.00%)	20 (80.00%)	75.00%
Average			87.50%	76.36%	84.21%	
Biology Podcast Final Grade						82.69%

Based on the results of expert validation in Table 5, the biology podcast media received an assessment score of 82.69%. If interpreted, this value indicates that the media is valid and can be used as a learning tool. According to Ridwan (2010), learning media is considered feasible if the average assessment score is ≥ 71 .

The biology podcast was validated with one revision. The validation results, in the form of comments (criticisms and suggestions) from validators, were used to improve the media. According to Dick and Carey in Sirumapea et al. (2018), formative evaluation can be carried out in several stages, namely individual evaluation (one-on-one trial) with 1–3 students, small group evaluation consisting of 10–15 students, and field trials with test subjects on a wider scale.

Table 6. Results of Learner Responses to Biology Podcast Learning Media on Each Assessment Aspect

No.	Assessment Aspect	Score Value (%)	Description
1	Visual Design	84.17	Very worthy
2	Presentation	81.67	Very worthy
3	Material	85.00	Very worthy
4	Linguistics	80.56	Worth
5	Learning	80.42	Worth
6	Audio	81.67	Very worthy
Average		82.25	Very Decent

Based on the response analysis results in Table 6, the biology podcast media that students have assessed shows an average assessment score of 82.25% of the overall aspect, with a very feasible category. This shows that biology podcast products are very feasible to use as media in learning the environmental change chapter of the environmental pollution subchapter.

Based on the analysis of the results of learner responses, the assessment of visual design aspects is related to indicators of the attractiveness of images/illustrations and responses to podcast covers that contain data. The data presented in the biology podcast episode includes illustrations, bar charts, posters, and cartoons. The diversity of graphic design on the biology podcast cover received a score of 84.17% from students. This indicates that the biology podcast cover graphics attract students to listen to the audio in the learning process. According to Simbolon & Besti (2021), visual design must be attractive. The choice of colours and images is very influential in attracting users who like visuals to listen to the audio immediately. This is also confirmed by Fadilah et al. (2017), who state that the formula for success in presenting podcasts lies in light and attractive packaging by strengthening the characteristics of the podcast as a medium of communication.

The presentation aspect, related to the ease of access to podcast media, audio duration, episode description, and students' interest in listening after reading the podcast description, obtained a score of 81.67%. The duration used by biology podcasts ranges from 6 to 12 minutes. This shows that access to podcast media is easy and the duration is quite good. According to Syuhada et al. (2023), the advantages of using podcasts in learning include flexibility and easy access, because podcasts can be accessed and played anytime and anywhere, providing flexibility for students to learn according to their own time. Easy access through devices such as mobile phones or computers also makes it a practical learning alternative without having to buy books or visit the library. Furthermore, regarding the duration of podcasts, Laila (2020) states that the duration of podcasts should remain short. Best Practice in Educational Podcasting, KUMC (2016), suggests that the duration of podcasts ranges from 10 to 15 minutes. This is supported by Ramdhani et al. (2020), who stated that in the context of podcast-based learning, it is important to pay attention to the duration aspect of presenting material so as not to cause boredom and to maintain the level of focus of students during the listening process.

In the linguistic aspect, with the assessment points of language that is easy to understand, clear, without double meaning, interactive, and interesting to listen to, the biology podcast scored 80.56%. According to Wahyuni (2021), podcasts excel in understanding because they use contemporary, everyday children's language, making it easy to understand. Podcasts also excel in students' interest because the chat usually occurs in two directions: questions and answers, interspersed with jokes. This is in line with Ramdhani et al. (2023), who emphasise that aspects of speaking style, such as intonation, articulation, tempo, word choice (diction), and proper sentence structure, need to be considered in order to attract the attention and interest of students in listening to learning podcasts.

In the learning aspect, with assessment points related to the ease of use of biology podcast media, listening to episodes until completion, making it easier for students to learn independently by making notes on material, media that allows multitasking activities, easy use anytime and anywhere, the need for audio scripts/transcripts, and the ability to train students' analytical power and critical thinking, the biology podcast scored 80.42%. According to Diana & Saputra (2020), podcast media effectively increases students' interest in learning. This can be seen from the participation and activity of students in discussions and in asking and answering questions about the learning materials. This is reinforced

by Maulida et al. (2021), who state that the use of audio podcast media during learning can shape students to be active and creative.

In the linguistic aspect, the use of language is still not interactive and interesting. This can happen because the design of each podcast episode uses a script that contains material sequentially. So, what is heard by students is that the language used is less flexible, relaxed, and sounds stiff, even though it uses non-formal greetings from everyday life. However, the language used can still be understood by students. According to Wahyuni (2021), using friendly language in podcasts creates an atmosphere like learning and chatting with friends, so that students do not realise they are learning. The advantage is that because it is delivered in light language, students quickly understand and can answer questions related to the topic of discussion.

