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Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

Developing Online Tutorials Through Peer-Assisted Learning (PAL): The Four-Component Instructional Design (4C/ID) Model

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The Four-Component Instructional Design (4C/ID) model facilitates complex learning, while Peer-Assisted Learning (PAL) offers a robust framework for collaborative acquisition of knowledge and skills. This study investigates how a collaborative environment, integrated within the 4C/ID framework, can enhance the effectiveness of online tutorial development by learning designers. Employing a qualitative approach, we explored the underlying mechanisms of the design process. Preliminary findings suggest that integrating PAL with 4C/ID improves the quality and engagement of online educational content. This research suggested the potential of collaborative strategies in instructional design, proposing a model that could be beneficial for enhancing future educational practices.

Keywords: 4C/ID model, peer-assisted Learning (PAL), collaborative learning, learning design, qualitative study

Four-component instructional design (4C/ID)

Instructional design approaches based on objectives break tasks into specific learning goals (Frerejean et al., 2019). Instructors are guided to select the most effective method for each goal, continuing until all objectives are met. Similarly, learning designers preparing materials must adhere to guidelines that specify tasks, goals, and content to satisfy various learning objectives. The 4C/ID model, developed by van Merriënboer and colleagues (2002), is an instructional design framework tailored for complex learning. This type of learning targets integrative goals, simultaneously developing knowledge, skills, and attitudes essential for acquiring complex skills and professional competencies. The model offers a structured approach to analyse real-life tasks and convert them into a blueprint for educational programs, as elaborated by Frerejean et al. (2019). Given its emphasis on integrating multiple skills, the 4C/ID approach is particularly effective for designing and teaching complex skills within authentic learning contexts, such as technology design tasks. While learning designers can adopt this model to help and support their designing processes and testing the effectiveness for the learning materials.

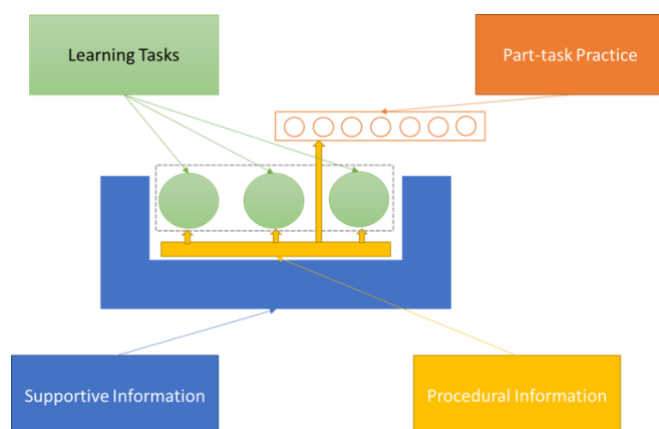


Figure 1 4C/ID Model (Adapted from Merriënboer & Kirschner, 2018)

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The 4C/ID model, as outlined by van Merriënboer and Kirschner (2018), consists of four critical components: (a) learning tasks, (b) supportive information, (c) procedural information, and (d) part-task practice (Figure 1). Learning tasks are designed to integrate skills, knowledge, and attitudes, which are pivotal to the instructional goal and frequently encountered in practical settings. Supportive information provides the theoretical background needed to handle the non-recurrent aspects of tasks, such as problem-solving, reasoning, and decision-making, thereby aiding in the acquisition of well-structured knowledge or cognitive schemas. The latter two components, in contrast, focus on automating these schemas and developing task-specific procedures that require minimal cognitive processing resources (Frerejean et al., 2019). Collectively, these four components offer a framework that guides learning designers in focusing and testing their content and materials effectively. In alignment with the four components of the 4C/ID model, ten steps to facilitate complex learning was introduced to guide the design process (van Merriënboer & Kirschner, 2017). This structured approach is versatile, applicable to creating instructional materials and learning tasks across various educational levels. Consequently, this study will engage Master of Learning Science and Technology students, prompting them to apply the 4C/ID model in developing their online tutorials.

Peer-assisted learning (PAL) and the design of MultiPAL

Peer-Assisted Learning (PAL) is highly regarded for its capacity to foster knowledge and skills acquisition, leveraging collaborative dynamics where students actively support each other towards shared learning goals (Topping et al., 2017). Among its forms, peer tutoring involves asymmetrical roles where more knowledgeable peer tutors facilitate learning through explanations, questioning, and reasoning (Duran & Monereo, 2005; Roscoe & Chi, 2007). This interaction not only helps tutees address misconceptions but also enriches the tutors' understanding as they reflect on the learning process and engage in the exchange of knowledge and ideas (Roscoe & Chi, 2008).

