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Indice

The Progressive Design Method Development to Enhance Students' Participation in Blended University Courses: Design-Based Research

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Abstract

In this case study, we employed the Design-Based Research (DBR) approach to explore the evolution of a teaching method, the Progressive Design Method (PDM), centered around peer feedback, specifically crafted to enhance student engagement within blended university courses. We examined the three successive iterations of the PDM, involving respectively 17 students, 29 students and 28 students, enrolled in a university course. The task for the students was to develop a project as a team and give feedback on their colleagues' projects. The iterations were elucidated via Conjecture Mapping, while they were assessed through Productive Participation and Informative Participation within the online learning environment. The outcomes reveal that the iterative refinement of the design led to the identification of optimal PDM implementations, facilitating increased student participation and paving the way for innovative enhancements. Implications for the design of learning environments based on the PDM approach are discussed.

Keywords: Peer Feedback, Project-Based Learning, Knowledge Building, Design-Based Research, Students' Participation

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Introduction

In higher education blended courses, "participation" is a crucial indicator of active learning. In order to encourage student participation, the Progressive Design Method (PDM) was developed by Cacciamani (2017), which integrates Knowledge Building, project work, and peer feedback.

The Knowledge Building (KB) model is defined through 12 principles that work together in a complex system to organize a Knowledge Building community (KBC) and focuses on creating new knowledge through discourse (Scardamalia & Bereiter, 2010). The essence of Knowledge Building is the production and continuous improvement of ideas to advance community knowledge (Soliman et al., 2021). KB engages students in knowledge creation as in innovative communities, where students set forth questions, initial theories, and improve their theories as they gain new information and work to generate coherent explanations (Tan et al., 2021). Such a continuous improvement is based on discursive interactions in *design mode*, a way to work with knowledge. The main concern is the "usefulness, adequacy, improvability, and developmental potential of ideas" (Bereiter & Scardamalia, 2003, p. 7).

To support KBC activities, Knowledge Forum (KF), a multimedia online environment, has been created according to the KB principles (Scardamalia, 2004). The interface to support knowledge building activity foresees four specific features: "views", "notes", "build-on", and "scaffolds". Views are collaborative spaces for discursive interactions to discuss a specific topic. In these spaces, members of a KBC can share their ideas, questions, and problems of understanding using written messages called "notes". They can also expand upon ideas shared by other members or respond to questions posed by the instructor or fellow students through a feature known as "build-on". In other words, they can create messages connected to other messages through arrows. Scaffolds are epistemic markers that facilitate sharing ideas for knowledge building. The members of the community can select scaffold supports such as "I need to understand" and "My theory", and they can insert them into a note or a build-on for integration into their discourse (Soliman et al., 2021). Analytic Tools built into KF enable users to monitor participation and collaboration and permit teachers to provide just-in-time formative feedback to ongoing processes in KBC (Teplovs & Scardamalia, 2007).

Inspired by the KB model, the PDM involves students creating new knowledge using Project Based Learning (PjBL). PjBL aims to promote an experience of meaningful learning for students by proposing a driving problem presented inside a contextual situation as the starting point of the activity that requires the development of a project (Ching & Hsu, 2013). In developing projects, the students take responsibility for creating products, engaging in various activities such as asking questions, brainstorming to create ideas, seeking information from sources, and designing and testing alternative solutions to solve their problems (Blumenfeld et al., 1991). During this elaboration process, students also create a series of artifacts, applying what they have previously learned or using the information they have searched for and acquired during their activity. Created artifacts are external representations of students' solutions to the problem that can be shared and submitted for critical evaluation by both the teachers and peers for their progressive improvement. In a review, Kokotsaki et al. (2016) highlighted the positive effects of PjBL on learning, motivation, and positive attitudes toward collaboration with peers. Crespí et al. (2022) showed that university students involved in PjBL significantly developed their interpersonal skills, specifically teamwork and communication, compared to a control group without PjBL. PjBL can be well integrated into a KB perspective considering that the students (as Epistemic Agents) assume a collective cognitive responsibility to work collaboratively to find solutions to challenging problems, creating new knowledge embodied in their project of intervention.