In the audio aspect, with assessment points related to audio clarity and audio sound effects, the biology podcast scored 81.67% (very feasible). According to Pitarto (2014), sound effects are used to describe the atmosphere in the audio. This is confirmed by Indriastuti & Saksono (2014), who state that through audio podcasts that can provide additional features such as sound effects, it is possible to provide listener imagination and bridge the limitations of direct experience—for example, if an object or phenomenon cannot be observed in real life, podcasts can present it virtually in audio form.

The results of students' responses, in general, showed that biology podcasts received positive responses. Some comments about biology podcasts were as follows (Personal Data 20/08/22):

- (1) *“Seruu dan asik, media yang anti mainstream dan kekinian.”*
- (2) *“Pengalaman belajar yang unik dan menarik. Saya baru mencobanya dalam pembelajaran biologi. Saya merasa terbantu, materi menjadi ringan dan mudah untuk dipahami.”*
- (3) *“Podcast biologi seruu abiss! Saya baru pertama kali belajar dengan podcast dan membuat Saya lebih tertarik untuk belajar. Pemilihan bahasa dan intonasi pas. Saya merasa lebih nyaman dan paham dengan materi yang dijelaskan. Mungkin deskripsi di awal halaman lebih dipersingkat aja.”*
- (4) *“Pembahasan podcast tentang masalah dalam kehidupan sehari-hari banget, apalagi tentang sampah. Pembawaan enak di denger plus sound effect nya nambah suasana nya, sukaa.”*
- (5) *“Saya mendukung pembelajaran dengan podcast, karena disamping penggunaannya ga terlalu rumit. Saya nyaman dan rileks selama mendengarkan pembelajaran.”*
- (6) *“Episode 2 dan 4 udah menarik. Tetapi episode 1 masih kurang menurut Saya.”*

Positive responses from learners highlight the effectiveness of podcast-based learning media in influencing learners' learning atmosphere. Punomo et al. (2023) state that the optimal use of podcasts by teachers can improve the quality of the learning process and arouse students' learning motivation. This media can create a more interactive and lively learning atmosphere, thus encouraging active student involvement in learning activities. In their research, Haka et al. (2023) proved that podcasts can motivate learners to increase their enthusiasm during the learning process. In addition, it was proven by Wijayanto et al. (2020) in their research that revealed the successful use of podcasts with increased student interest and learning outcomes. More than that, Augie (2021) shows that the results of using podcasts as learning media can develop students' thinking skills.

Conclusion

The Bee O Podcast was developed using a simplified 3D model based on Thiagarajan's 4D framework (Define, Design, Develop), which included preliminary studies, instrument preparation, media design, expert validation, and limited trials involving 15 students. Validity scores from material experts (87.50%), media experts (76.36%), and biology teachers (84.21%) yielded an average of 82.69% (very valid), although some aspects reached only 80% (valid), indicating areas that require further improvement. Student responses averaged 82.25%, categorized as very feasible for classroom use. Therefore, the Bee O Podcast is considered a valid and feasible biology learning medium on environmental change, with some aspects still needing refinement.

Acknowledgment

Thank you to all parties who have contributed to this research.

References

- Augie, K. T. (2021). Penggunaan Podcast Untuk Mengembangkan Keterampilan Berpikir Komputasi Siswa Selama Gangguan Pandemi. *Didactical Mathematics*, 3(1), 41-47.
- Arikunto. (2006). *Metodologi Penelitian*. Bandung: Rineka Cipta.
- Best Practice in Educational Podcasting. (2016). *Taken from University of Kansas Medical Center*. www.kumc.edu

