Co-designing a digital problem-based learning (DPBL) intervention informed by medical students' perspectives: Student-produced podcasts to enhance collaborative competencies

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Podcasting is increasingly integrated into medical education and formal curricula. Although creative podcasting has been successfully applied in various contexts, the use of podcasts in medical education has primarily been substitutional and supplementary. Creative podcasting aligns with problem-based learning principles by transforming students from passive recipients into active learners. This preliminary co-design study explored medical students' perspectives on using creative, student-produced podcasts to enhance collaborative competencies and their preferences for designing a new educational intervention. The study, approved by Aalborg University's Ethics Committee, employed semi-structured focus group interviews with medical students to co-design a podcast-based intervention. Data were analysed using Braun and Clarke's reflexive thematic analysis, guided by the activity-centred analysis and design (model. Students emphasised the need for clear guidelines, process orientation and methodological variation (epistemic design); suitable environments, accessible technology and supervisor support (set design), as well as interpersonal interactions and optimal group composition (social design). Co-designing with students aligns with existing literature and offers valuable insights for tailoring technology-enhanced educational interventions to local contexts.

Implications for practice or policy:

- Course leaders can co-design learning activities with students to align interventions with local contexts and existing literature.
- Educators can create a safe learning environment for creative student-produced podcasting that encourages exploration, risk-taking and openness.
- Educators may support equitable participation by providing a good-start guide with technical guidance and clear expectations.
- Curriculum designers can emphasise process over product when integrating creative student-produced podcasts to promote meaningful collaboration.

Keywords: digital technologies, podcast, problem-based learning (PBL), medical education, CanMEDS framework, co-designing, qualitative research

Introduction

Effective collaboration is a core competency for medical students and a fundamental requirement for safe, high-quality patient care (Broome, 2007; Fewster-Thuente & Velsor-Friedrich, 2008; Frank & Sherbino, 2015). The CanMEDS framework emphasises the collaborator role as essential for future physicians, requiring them to work seamlessly with colleagues, communicate effectively and contribute to a collaborative healthcare environment (Frank & Sherbino, 2015). Developing these skills early in medical education is critical, yet challenging, particularly in large cohorts where opportunities for

meaningful interaction can be limited. Student attitudes towards collaboration also influence engagement and learning outcomes, making it vital to design interventions that actively promote those behaviours.

The integration of digital technologies in medical education has become increasingly prevalent (De Leng & Gijlers, 2015; Dergham et al., 2023; Hutchcraft et al., 2023; McMenamin et al., 2018), aiming to enhance various competencies among medical students and prepare future healthcare professionals for a rapidly evolving digital landscape. Digital problem-based learning (DPBL) is one such approach that seeks to leverage technology, thus facilitating active learning and collaboration among students (Tudor Car et al., 2019). By incorporating digital tools and platforms, DPBL aims to provide a dynamic, interactive learning environment that simulates real-world medical scenarios, thereby enhancing students' problem-solving and critical thinking skills (Cowan et al., 2010; Mitchell & Savill-Smith, 2024; Tudor Car et al., 2019).

DPBL aims to support collaboration by creating opportunities for group discussions, peer feedback and joint problem-solving tasks. These activities might enhance students' understanding of medical concepts and improve communication, collaboration and self-learning (Clark, 2006; McParland et al., 2004; Rich et al., 2005; Tudor Car et al., 2019). Additionally, digital technologies in health professions education have demonstrated benefits such as enhancing diagnostic reasoning (Balslev et al., 2005; Chan et al., 2010; Kong et al., 2009), fostering problem-solving (Jin & Bridges, 2014; Kong et al., 2009; Reich et al., 2007) and self-directed learning (Jin & Bridges, 2014; Kong et al., 2009; Reich et al., 2007) and supporting the integration of interpersonal and professional skills (Chan et al., 2010). They also stimulate higher-order thinking (Balslev et al., 2005; Chan et al., 2010) and improve long-term knowledge retention (Bowdish et al., 2003) and self-perception (Reich et al., 2007). Moreover, medical students have reported that DPBL allows for greater flexibility and accessibility in learning (Rathleff et al., 2025).

DPBL encompasses diverse digital learning tools (Jin & Bridges, 2014), including web conferencing platforms, digital games and podcasts (Tudor Car et al., 2019). In this context, creative, student-produced podcasting offers a novel way to foster collaboration by encouraging active participation, teamwork and reflective dialogue within a PBL environment. Podcasting is increasingly integrated into medical education (Kelly et al., 2022), yet its use has primarily been substitutional or supplementary (McGarr, 2009), that is, replacing traditional lectures or supplementing these. Exploring medical students' perspectives on creative podcasting is therefore pertinent, as this approach has enhanced various skills in other contexts (Kemp et al., 2012; Kendall, 2013; Lee et al., 2011; Snowball & McKenna, 2017), such as teamwork (Kendall, 2013). Moreover, creative podcasting aligns with PBL values (Barrows, 1985; Savery & Duffy, 1995) by transforming students from passive recipients to active learners. This approach also reflects, to some extent, the principles of the students as partners framework, which advocates for meaningful collaboration between students and educators in the design of learning experiences (Dai & Matthews, 2023; Healey et al., 2014). Such partnerships complement PBL by promoting shared responsibility, enhancing engagement and ensuring interventions are relevant to learners' needs (Bovill, 2014; Bovill et al., 2009; Maharajan et al., 2025; Money et al., 2016).

In line with these principles, this study investigated second-semester medical students' perspectives on using creative, student-produced podcasting to facilitate collaborative competencies and how they would prefer a new educational intervention to be designed for future first-semester medical students. This study is a preliminary co-design study informed by student consultation. It explored students' perceptions of collaboration and creative podcasting in medical education to generate actionable design recommendations for a future educational intervention to be implemented in the first semester course Introduction to Problem-Based Learning, Communication and Health Science Practice.

The study was guided by the following research questions:

- What are medical students' perceptions of using creative, student-produced podcasting to facilitate collaboration?
- How would medical students design a new educational intervention using student-produced podcasting to enhance collaboration within the medicine programme at Aalborg University?