Peer feedback is a communicative process in which learners communicate with each other about performance and standards required in a learning activity (Liu & Carless, 2006). Peer feedback is provided by learners of equal status; however, the key distinction from teacher feedback is that peers may not be domain experts. Consequently, the accuracy of peer feedback can vary (Gielen et al., 2010). Nicol and colleagues (2014) identified the benefits of peer feedback as follows: Firstly, students often perceive their peers' feedback as more understandable and useful than the teacher's feedback, as it is written in a more accessible language. Secondly, the amount and variety of feedback that students receive are augmented; in some situations, this may increase the likelihood that students will identify the feedback they need, differently from the situation where they only receive the feedback that teachers feel is useful or have time to produce. In addition, receiving peer feedback helps to raise students, as authors, to the different viewpoints of different readers. Lastly, if students are involved in evaluating their peers' work, on one hand, they have to explain their judgmental criteria and, on the other hand, they are engaged in a reflective activity related to their work, thanks to the feedback received by their colleagues. Huisman and colleagues (2019), in a meta-analysis of higher education students' academic writing, showed that engagement in peer feedback resulted in more considerable writing improvements compared to no-feedback and self-assessment conditions.

Peer feedback can be used in KB activities according to the Concurrent, Embedded, and Transformative Assessment principle of the KB model that highlights that assessment is an integral part of the effort to advance knowledge, and students need to engage in a continuous evaluation process to identify problems to solve as the work proceeds.

The present study aims to employ a Design-Based Research (DBR) approach applied to the PDM, with the Conjecture Mapping technique (Sandoval, 2014), to refine the combination of PjBL and peer feedback in a KBC. DBR emphasizes introducing educational innovations through iterative design, implementation, and evaluation cycles. This process leads to a contextual, theoretical model of innovation (Anderson & Shattuck, 2012). DBR can enhance PDM design principles through Analytic Tools, aiding data measurement, analysis, and reporting for understanding and optimizing learning environments (Siemens et al., 2011). The study focuses on this research question: How can we enhance students' participation in a blended university course? The development of PDM will try to provide answers to this question.

Method

Context and Participants

This study involved second-year students pursuing the Psychological Sciences and Techniques program at the University of Valle d'Aosta, Italy, enrolled in a Practical Guided Experience course called "Learning Psychology and Digital Technologies". This course aimed to improve their skills in creating digital technology-based projects for education. The task assigned to the students was to create a team project utilizing digital technologies in learning contexts and to provide feedback on the projects developed by the other teams. The course comprised eight face-to-face sessions, totaling 24 hours, with a 70% attendance requirement. In the first iteration, there were 17 students (14 females, 3 males), average age 22.35 (*SD* = 2.83 years). The second iteration had 29 students (24 females, 5 males), with an average age of 22.45 (*SD* = 4.3 years), and the third iteration included 28 students (23 females, 5 males), with an average age of 22.22 (*SD* = 3.53 years). All students provided informed consent for participation.

Online environment

In this EPG course, KF was used to support the activities in F2F meetings. The students were also free to work at home if they preferred (see Figure 1). In KF three Interaction views have been created: A 'Self-presentation' view in which members of the community presented themselves, a 'KB model' view in which students were asked to produce a critical analysis in terms of the advantages and problems of the KB model, by using some bibliographic references and considering its implementation in Italian schools, and 'Design' views which are used to share the projects and for peer/teacher feedback. In Figure 1 it is possible to see an example of the peer feedback activity with a note containing a part of a project (with the title "Dall'apprendimento passivo alla costruzione di conoscenza attiva") aligned in the left part of the picture, near the upper corner and a list of build-ons (notes linked to other notes) containing feedback provided by the members of the other groups.

Figure 1.
A view of KF used during the EPG

Measures and data analysis

We analyzed Productive Participation (sharing one's ideas) and Informative Participation (taking ideas from others) (Cacciamani, 2017). Student messages written in KF indicated Productive Participation, while messages read indicated Informative Participation. Teacher activities were excluded. The amount of data is, then, represented by the contributions written and read in each iteration in the online environment by the students, detected through the Analytics Tools of KF.

Three interactive phases in the course required student participation:

- Self-presentation: Students introduced themselves to the community. In this phase, we collected: 33 messages and 308 readings in the first iteration, 81 and 636 readings in the second iteration, 53 messages and 512 readings in the third iteration.