Unlike the peer tutoring, the cooperative learning involves small groups collaboratively working towards consensus on specific tasks or problems (Topping, 2020). In this model, each member contributes different facets of the task, fostering a collective outcome that often surpasses traditional learning achievements (Kobayashi, 2020). However, despite their benefits, both peer tutoring and cooperative learning present challenges, such as modest learning gains in peer tutoring linked to program duration and session length, and efficiency issues in cooperative learning due to responsibility diffusion and inconsistent participation levels (Alegre et al., 2019; Topping, 2020).

To address these challenges, this study introduces MultiPAL, an innovative model that combines the advantages of both peer tutoring and cooperative learning while mitigating their drawbacks. In MultiPAL, multiple tutors work with a single tutee, creating a dynamic, multidimensional educational environment (Figure 2). This format not only enhances tutor-tutee interactions requiring more preparation before the tutoring session by combining the knowledge within a tutor team together, but also promotes the exchange of knowledge among tutors, enriching the learning experience for the tutee with diverse perspectives and a deeper knowledge base. By countering the limitations of conventional methods, MultiPAL fosters thorough preparation and active engagement among peer tutors and addresses issues like responsibility diffusion observed in cooperative learning.

This study

This study integrates peer-assisted learning with the 4C/ID model, involving students who aim to become learning designers in creating an online tutorial. Utilising the 4C/ID framework, participants engage in the MultiPAL process, which encompasses designing, testing, and refining the tutorial. The tutor team, consisting of the learning designers, is tasked not only with designing the tutorial but also with evaluating its effectiveness. This involves incorporating learning tasks, problem-solving exercises, and reasoning activities into the online tutorial. Additionally, procedural information and part-task practice are included to enhance understanding and mastery of the learning tasks. The effectiveness of these materials is evaluated through

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testing with a tutee at various stages of the 4C/ID model to determine if further modifications are needed. The peer tutors collaborate to develop and refine the learning materials, presenting them to the tutee weekly over a eight-week period, simulating a real tutoring environment. This iterative cycle of design, test, and refinement is crucial to ensuring that the educational content effectively meets the learning objectives.

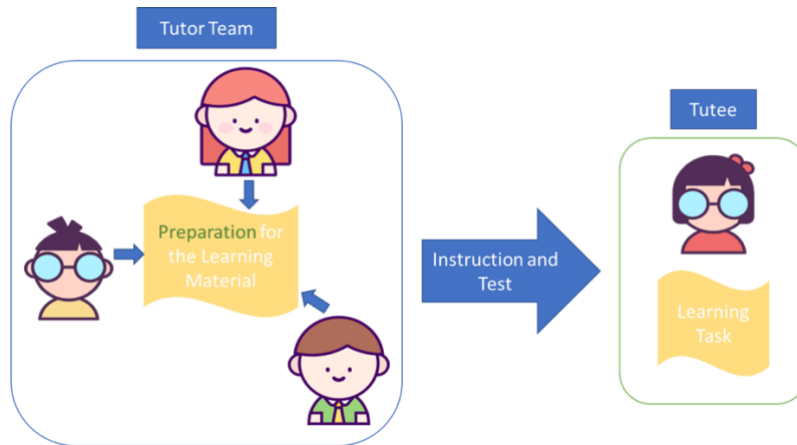


Figure 2. The design of MultiPAL

Research questions

This study focuses on the integration of Peer-Assisted Learning (PAL) with the Four-Component Instructional Design (4C/ID) model, specifically in the context of learning designers developing online tutorials. The research aims to address two central questions:

1. What is the feasibility of implementing PAL along with the 4C/ID model for learning designers to develop tutorials?
2. What benefits can students get from the new design of Peer-Assisted Learning?

The first question explores the practical aspects of merging PAL strategies with the 4C/ID framework in instructional design. It seeks to determine the logistical, technical, and educational viability of this approach for learning designers. Key considerations include the adaptability of the 4C/ID model to incorporate collaborative learning elements, the resources required (such as time, technology, and training), and potential barriers in the implementation process. The second question investigates the specific advantages that students can gain from the newly designed PAL framework. This involves assessing the learning outcomes, such as enhanced understanding of complex concepts, improved retention rates, and increased engagement and motivation among learners. It also looks at the broader educational impacts, such as the development of critical thinking and problem-solving skills, the effectiveness of peer feedback, and the fostering of a supportive learning community.

Methodology

This study mainly adopts a qualitative research design to comprehensively assess the feasibility and benefits of integrating Peer-Assisted Learning (PAL) with the Four-Component Instructional Design (4C/ID) model. This involves the video recording of the testing process, the final online tutorial (the artifact), and subjective feedback from participants through their written reflection to gain insights into their experiences and perceptions of the learning process.