Materials and methods

Ethics and data protection

The internal Research Ethics Committee and the internal Data Protection Agency at Aalborg University reviewed the study and granted ethical approval (Reference ID: AAU084-1059096) and data approval (Reference ID: AAU031-1058999). Participation was voluntary, and all students provided written informed consent. No financial or material compensation was offered; however, light refreshments were provided during the focus group interview to create a comfortable setting. The ethics approval included safeguards to ensure voluntary participation and reduce any sense of obligation when students were approached directly. Importantly, C.R.R. held no teaching or assessment responsibilities for these students, further reducing the risk of perceived coercion. While the focus group format meant that participants and the interviewer were aware of each other, confidentiality was preserved by assigning ID numbers for all data handling. No identifying information was included in the transcripts or reported in the manuscript.

Co-design of the student-produced podcast intervention

The semi-structured focus group interviews with second-semester medical students were integral to co-designing a future teaching intervention centred on creative, student-produced podcasts in medical education at Aalborg University to be implemented within the first-semester course Introduction to Problem-Based Learning, Communication and Health Science Practice. Within this course, there are several learning objectives, a substantial part focusing on collaborative competencies aligning with the CanMEDS collaborator role (Frank & Sherbino, 2015). The initial concept involved small groups of medical students producing podcasts on medical or collaborative topics. This idea was explored with the students, and the qualitative findings, along with literature evidence, informed the intervention's subsequent design. The exploration of concepts and design ideas occurred during the semi-structured focus group interview as part of the study, rather than through a separate pre-study phase.

Essential elements identified from the focus group interview were categorised using the activity-centred analysis and design (ACAD) model (Goodyear et al., 2021).

The ACAD model provides a meta-theoretical framework for understanding complex learning situations by emphasising an activity-centred approach aligning with PBL and constructivist theories. It categorises instructional design into three categories: epistemic design (tasks students perform), set design (e.g., digital tools used, artefacts and learning spaces) and social design (student engagement and social roles). These categories were envisioned to help identify key design considerations for the subsequent podcast intervention. The ACAD model acknowledge the complexity and dynamic nature of learning activities and it emphasises the need for local adaptations based on specific contexts, resources and student needs (Goodyear et al., 2021) .

Goodyear et al.'s (2021) ACAD model was selected because it provides a structured yet flexible way to analyse and design complex learning situations, focusing on what students actually do rather than solely on teacher intentions or technological features. This activity-centred perspective is crucial in PBL contexts, where learning emerges through collaboration and self-directed engagement. By categorising designable elements into epistemic, set and social, ACAD supports the creation of interventions that balance process orientation, technological accessibility and group dynamics – key factors identified by students in this study.

Qualitative design and analysis

The qualitative interview was reported in accordance with the consolidated criteria for reporting qualitative research (Tong et al., 2007). The following sections describing the method are structured according to three domains of the consolidated criteria checklist.

Domain 1: Research team and reflexivity

Personal characteristics: The interview was conducted by C.R.R., who is experienced in qualitative research (Rathleff et al., 2017; Jorgensen et al., 2016). With over 10 years of clinical experience as a physiotherapist and clinical educator, she is familiar with diverse individuals and the medical field.

Relationship with participants: Prior to the interview, C.R.R. and the participants had a superficial relationship. Initial contact occurred during a lecture, followed by email communication. Participants knew the interviewer was a doctoral student with research objectives and that she had been a clinical educator in an acute hospital setting, collaborating with medical students and physicians. The other two of us acted as supervisors and were involved in the study design and analysis but did not attend the interviews. One of us was the course coordinator for the relevant subject and was therefore familiar to the students from prior teaching.

Domain 2: Study design

Theoretical framework: This study's methodological orientation was grounded in constructivism, consistent with PBL principles (Barrows, 1985; Savery & Duffy, 1995). PBL is a student-centred pedagogy characterised by collaboration, personal autonomy, generativity, reflectivity, active engagement, personal relevance and pluralism (Lebow, 1993). This constructivist qualitative research employed focus group interviews to understand a phenomenon from the perspectives of those experiencing it, consistent with the constructivist paradigm (Given, 2008). The constructivist approach framed the research question and aimed to comprehend the true meanings attributed by medical students, incorporating their insights for future co-students' benefit. The design of the educational intervention in collaboration with students sought to promote student-centredness and relevance, increasing motivation and active engagement. The study was designed as a co-design process using student consultation. While perceptions of collaboration were explored, the primary aim was to translate these insights into practical design recommendations for an educational intervention.

Participant selection: A purposive sample of second-semester undergraduate medical students was selected. All had taken and passed the course Introduction to Problem-Based Learning, Communication and Health Science Practice, which is the course the subsequent podcast intervention would be implemented in, in their first semester. Approximately 280 students received an email from the study secretary. Interested students emailed C.R.R., who provided detailed study information, ethical considerations and interview dates. Due to a low response rate, C.R.R. presented the study during a lecture and approached students directly. The final sample consisted of 7 students who attended the scheduled interview. To minimise any perceived power imbalance, students were explicitly informed that participation was voluntary and unrelated to their academic performance or standing. This was reinforced in the written consent process.

Setting: The interview took place in a windowless university meeting room with only C.R.R. and the students present. Participants consisted of three female and four male medical students, aged 19 to 23, with an average age of 20.

Data collection: Before the interview, the semi-structured interview guide was pilot-tested with a second-semester health research student, leading to adjustments such as reducing the number of interview questions due to time constraints, emphasising building on each other's ideas and focusing on personal course experiences. During the focus group interview, students were welcomed by C.R.R. and provided with study information and they signed the informed consent forms. They introduced themselves by stating their name, age and field of study. The interview comprised two parts: first, undertaking a 2-minute reflection on students' positive and negative group collaboration experiences within the first-

semester PBL course, documented on A3 paper; second, designing a teaching intervention for a future first-semester PBL course to promote collaboration through podcast production, guided by the ACAD model (Goodyear et al., 2021) to adress specific practical aspects of the design.