- KB model: Students critically analyzed the potential use of this model in Italian schools. In this phase, we collected 31 messages and 148 readings in the first iteration, 58 messages and 394 readings in the second iteration, and 47 messages and 332 readings in the third iteration.
- Design: Students collaboratively developed and shared their digital education project on KF, providing and receiving feedback and giving answers to the feedback received. In this phase, we collected 18 messages and 206 readings in the first iteration, 152 messages and 1,266 readings in the second iteration, and 176 messages and 1,765 readings in the third iteration.

Results will be presented based on the three indicated phases.

In the data analysis, of each iteration we used a Student's T-test to compare Productive and Informative Participation in each work phase to assess iteration effectiveness. After the three iterations, we compared Productive and Informative Participation across the three interactive phases using the Kruskall-Wallis test due to ANOVA conditions not being met. We employed the U-Mann Whitney test for pairwise iteration comparisons when statistically significant differences emerged.

Design Implemented in the Iterations

First Iteration

In this course, the starting point of the design was to create a context in which students could work collaboratively on the development of projects and share reciprocal feedback. PDM was implemented in the course through the following principles (Cacciamani, 2017):

1. *Students as Members of a KB Community:* Students work collaboratively in KB communities on project design.
2. *Critical Theoretical Model Analysis*: They analyze theoretical models (KB in this study) to assess their advantages, critical aspects, and potential application in their projects.

3. *Critical Case Analysis*: Students review research experiences, typically scientific articles, to gather insights for their projects and adopt ideas helpful in developing their projects.
4. *Progressive elaboration of the project*: Projects evolve in steps; in each of them, the students' design activity was supported by some guiding questions provided by the teacher, working as scaffolds and focused on the following aspects:
   - Identifying the theoretical model of reference for the project, context, participants, goals, and title.
   - Defining phases, timing, instruments, and resources.
   - Selecting the assessment and evaluation method.
   - Creating advertising (e.g., video or PowerPoint) to justify project adoption by stakeholders.
5. *Distributed Feedback*: At each step, project updates are shared on KF (e.g., PowerPoint presentation) for community members to review and provide feedback. Feedback is shared among all community members, including the teacher, across all project development stages.
6. *Recursive Design*: After receiving feedback in KF, each team is given time to reflect on any ideas that emerged through the feedback and to introduce changes in their projects.

The design for the first EPG iteration implemented these principles, as described in Figure 2, according to the Conjecture Map (Sandoval, 2014).

As seen in Figure 2, supporting tools included teacher's lessons, articles for analysis, and KF with Self-presentation, KB model, and Design views. Task structure involved critical KB model analysis in sessions 1-5 and project development for digital technology in education in sessions 4, 6-8. Participants worked in teams for F2F interaction.

Discursive practices included oral feedback from peers/teacher in sessions 4 and 8, written feedback in sessions 6 and 7, and various forms of student interaction for KB model and article analysis (e.g., work groups, jigsaw, plenary sessions).

Five work groups, each with about four students, developed projects on digital technology in education. Table 1 presents data on Productive and Informative participation at the end of the First iteration.