- Bolliger, D. U., Supanakorn, S., & Boggs, C. (2010). Impact of Podcasting On Student Motivation In The Online Learning Environment. *Computers & Education*, 55(2), 714-722.
- Brown, A., & Green, T. D. (2007). Video Podcasting in Perspective: The History, Technology, Aesthetics, and Instructional Uses of A New Medium. *Journal of Educational Technology Systems*, 36(1), 3-17. doi:10.2190/ET.36.1.b
- Cheta, W., & Eberechukwu, A. S. (2018). Podcast Versus Vodcast and Students' Academic Achievement in Information and Communication Technology (ICT) a Research Course. *British Journal of Education*, 6(1), 103-110.
- Dalila, Nadana dan Ernungtyas, Niken Febriana. 2020. Strategi Storytelling, Spreadability dan Monetization Podcast Sebagai Media Baru Komedi. *Jurnal Riset Komunikasi (JURKOM)*, 3(2), 140-160.
- Determann, J. M. (2020, October 7). *Innovations in Education: Teaching with Podcast. Newsletter of the History of Science Society*, 49(4), 1-11.
- Diana, & Saputra, B. A. (2020). Pengembangan Media Pembelajaran Podcast Smamita Bercakap dalam Pembelajaran Ekonomi di SMA Muhammadiyah 1 Taman. *Jurnal Pendidikan dan Ilmu Sosial*, 375-382.
- Eka, Randi. (2018, Agustus 27). *Podcast User Research in Indonesia 2018 by DailySocial and JakPat*. Taken From: DailySocial: <https://dailysocial.id/post/laporan-dailysocial-penggunaan-layanan-podcast-2018>.
- Fadilah, E., Yudhaprarnesti, P., & Aristi, N. (2017). Podcast sebagai alternatif distribusi konten audio. *Jurnal Kajian Jurnalisme*, 1(1).
- Faradinna, N. (2020). *Peran Podcast dalam Mengembangkan Knowledge Society*. Jakarta: Universitas Pertamina.
- Haka, N. B., Sari, L. K., Handoko, A., Hidayah, N., & Masya, H. (2023). RICOSRE-Assisted Learning with Podcasts in Biology Education: Enhancing Analytical Thinking and Communication Skills. *Journal of Hypermedia & Technology-Enhanced Learning*, 1(1), 18-25.
- Hutabarat, P. M. (2020). Pengembangan Podcast Sebagai Media Suplemen Pembelajaran Berbasis Digital pada Perguruan Tinggi. *Jurnal Sosial Humaniora Terapan*, 2(2), 107-116.
- Indriastuti, F., & Saksono, W. T. (2014). Podcast Sebagai Sumber Belajar Berbasis Audio. *Jurnal Teknodik*, 18(3), 304-314.
- Laila, D. (2020). Inovasi Perangkat Pembelajaran Menggunakan Aplikasi Podcast. *Prosiding Seminar Nasional PBSI-III Tahun 2020 (pg. 7-12)*. Medan: Universitas Negeri Medan.
- Lee, M. J., & Chan, A. (2007). Reducing the effects of isolation and promoting inclusivity for distance learners through podcasting. *Turkish Online Journal of Distance Education*, 8(1), 85-104.
- Maulida, M., Hanafi, S., & Nulhakim, L. (2021). Efektivitas Media Audio Podcast Sebagai Gaya Belajar Auditorik Di Sd Islam Kreatif. *JTPPM (Jurnal Teknologi Pendidikan dan Pembelajaran): Edutech and Intructional Research Journal*, 8(2).
- Pitarto, E. (2014). How to Make Audio Project with Audacity (Membuat Media)
- Purnomo, A., Kurniawan, G. F., Maulida, I., Worotyca, T. I., & Naziya, I. (2023). Peningkatan keterampilan pengembangan media bagi guru sejarah kabupaten Semarang melalui pelatihan pemanfaatan podcast dalam pembelajaran. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 2(2), 40-48.
- Ramadhani, J. S., Firmansyah, M. B., Wilujeng, I. T., Putri, N. N., & Nafisah, D. (2023). Pemanfaatan podcast Spotify sebagai media pembelajaran bahasa Indonesia. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, 14(2), 135-143.
- Rane. (2018). *5 Alasan Kenapa Podcast Adalah Masa Depan Konten*. Diambil kembali dari Suarane. Taken from org: <http://suarane.org/5-alasan-kenapa-podcastadalah-masa-depan-konten/>
- Ridwan. (2010). *Dasar-dasar Statistika*. Bandung: Alfabeta.
- Simbolon, M. (2021). *Insani and Besti Rohana Simbolon.. Podcast Suara*
- Sugiyono, S. (2015). *Metode penelitian & pengembangan research and development*. Bandung: Alfabeta.
- Syuhada, F., Rizky, N. F., Putra, A. D. T., & Febriansyah, A. (2023). LAMLOP (Learning About Maritim In The Port) Media Pembelajaran Berbasis Podcast. *JURNAL PTI (PENDIDIKAN DAN TEKNOLOGI INFORMASI) FAKULTAS KEGURUAN ILMU PENDIDIKAN UNIVERSITA PUTRA INDONESIA" YPTK" PADANG*, 32-37.
- Thiagarajan, S. (1974). *Instructional Development For Training Teachers Of Exceptional Children: A sourcebook*.
- Wijayanto, P. S., Setiawan, W., Wahyudin, W., & Firmansyah, A. (2020). Meningkatkan hasil belajar siswa melalui media youtube (podcast) dengan metode pembelajaran pendidikan jarak jauh pada materi komputer dan jaringan dasar di smkn 3 bandung. *Jurnal Guru Komputer*, 1(1), 50-62.
- Zellatifanny, C. M. (2020). Tren Diseminasi Konten Audio on Demand melalui Podcast: Sebuah Peluang dan Tantangan di Indonesia. *Jurnal Pekommas*, 5(2), 117-132.