Interviews were recorded and transcribed verbatim immediately after data collection using Whisper©, then reviewed for accuracy by C.R.R. Transcripts were returned to participants and participants were given 1 week to review the transcripts and provide feedback, but no changes were requested. The interview lasted 1 hour, 4 minutes and 25 seconds, with no repeat interviews conducted.

Data saturation could not be confirmed with only seven participants; however, the students' perspectives are supported by the research literature (Balslev et al., 2005; Chan et al., 2010; de Jong, 1995; Dolmans et al., 2016; Godsk & Møller, 2024; Jin & Bridges, 2014; Poort et al., 2022; Rathleff et al., 2025).

Domain 3: Analysis and findings

Data analysis: The semi-structured focus group interview was analysed using the ACAD model alongside Braun and Clarke's reflexive thematic analysis (Braun & Clarke, 2006, 2021). This approach identifies patterns of meaning through coding and theme development, with flexibility in theoretical and research design (Braun & Clarke, 2021). We employed a theoretical thematic analysis approach (Braun & Clarke, 2006, p. 86). The iterative process followed six phases (Table 1), with codes identifying features of interest (Boyatzis, 1998; Braun & Clarke, 2006). Boyatzis (1998) was referenced to define the concept of a code; however, the analysis followed Braun and Clarke's (2021) reflexive thematic analysis, which prioritises transparency and reflexivity over inter-coder reliability. We focused on semantic themes, identified within the explicit or surface meanings of the data (Braun & Clarke, 2006, p. 84). C.R.R. and P.K.T. coded the data using deductive and inductive approaches (Bingham & Witkowsky, 2022). The initial codes were generated by C.R.R. and grouped into themes through an inductive process, followed by a deductive step using the ACAD framework (Goodyear et al., 2021) to structure themes into epistemic, set and social design modalities. The meaningfulness and coherence of themes were reviewed collaboratively by C.R.R. and P.K.T. during Phases 4 and 5, where codes were checked against the coded extracts and the full data set to ensure consistency. Final refinement and reporting (Phase 6) were also completed jointly by both of us. The 15-point checklist for good thematic analysis was followed (Braun & Clarke, 2006). Initial coding was conducted in NVivo during Phase 2, with subsequent analysis in Microsoft Word and physically on a desk and whiteboard to enhance material overview. Participants were invited to comment on the transcription but did not review the analysis. They will receive the study results after publication.

Table 1
Application of Braun and Clarke's (2006, 2021) reflexive thematic analysis during each phase

Phase	Description of the process
Phase 1: Familiarising yourself with your data	Transcribing data, reading and re-reading the data, noting down initial ideas.
Phase 2: Generating initial codes	Systematically coding interesting features across the entire data set, collating relevant data for each code (Table 2).
Phase 3: Collating codes to the themes	Collating codes into the themes, gathering all data relevant to each of the themes (Figure 1).
Phase 4: Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis (Figure 2).
Phase 5: Re-reviewing themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells (Figure 3).
Phase 6: Producing the report	The final analysis opportunity: selecting vivid extract examples, analysing selected extracts, relating analysis to research question and literature, producing a scholarly report (Results and Discussion).

Results

Phase 1: Data familiarisation

The data were transcribed, and the transcripts were read multiple times while initial ideas was marked on the prints of the transcription.

Phase 2: Generating initial codes

The following 31 codes were systematically identified across the entire data set, and data relevant to each code were collated to it, accordingly. The codes can be seen in Table 2.

Table 2
Codes identified across the entire data set

Codes (no.)	Labels (names)
1	Process orientation.
2	A product-oriented collaboration.
3	Collaboration diminishes when one has to rush and work at a high pace.
4	Delegation means that one is not actually collaborating, but rather doing things individually.
5	Clear agreements for collaboration.
6	The opportunity to discuss matters in plenary sessions provides multiple perspectives and allows for the correction of understanding.
7	Enjoyable and educational.
8	Collaboration is enhanced by individual pre-preparation.
9	Significant differences in skill levels within the collaboration can make it challenging to ensure the group functions effectively.
10	The collaboration has a social dimension.
11	A safe environment.
12	The potential of podcasts.
13	Podcast format: Humorous or dry.
14	Podcast content: Group issues or theoretical. Discussion, conversation or interview.
15	Group composition: Possibly a study group. Advantages and disadvantages of being in a group where members are familiar with each other.
16	Physical attendance enhances collaboration.
17	Insight into others' and one's own learning.
18	Collaboration location: In-person or group room. Online. Recording studio.
19	Podcast duration: minimal and maximum length.
20	Software for recording and editing podcasts. Not obscure.
21	Getting-started guide to ensure everyone is on the same technical level. Common foundation.
22	Discussing group issues promotes collaboration.
23	Group size: 5–7, 6–8 members, large enough to present diverse perspectives but not too large at the same time.
24	Icebreaker early on to create a safe learning environment.
25	Collaboration is hindered if there is silence or awkwardness, and members do not know each other well enough to break the awkwardness.
26	Collaboration can be hindered if one's inputs are not well received.
27	The working method can hinder collaboration if it is too uniform.
28	Lack of sensitivity towards each other can hinder collaboration.
29	Feedback from the adviser on the product.
30	Accessible adviser during the creation of the podcast.
31	The purpose of the podcast. Why?

Phase 3: Collating codes to the themes

The 31 codes were initially collated into three themes. Theme 1 was called Facilitating factors for collaboration among medical students, Theme 2 Hindering factors for collaboration among medical students and Theme 3 Design modalities. Theme 3 included three sub-themes related to the ACAD domains (Goodyear et al., 2021): epistemic, set and social design. The specific codes collated to each theme are shown in Figure 1. To illustrate how codes were grounded in the data, two representative quotes are provided below for one key code within each theme:

Theme 1 – Code 1: Process orientation

> ID2: Yes, I think many of the study hall exercises we had were good for promoting collaboration because we were placed in a situation where the product itself was not necessarily decisive, but where the important thing was that we created it together.
> Interviewer: Hmm.
> (nods) Does anyone else … I hear it a bit as if you're saying that when it's a process, it promotes collaboration more than when it's product-oriented.
> ID2: Yes.
>
> ID4: Yes, I somewhat agree. We only came to complete the module assignment, and we didn't talk at all. We just delegated the tasks and then went home when we were finished. So there was no collaboration whatsoever. It was just about getting it done.