Figure 2.
Conjecture Map for the first iteration

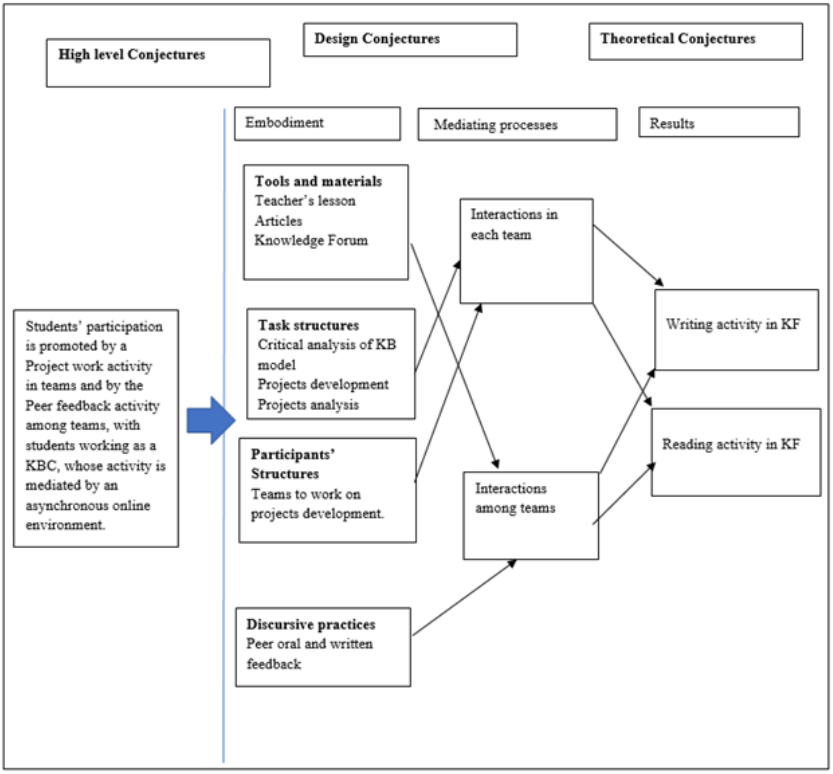


Table 1.
Productive participation and Informative participation in the first iteration

1st iteration	1st phase	2nd phase	3rd phase
	Mean (SD)	Mean (SD)	Mean (SD)
Written contributes	1.94 (1.40)	1.82 (2.09)	1.06 (1.85)
Read contributes	18.12 (13.22)	8.71 (9.26)	12.12 (13.18)

With references to the written contributions, there were no statistical differences between the first and the second phase ($t_{(16)} = 0.20$, $p > .05$), between the second and the third phase ($t_{(16)} = 1.22$, $p > .05$), and between the first and the third phase ($t_{(16)} = 2.02$, $p > .05$).

Concerning reading contributions, we have identified a statistically significant decrease from the first and the second phase ($t_{(16)} = 3.07$, $p < .01$), an increase between the second and the third phase ($t_{(16)} = -2.19$, $p < .05$), and no difference between the first and the third phase ($t_{(16)} = 1.65$, $p > .05$)

In the first iteration, teacher observations indicated that students had no issues using KF for Self-Presentation and KB model analysis. However, peer feedback in the 'Design' view was limited, with students providing just one short feedback on average. This suggests potential challenges in offering feedback to peers. Additionally, the oral peer feedback did not guarantee the integration of ideas into subsequent meetings to refine the project. Teams tended to prioritize teacher feedback over that from their peers for project improvement.

Second Iteration

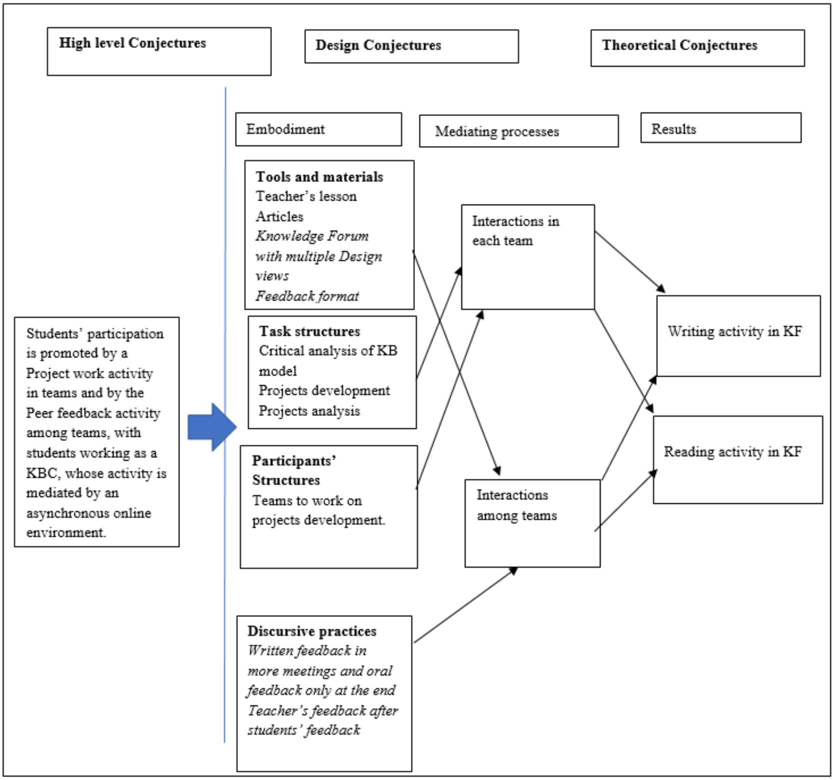
Considering the limits that emerged in the previous iteration, four main changes are introduced, as represented in *italics* in Figure 3.

The main changes in the second iteration were made in the Tools and materials and the components of the Discursive practice.

The changes in the Tools and materials component included:

- *Multiple Design views for the distributed feedback*: In contrast to the single 'Design' view in the first iteration, we introduced five separate views, each corresponding to a specific design step. This change aimed to facilitate targeted peer feedback for each aspect of the project and encourage greater student engagement in the feedback process.
- *Feedback framework*: The teacher introduced a framework to enhance peer feedback quality. It emphasized that feedback could include questions, identify positives or negatives, and offer suggestions for project improvement.

Figure 3.
Conjecture Map for the second iteration



The changes in the Discursive practices' components included:

- *Increased Written Feedback:* We expanded written feedback in KF during the course, starting in session 4 (and continuing in sessions 6 and 7) to encourage reflection among students. In session 8, we retained oral feedback since it was the final meeting, and further project improvement was impossible.
- *Providing teacher's feedback after students' feedback*: To prevent influencing students' activity, teacher feedback was given only after students had provided their feedback.

In the second iteration, six groups, with around five students each, worked on six projects related to digital technology in education. The teacher observed increased student engagement in providing peer feedback. Table 2 displays data on Productive and Informative participation at the end of the second iteration.

Table 2.
Productive participation and Informative participation in the second iteration

2nd iteration	1st phase Mean (SD)	2nd phase Mean (SD)	3rd phase Mean (SD)
Written contributes	2.79 (2.37)	2.00 (2.07)	5.24 (3.68)
Read contributes	21.93 (20.33)	8.72 (8.74)	43.66 (34.78)

With references to the written contributions, there were no statistical differences between the first and the second phase ($t_{(28)} = 1.30$, $p > .05$). We have observed, however, a statistically significant increase from the second to the third phase ($t_{(28)} = -4.61$, $p < .01$), and from the first to the third phase ($t_{(28)} = -2.71$, $p < .01$).

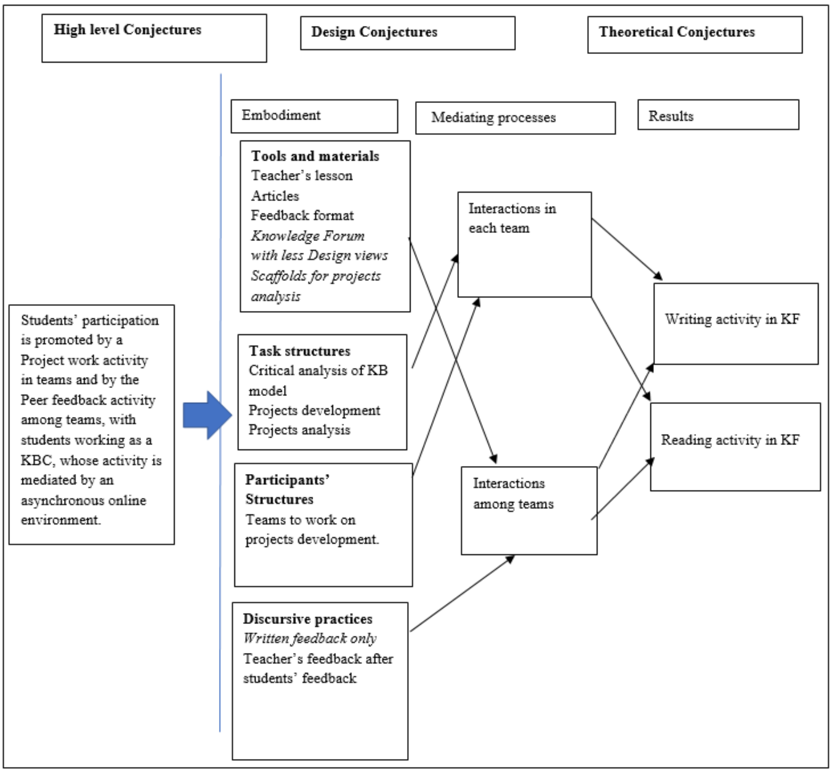
Concerning the read contributions, a statistically significant decrease emerged from the first to the second phase ($t_{(28)} = 3.53$, $p < .01$), and statistically significant increases from the second to the third phase ($t_{(28)} = -5.87$, $p < .01$), and between the first and the third phase ($t_{(28)} = -3.60$, $p < .01$) were observed.