Theme 2 – Code 25: Collaboration is hindered if there is silence or awkwardness, and members do not know each other well enough to break the awkwardness

> ID1: Bad atmosphere hinders it, and awkwardness. (everyone laughs audibly)
> ID7: Yes.
> ID1: Silence. Things like that, yes.
> ID2: Well, I would probably say, especially regarding the awkwardness, that if you've had just one occasion where you've spent time together outside the academic setting, it actually skips that process. Otherwise, it always takes a few minutes before things start to flow. Whereas if you can go from small talk and maybe saying hello to each other in the hallway, then when you sit down to work, it runs much better. Also because breaking down that shyness means you're not afraid to consider something that might not be academically correct. And that means you can get a better outcome because you can help each other get on the right track, instead of sitting with lots of uncertainties that you don't process.

Theme 3 - Code 13: Podcast format: Humorous or dry

> ID1: I think there should be enough freedom for humour to be part of it. Because if it's a dry podcast, it will probably quickly disappear from the work process.
> ID3: And especially if you say the goal is collaboration, that it should promote collaboration. Sure, a conversation about that philosophy [the lecturer] throws out might help learning, but now the goal is collaboration, so it's about having fun, socialising, and getting to know each other. And I think that's more important than us just learning some text or some study material. That's fine.

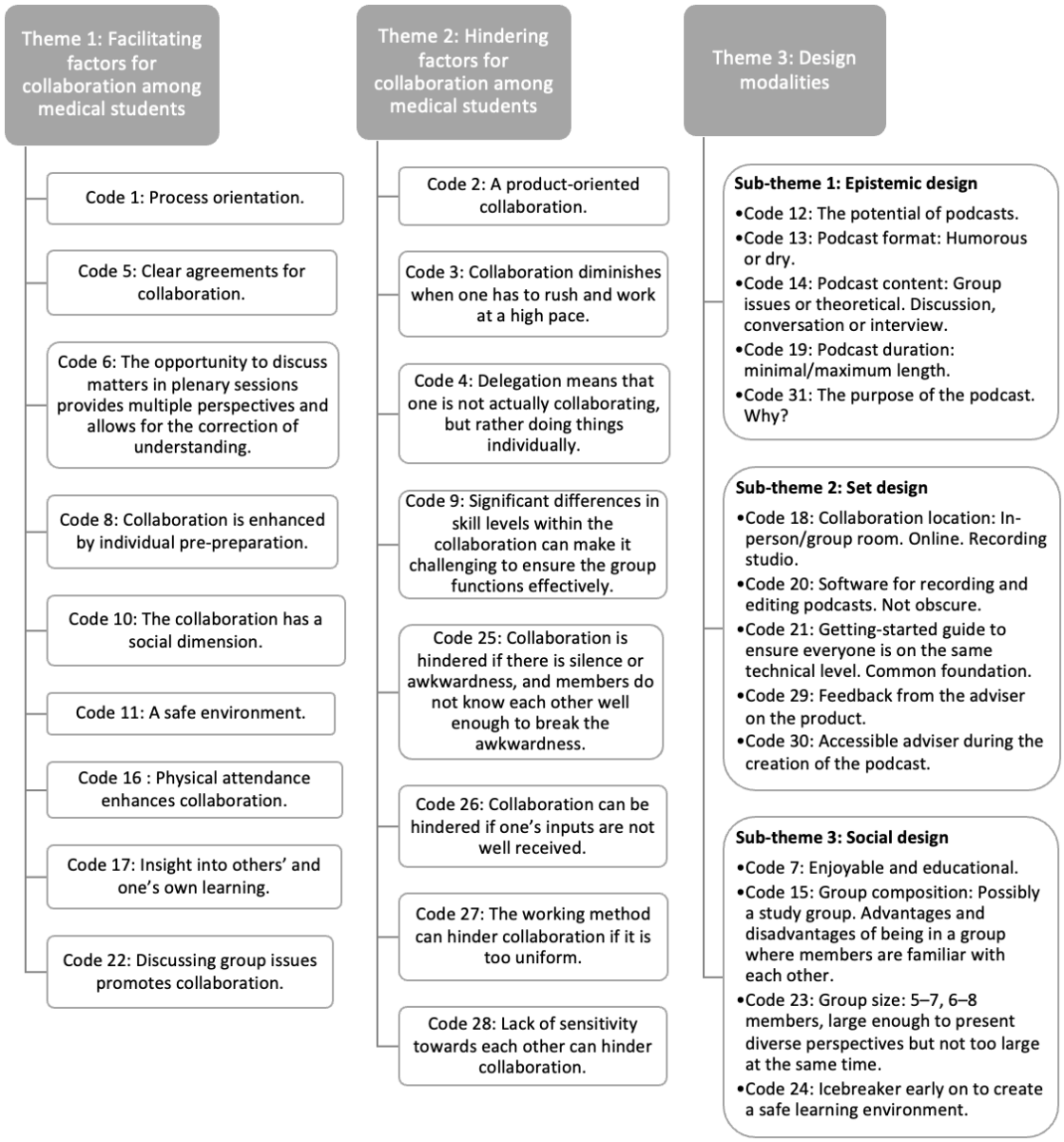

Figure 1. The codes collated to the themes and sub-themes

Phase 4: Reviewing themes

After reviewing the initial thematic map, the themes were reorganised to improve clarity and alignment with the ACAD framework. Figure 2 presents an overview of the revised structure. In this phase, the focus was on ensuring that sub-themes captured distinct aspects of collaboration and podcast design. For example, within epistemic design, sub-themes reflected both task characteristics (e.g., process orientation) and perceived benefits of group work. Similarly, set design emphasised practical enablers such as technology and supervisor support, while social design highlighted interpersonal dynamics and group composition. This reorganisation aimed to strengthen conceptual coherence rather than change the underlying codes.