In this iteration, teacher observations indicated students had no issues using KF for Self-presentation and KB model critical analysis in a blended approach. However, student feedback appeared less in-depth in project analysis, and the five "Design" views seemed confusing. Also, the oral feedback in the final lesson was not particularly helpful.

Third Iteration

Considering the limits that emerged in the previous iteration, three main changes are introduced in the third iteration, indicated in *italics* in Figure 4:

Figure 4.
Conjecture Map for the third iteration



In the third iteration, we made key changes in Tools, Materials, and Discursive practices:

- *Fewer Design Views*: To prevent student confusion, we introduced only three Design views, each corresponding to a meeting where the project received written feedback from peers and the teacher.
- *Introducing Project Analysis Scaffolds*: The teacher offered scaffolds containing questions (e.g., *Is the number of the course participants defined?*) for students to use in project analysis during feedback. These questions were strongly connected with the questions provided as scaffolds, already in the first iteration, to support the project design, aiming to favour the students' comprehension that understanding the instructions to design their project is the base for giving effective feedback to their peers' product. These questions were then introduced to help students assess the completeness of projects, and students followed a similar format as the previous iteration in the formulation of the feedback, utilizing questions to be clarified, identifying positives or negatives, and suggesting improvements.

The changes in the Discursive practice components are:

- *Entirely Written Feedback:* We eliminated oral feedback and structured the course around four meetings with written feedback.

Data on Productive and Informative participation at the end of the third iteration are in Table 3.

Table 3.
Productive participation and Informative participation in the third iteration

3rd iteration	1st phase Mean (SD)	2nd phase Mean (SD)	3rd phase Mean (SD)
Written contributes	1.89 (1.31)	1.68 (2.23)	6.29 (5.05)
Read contributes	18.29 (13.37)	11.86 (12.83)	63.04 (44.35)

With references to the written contributions, there were no statistical differences between the first and the second phase ($t_{(27)} = 0.48$, $p > .05$). However, we have observed a statistically significant increase from the second to the third phase ($t_{(27)}$ = -4.76, p < .01) and from the first to the third phase ($t_{(27)}$ = -4.85, p < .01).

With references to the read contributions, we detected a statistically significant decrease between the first and the second phase ($t_{(27)}$ = 3.28, p < .01), and statistically significant increases between the second and the third activity ($t_{(27)}$ = -6.99, p < .01) and between the first and the third activity ($t_{(27)}$ = -6.34, p < .01).

Results

In order to identify the best implementation of the PDM, we compared the Productive Participation in the three iterations (Table 4).

Table 4.
Productive Participation

Iterations	1st phase Mean (SD)	2nd phase Mean (SD)	3rd phase Mean (SD)
1st	1.94 (1.40)	1.82 (2.09)	1.06 (1.85)
2nd	2.79 (2.37)	2.00 (2.07)	5.24 (3.68)
3rd	1.89 (1.31)	1.68 (2.23)	6.29 (5.05)

Comparing through the Kruskall-Wallis test the first phase of the three iterations, there were no statistically significant differences ($H_{(2)}$ = 2.45, p > .05). Also, comparing the second phase of the three iterations, significant statistical differences were not found ($H_{(2)}$ = 0.64, p > .05). A significant statistical difference emerged comparing the third phase of work among the three iterations ($H_{(2)}$ = 20.29, p < .001). The U-Mann Whitney test highlights that the Productive Participation in the second iteration was higher than in the first iteration (Z = -3.83, p < .01). In addition, the Productive Participation in the third iteration was higher than in the first iteration (Z = -4.27, p < .01). Also, no statistically significant differences were observed between third and second iteration.

We also compared Informative Participation in the three iterations (Table 5).

Table 5.
Informative Participation

Iterations	1st phase Mean (SD)	2nd phase Mean (SD)	3rd phase Mean (SD)
1st	18.12 (13.22)	8.71 (9.26)	12.12 (13.18)
2nd	21.93 (20.30)	8.72 (8.74)	43.66 (34.78)
3rd	18.29 (13.37)	11.86 (12.83)	63.04 (44.35)

Comparing the first phase of the three iterations, there were no statistically significant differences ($H_{(2)} = 0.36$, $p > .05$). Also, comparing the second phase of the three iterations, no statistically significant differences were found ($H_{(2)} = 0.79$, $p > .05$). However, a statistically significant difference emerged comparing the third phase of work among the three iterations ($H_{(2)} = 25.97$, $p < .001$). The U-Mann Whitney test highlights that the Informative Participation in the second iteration was higher than in the first iteration ($Z = -3.49$, $p < .01$). Also, in the third iteration the Informative Participation was higher than in the first iteration $Z = -5.02$, $p < .01$). In addition, the differences among the third and the second iteration are near the statistical significance ($Z = -1.94$, $p = .051$). In the third iteration, the mean of the notes read tends to be higher than in the second iteration.

Discussion

This study used a DBR approach to develop the Peer Feedback-Based PDM model through three iterations with varying designs. The research question of the study was focused on how to enhance students' participation in a blended university course through the PDM. We compared each phase of the PDM across the iterations, focusing on Productive and Informative Participation. Results revealed increased Productive and Informative Participation in the Design phase of the second and third iterations compared to the first iteration. Notably, there were no significant statistical differences between the third and second iterations, but Informative participation was higher in the third iteration than the second. Online participation results can be explained by the progressive design refinements across iterations, which introduced four key innovations: 1. Written feedback in the online environment, 2. Project analysis scaffolds, 3. Feedback framework, and 4. Distributed feedback over time and space. The first aspect – written feedback in the online environment – promotes higher participation by fostering reflective activity, aligning with findings from other studies (e.g., Nicol et al., 2014). Written feedback in the online environment allows students to better organize, through writing, their ideas when giving feedback to their peers. In this regard it is interesting to notice that, as highlighted by Li and Grion (2019) in their study, students consider giving feedback as a process that can influence their learning more than receiving feedback. In addition, thanks to the online environment, each member of the teams can read and reflect on feedback received at their convenience. Finally, the online written feedback can be used in F2F discussions by each team to modify the project according to the feedback received. The second aspect – scaffolds for project analysis – can promote higher participation by giving a checklist on what to focus on to better analyze the projects and provide more information feedback, which leads to more student control on the feedback activity (Gibbs & Simpson, 2004).

The third aspect – the feedback framework provided – has helped the students identify specific aspects to formulate feedback messages. The fourth aspect – distributed feedback over time and space – promotes increased participation by ensuring timely feedback (Gibbs & Simpson, 2004). Providing feedback to colleagues at each project phase allowed for precise identification of areas for change. Likewise, receiving peer feedback at each step enabled students to address project modifications promptly. Organizing the virtual environment for feedback exchange reduced confusion and improved students' orientation, enhancing participation. The combination of the effects of the four mentioned aspects introduced in the design of PDM can have stimulated, then, an increase in students' online participation. Based on the data from Analytics Tools, the results confirm that PDM in the second and third designs, built through the DBR methodology, is a valid method to promote student participation in a blended university course.

In terms of design principles of PDM, considering the innovations introduced and the improvement of participation obtained in the third phase of the second and third iterations compared to the first iteration, we can add a principle called "Supported feedback activity" as follows: Students are supported in their feedback activity by scaffold for analysis of the project (e.g., a checklist with crucial questions about features of the project) and by a feedback framework (e.g., questions, positive or negative aspects, suggestions for improvement).

It seems appropriate to highlight some limitations of the study. The first limitation of the study is related to having PDM tested in only one course (Psychological Sciences and Techniques). It would be important to test the effectiveness of the method in other degree courses to explore if any changes are required when the context changes. Another limitation is the prevalence of the female gender in the groups of participants involved in the three iterations. It would be useful to replicate the study with a group having a more balanced gender composition.

This study offers a new contribution to the field, introducing the PDM as a new method based on peer feedback to improve students' participation in blended university courses.

New directions of inquiry can involve using Content analysis to identify the kind of feedback provided (e.g., Cacciamani et al., 2018) to ameliorate the quality of the products and to introduce metacognitive reflections spaces during the activity to stimulate students in improving their peer feedback strategies (e.g. Cacciamani et al., 2021). In addition, considering the possibility of giving an incentive for effective feedback provided by the students to their peers and the introduction of a metacognitive reflection on the experience during the activity could be considered as new components to be introduced and tested to make the PDM more effective.

This study can offer, then, to teachers and researchers the PDM as a new method to design blended university courses that may favor students' participation.

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