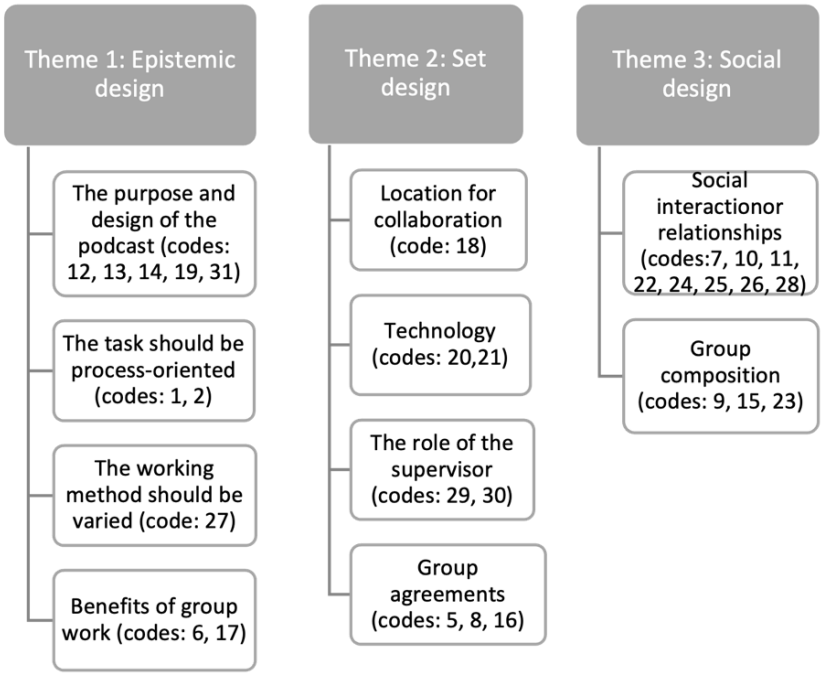

Figure 2. The initial thematic map of the analysis, with collated codes added under each sub-theme

Phase 5: Re-reviewing themes

Phase 5 involved refining sub-theme labels to better reflect their content and enhance readability. Figure 3 shows the final thematic map. While the underlying codes remained unchanged, some sub-theme names were adjusted to capture their essence more clearly (e.g., "Facilitator contribution" instead of "Role of the supervisor"). This step ensured that the final themes and sub-themes formed a coherent framework for presenting the findings.

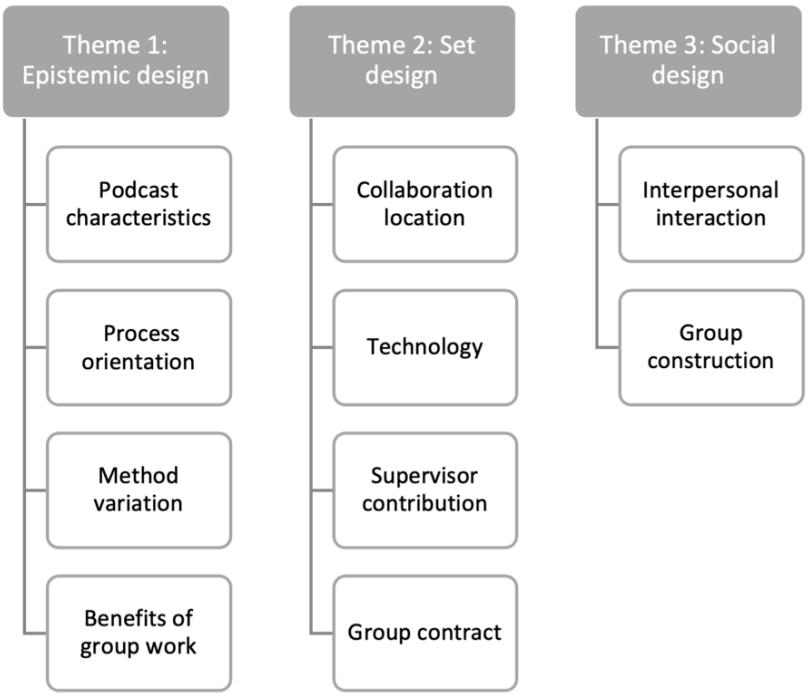

Figure 3. The final thematic map of the analysis, showing refined sub-theme labels. The underlying codes remained unchanged from Figure 2 and are therefore not repeated here.

Theme 1: Epistemic design

Within this theme, the medical students described how they wanted the tasks of the podcast intervention to be structured to support collaboration among students.

Podcast characteristics

The students emphasised that the task of constructing the podcast should be clearly defined, including specific details such as duration, format and content. Additionally, they stressed the importance of clarifying the purpose of producing podcasts. They recognised the potential of the podcast's creative format, noting that it was less monotonous than writing on a computer or completing more concrete, procedural tasks. This creative approach was seen as a way to encourage collaboration and enhance motivation for collaboration.

Regarding the content of the podcast, the students suggested topics such as ethical issues, which they found to foster the richest and most profound conversations during their first semester. Conversely, some students felt that philosophical questions could be too challenging if not fully understood. Many students believed that engaging in group discussions or panel sessions to solve various collaborative problems would be enjoyable and would stimulate collaboration.

Incorporating a humorous element was considered beneficial for promoting collaboration and reducing barriers. However, some students cautioned that the podcast should not be solely humorous, as this might undermine the perceived significance of the task:

> ID3: And especially if you say that the goal is collaboration, that is should promote collaboration. Sure, a conversation about that philosophy the lecturer (name removed) throws out might help with learning, but now the goal is collaboration, so it's really about having fun, enjoying ourselves, and getting to know each other. And I think that might be more important than just learning some text or some study material. That will be fine.

This highlights two opposing tendencies: students desired clear and defined guidelines for the podcast's format and content, while simultaneously valuing the freedom and creativity that the podcast format could promote:

> ID2: I also find it very limiting if the working method is completely uniform. This is especially true if one does a lot of the same tasks, particularly if they are primarily on paper or computer, as opposed to engaging in discussions or some form of sparring. Once you get started with it, it promotes the opportunity to both relate to each other and build upon existing knowledge.

Process orientation

The students emphasised that tasks could promote collaboration by focusing on the process rather than the final product. They provided specific examples from their university experiences, illustrating how different types of tasks inspired them to collaborate. When tasks emphasised the process of solving an assignment rather than merely submitting it, collaboration was encouraged. Furthermore, open-ended tasks were found to foster collaboration more effectively than limited or narrowly defined tasks. Open-ended tasks allowed students greater freedom to contribute their individual inputs towards solving the assignment:

> ID2: Yes, I believe that many of the study hall exercises we had where effective in promoting collaboration because we were placed in situations where the final product was not necessarily crucial; rather, the important aspect was that we completed it together.

In contrast to this process orientation, the students also highlighted exams and the quality of the end product as specific sources of motivation for active participation in the collaboration. This draws attention

to whether focusing on processes, assessments, or a combination of both can motivate students to engage in tasks and thereby enhance collaboration:

> ID1: It might be a good idea to say that this will be on the exam, because then people are always motivated to put in that extra effort. You could say that we are doing this to ensure you have good teamwork. 'Well, then I'd rather just go home." So, it might be a good idea. People are always ready then.

Method variation

The students discussed how rigid and uniform work methods can hinder collaboration, emphasising the importance of diverse and interactive approaches, such as discussions and brainstorming, to enhance teamwork and knowledge sharing. This highlights the need for flexible frameworks that allow creativity and individual contributions, contrasting with the limitations of strictly structured tasks.

> ID3: To add a bit more, I also think that in the module assignments, the framework was very rigid. It was like, "this and this, and this is what you need to answer." This rigidity made it somewhat limiting, as it is difficult to foster collaboration when the structure is so fixed, because people are not allowed to contribute with their own ideas.

Benefits of group work

Students emphasised the benefits of group work. They noted that group discussions facilitated better comprehension of texts and allowed for the clarification of uncertainties. Engaging in discussions within a group setting not only enhanced their ability to remember content more effectively but also provided a platform for correcting misunderstandings. This collaborative approach was deemed more advantageous than working individually, as it encouraged active engagement and the sharing of diverse perspectives. However, the students found that achieving the best outcomes from group work often required individual preparation. Additionally, gaining insights into one's own learning process was identified as crucial for effective group collaboration. This underscored the importance of being well prepared and self-aware to fully realise the benefits of collaboration:

> ID4: Yes, and also the discussions we have about things. If you haven't understood something completely correctly, others can correct you instead of you going on thinking you have understood it very well, only to have completely misunderstood it. You can then discuss it with your group.

Theme 2: Set design

Within this theme, the medical students described the tools, artefacts,and learning spaces they wanted to have in relation to the student-produced podcast intervention to support collaboration:

Collaboration location

> ID6: I would also argue that actually meeting in person demonstrates a certain level of interest from the collaborators, showing their commitment to the project.

As can be seen from the quote by ID6, the students emphasised the importance of in-person meetings for effective collaboration, noting that physical presence demonstrated commitment and facilitated better collaboration. Additionally, they highlighted the need for agreed-upon meeting locations to accommodate all group members and underscored the significance of suitable environments, such as group rooms, to minimise distractions and enhance communication, especially for tasks requiring recordings.

Based on the students' quotes, arranging in-person meetings was beneficial for collaboration. Furthermore, collaboration was improved when learning spaces are agreed upon in advance and the chosen venues were appropriate for the intended purpose.

Technology

The students emphasised the importance of using accessible and straightforward software for recording and editing podcasts to facilitate mutual assistance within the group. They also suggested listing multiple software options to accommodate varying levels of familiarity and experience among group members. Additionally, they highlighted the need for a common technical foundation and initial guidance to ensure effective collaboration, as illustrated in the quotes below:

> ID5: In addition, it is perfectly fine that some members can help the rest of the group. But yes, as you mentioned, it is important that everyone has a foundation. It is beneficial to be able to help each other within the group.

> ID5: As a comment on what was mentioned earlier about getting off to a good start, which you touched on a bit, it also varies how much experience people have with IT and things like that. So it is good to have a little guidance from the beginning, so we can achieve good collaboration.

Supervisor contribution

The students underscored the importance of having accessible supervisors or instructors during the podcast creation process to provide timely assistance and guidance. Additionally, they emphasised the value of receiving feedback on the final product to ensure that the work was purposeful and to facilitate continuous improvement. This highlighted the benefits of supervisors being present and approachable, which could enhance the students' experience and support their learning:

ID5: Yes, because sometimes, I personally find it quite helpful to receive some feedback, whether it is on academic content or to understand if one has grasped it correctly, or to get comments on what one has produced. On the actual product itself.

Group contract

The medical students emphasised the importance of clear agreements for effective collaboration. They proposed a written group contract to address potential disagreements and provided examples of situations where such a contract could enhance positive collaboration. They highlighted the need for all group members to attend, contribute and communicate if they were late. They also discussed the challenges posed by varying levels of preparation and the formation of subgroups, which could hinder collective learning unless preparation levels were agreed upon. Additionally, they underscored the necessity of agreeing on meeting locations to ensure accessibility for all members. This meant that establishing clear agreements on collaboration fostered a more cohesive and productive group dynamic:

> ID4: When we worked on other assignments in study hall exercises, we collaborated and discussed them, and we also had a clear agreement that everyone would show up. We had this collaboration agreement in the group that we would all attend and contribute. However, for the module assignment, we had more of an agreement that we would just finish it quickly and go home.

Theme 3: Social design

Within this theme, the medical students described how the groups, dyads, teams or roles should be constructed to support collaboration among students during the student-produced podcast intervention.

Interpersonal interaction

Throughout the interview, the students highlighted the significance of interpersonal interaction in enhancing collaboration among them. They emphasised that social activities and informal interactions outside academic settings could reduce awkwardness and build trust. Enjoyable and relaxed environments fostered better communication and a willingness to share ideas, both of which were crucial for productive group work. Humour and shared goals were also seen as important elements that broke down barriers and promoted a sense of camaraderie. Additionally, the students underscored the

importance of having meaningful and engaging tasks to maintain interest and motivation within the group.

Therefore, interpersonal interactions and social activities were essential for improving collaboration by fostering trust and communication. Meaningful tasks, humour and shared goals further enhanced group cohesion and motivation:

> ID2: I agree, but I also think it is important that there is a purpose and meaning to participating in the podcast, because if you feel you are getting something out of it and you have good camaraderie, it also promotes engagement. As you mentioned, incorporating humor is very important because it breaks down the barriers people have, which are essentially there to protect themselves. By overcoming these barriers, you enter into a collaboration rather than just being people sitting in a room.

> ID4: Well, I think when you're with people you don't know, it's also about trust in others – that you can rely on the fact that what you say, even if it's wrong, stays in the room. Not where someone goes out and says: "she just said something really stupid" or something like that. It needs to feel safe to be there. Good trust means you just work so much better together.

Group construction

The students discussed the optimal group construction for effective collaboration among medical students. They suggested that groups of five to seven or six to eight members were ideal, as they were large enough to provide diverse perspectives but small enough to ensure everyone was heard. They also highlighted the challenges posed by significant differences in preparation levels and academic skills, which could hinder group functionality. Additionally, they examined the pros and cons of working with familiar group members, noting that while familiarity could enhance comfort and communication, it might also limit exposure to new ideas and perspectives.

Consequently, effective collaboration required an optimal group size that balanced diverse perspectives and individual participation. Additionally, managing differences in preparation and skills, along with balancing familiarity and diversity, was crucial for enhancing group functionality and achieving successful outcomes:

> ID5: One must also be careful not to have too many members, as this can prevent everyone from being heard. However, it is beneficial to have enough members to provide diverse perspectives on the task.

ACAD design modalities

Based on student feedback within the three ACAD categories (Goodyear et al., 2021), the following key design considerations for a new creative, student-produced podcast intervention are outlined in Figure 4.

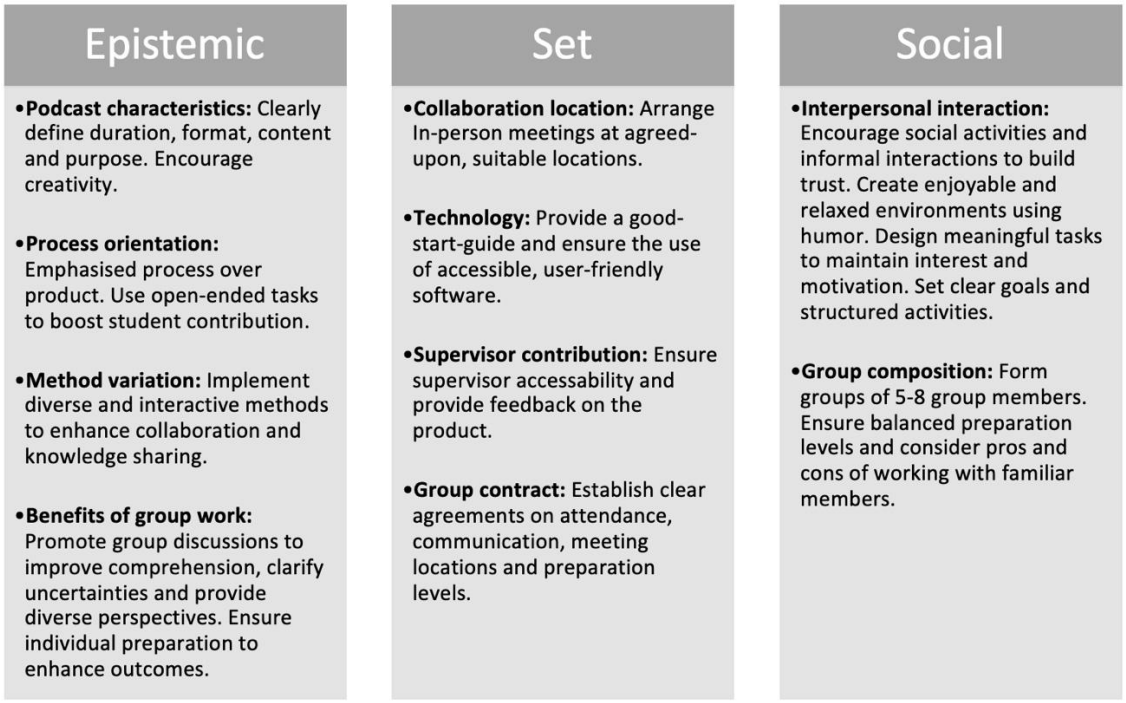

Figure 4. Design modalities proposed by the medical students in relation to a student-produced podcast intervention fostering collaboration

Discussion

This study addressed the challenge of enhancing collaboration competencies among medical students in problem-based learning, where traditional approaches often fail to engage all group members effectively. Our findings provide new insights into how a creative, student-produced podcast intervention can support collaboration. Specifically, the analysis identified three design modalities – epistemic, set and social – that shape collaborative dynamics and inform practical recommendations for educators. These findings extend existing knowledge by highlighting these students' perspectives on podcast design and offering concrete strategies, such as including a good-start guide and using accessible technology, may foster equitable participation and meaningful collaboration.

By framing this as a preliminary co-design study, the findings provide context-specific insights that inform the development of collaborative learning interventions, rather than aiming for generalisable claims.

While this study provides new insights into how podcast-based interventions can support collaboration, the findings should be interpreted with caution due to the small sample size. These factors constrain generalisability, and the implications presented here are intended as exploratory rather than prescriptive.

Epistemic design

Process orientation

Students found that process orientation improved collaboration. Linked to deep learning and deep-level processing (Dolmans et al., 2016; Marton & Säljö, 1976), this approach values the learning journey over exam outcomes. Deep learning is crucial in higher education (Dolmans et al., 2016) and should be involved in successful learning and studying, as emphasised by the Bologna declaration (Asikainen, 2014). In practice, process orientation can manifest through activities like group discussions, explaining, demonstrating, negotiating, reflecting (de Jong, 1995) and iterative case work, fostering deeper engagement and collaboration.

While students suggested process orientation improves collaboration, they acknowledged exams motivate prioritising certain tasks, potentially contradicting process orientation as the best incentive. Exams often lead to surface learning, focusing on assessed topics (Hassan et al., 2023; Zhang et al., 2011). To address this, educational design can integrate assessed process oriented activities, like reflective essays or group project evaluations, ensuring students value the process and product. Educators can emphasise the long-term benefits of deep learning and collaboration skills for professional success beyond exams.

Despite the technology's product orientation, focusing on the process is crucial in implementing a creative, student-produced podcast intervention.

Set design

Possibly a good-start guide?

The idea of a good-start guide emerged from students' own suggestions during the focus group interview, rather than from the literature. For educators implementing a creative, student-produced podcast intervention or activity, we recommend a good-start guide. This ensures all group members understand working methods and expectations, reducing misunderstandings and promoting effective collaboration. Godsk and Møller (2024) have noted that audio production enhances student engagement provided they have the necessary equipment and skills (Bolliger & Armier, 2013). Medical students producing podcasts need technological skills and similar competencies. A good-start guide should clarify relevant software options and include a workshop for hands-on experience with a skilled instructor. Educators can also provide links to online tutorials and encourage peers mentoring. These elements create structured, supportive environment that enhances collaboration and ensures all students are equipped to participate effectively.

Social design

A safe environment

Creating a psychologically safe environment is crucial for effective collaboration. Students emphasised the importance of open communication and trust. Poort et al. (2022) found trust to be the strongest contributor to group work engagement among 1025 students from universities in the Netherlands and Canada. Consequently, it becomes imperative to explore methods for establishing a safe learning environment. To create a safe learning environment, educators can, for example, set clear expectations for respectful communication and behaviour within the group and create opportunities for students to express their concerns and feedback without fear of judgement.

Humour's potential to create a safe and enjoyable learning environment, thereby enhancing group cohesion and collaboration, was specifically noted by the students. According to Meyer (2000), humour can serve as a cognitive tool to redefine sociocultural realities, promoting a mirthful state, a light and open atmosphere that encourages communication and trust. Additionally, humour functions as both a unifying and dividing force within social settings, facilitating communication and reducing tension (Meyer, 2000). Recent studies reinforce these findings. Robinson et al. (2024) identified affiliative humour as particularly effective in promoting engagement and cognitive processing, while cautioning against aggressive humour styles. Similarly, Isagan et al. (2023) demonstrate that humour, when used sensitively, reduces anxiety and fosters a positive classroom climate, supporting collaboration and trust. These insights align with students' perspectives in this study, who highlighted humour's role in breaking down barriers and creating a relaxed, inclusive environment.

In addition, Arici and Kutlu (2023) have highlighted that a positive disciplinary atmosphere and a sense of belonging further enhance collaboration skills, complementing the role of humour in creating a safe and supportive learning environment. To integrate humour effectively without it becoming distracting, educators should ensure that humour is relevant to the topic, used in moderation and employed at appropriate times to prevent it from overshadowing learning objectives. Encouraging students to

contribute their own humorous insights can also foster a relaxed and engaging atmosphere, promoting trust and openness within the group.

Practical recommendations

In implementing creative, student-produced podcasting for medical students, educators should focus on clear communication and structured activities to enhance group functionality. Epistemic design should emphasise individual pre-preparation, enabling students to contribute more effectively and confidently during group discussions. Set design should ensure that activities are both enjoyable and educational, increasing motivation and engagement. Social design must create a safe environment where students feel comfortable sharing ideas and making mistakes, fostering open communication and trust. Additionally, incorporating student feedback into the design of educational interventions ensures that the learning experience remains relevant, effective and adheres to local contexts. These factors collectively contribute to a more cohesive and productive collaborative learning experience, ultimately targeting the enhancement of collaborative competencies.

Limitations and future research

This study's limitations include its small sample size and the specific context of Aalborg University, which may limit generalisability to other settings. Future research should examine the implementation of student-produced podcasts in diverse medical schools to assess effectiveness across varied educational environments. Studies with larger and more diverse student populations are needed to validate and extend the findings, thereby strengthening the evidence base for integrating creative, student-produced podcasts into collaborative learning designs in higher education. Investigating long-term outcomes and the integration of technology in PBL could provide valuable insights for enhancing collaborative learning experiences.

Conclusion

In conclusion, our study highlights the significant role of various design modalities in implementing a creative, student-produced podcast intervention within medical education. Medical students identified key elements that align with existing literature and provide valuable insights for tailoring the intervention to a medical educational context.

An essential aspect of implementation is focusing on the process rather than the final product, encouraging open-ended tasks and facilitating group discussions to enhance comprehension and collaboration. To address the contradiction of exam-driven priorities, integrating assessed process-oriented activities is recommended. Additionally, the creation and distribution of a good-start guide is recommended. This ensures all group members have a common understanding of working methods and expectations, fostering a structured and supportive environment that enhances collaboration. Finally, creating a psychologically safe environment is crucial for effective collaboration. Educators should foster a learning environment where students can explore different perspectives, make mistakes, and communicate openly.

Author contributions

Camilla Rams Rathleff: Conceptualisation. Investigation. Data Curation. Formal Analysis. Writing – original draft., Writing – review and editing. **Thomas Ryberg:** Conceptualisation. Writing – review and editing. **Patrik Kjærsdam Telléus:** Conceptualisation. Formal Analysis. Writing – review and editing.

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