Participants

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The study adopts a purposive sample of students from a Master's unit of study in Educational Technology. Participants are organized into two groups, each with four students, totalling eight participants. The groups operate on a rotational basis, with each student alternating roles weekly throughout the 8-week study duration. The roles are distributed as follows: one student serves as the lead tutor, two as observers during the tutoring session, and one as the tutee. Each student will assume the role of lead tutor twice, observer four times, and tutee twice. The tutee also switches groups periodically to evaluate the other group's online tutorial. This structure allows all members to participate in both the development and the testing phases of the online tutorials. Additionally, all participants were provided with informed consent, ensuring adherence to ethical guidelines in educational research with the approval from the Ethics Committee, and all eight students provided the consent to use their data (recordings and artifacts) for analysing use.

Research procedure

The study engages participants in an eight-week project to develop an online tutorial, utilising the 4C/ID model. Each group designs a tutorial for beginners in educational data science using RStudio, integrated into a 2-hour Master's unit of study. The activity allocates 45 minutes each week, beginning with a 15-minute preparation phase. During this phase, the original four team members discuss to ensure the tutorial's logic and coherence and rehearse its delivery. Following this, the tutee joins another group to start the tutoring session. The lead tutor directs the session, focusing on the learning content, problem-solving techniques, and providing scaffolding support for the tutee. Simultaneously, the two observers document observations, particularly noting content development, preparation, and the dynamics of tutor-tutee interactions. After a 15-minute tutoring session, the tutee returns to their original group to discuss and reflect on the session's insights, bringing back valuable feedback for enhancing the online tutorial. The group then assigns roles and responsibilities for the upcoming week, ensuring continuous improvement in the tutorial development process.

Data collection

Various datasets have been gathered throughout the course of the study to thoroughly examine the learning process and outcomes. The data collection methods include:

1. **Video Recordings:** Video recordings of the sessions capture the interactions between the group of peer tutors and the peer tutee. These recordings specifically focus on the assistance provided by the tutors and the think-aloud process of the tutee as they engage with the tutorial, offering insights into the real-time learning dynamics and problem-solving strategies.
2. **Final Online Tutorial:** The completed online tutorials developed using RStudio are collected as tangible artifacts of the learning outcomes. These tutorials represent the culmination of the collaborative and instructional efforts of the participants over the study period.
3. **Written Reflections:** Participants are required to submit written reflections detailing their engagement with the project, their commitment levels, and their personal and educational gains from the activity. These reflections provide valuable qualitative data on the participants' perspectives, experiences, and the overall impact of the learning model on their skills and understanding.

Together, these data collection methods provide a comprehensive view of both the process and products of the learning experience, enabling a multi-dimensional analysis of the effectiveness and impact of integrating Peer-Assisted Learning with the 4C/ID model.

Data analysis

Video recordings were analysed using ELAN software to pinpoint specific learning difficulties encountered by the tutee and to observe how peer tutors facilitated overcoming these challenges. This analysis helped identify key moments of instructional intervention and effective tutoring strategies. For instance, it explored the specific strategies used by the lead peer tutor to address the tutee's questions. Given that the final online tutorial was intended to be self-paced and supportive, the lead tutor played a crucial role as the primary supporter during the tutoring sessions. This role involved adjusting the level of support provided to the tutee, ensuring it was appropriate and potentially beneficial for future users of the online tutorial.

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In conjunction with the video analysis, the final online tutorials developed in RStudio were reviewed to assess their effectiveness and to determine potential areas for improvement. We have also reviewed the adjustments to the tutorials among several weeks. This iterative process required participants to refine their online tutorial on a weekly basis, continually improving its quality and relevance.

Furthermore, sentiment analysis and content analysis were employed to examine the participants' written reflections on the activity. These analyses provided insights into the participants' emotional responses to the project and their perspectives on the learning process. They also helped identify areas for future improvement, as expressed by the participants in their reflections. This multi-faceted approach to data analysis ensures a comprehensive understanding of both the educational content and the emotional and cognitive impacts of the learning experience on the participants.

Preliminary results and discussion

Feasibility of PAL and 4C/ID integration

As learning designers, it is crucial to effectively develop materials that align with the specific requirements of the learning task, including its objectives and the type of support that can be most beneficial for learners. To achieve this, designers must first thoroughly understand the learning objectives associated with the tutorial development. They should engage in multiple iterations of testing and refining the content to align precisely with the learners' goals. The findings of this study demonstrate that integrating Peer-Assisted Learning (PAL) with the Four-Component Instructional Design (4C/ID) model is not only feasible but also significantly enhances the capabilities of learning designers in crafting effective online tutorials.

Participants engaged in multiple rounds of testing and refining their tutorials with actual users, who might eventually adopt the learning content. This approach utilises PAL as a framework for testing and enhancing the development of the tutorials. Moreover, participants who assumed the tutor role experienced benefits from the "learning-by-teaching" and "prepare-to-teach" effects, which not only aid in developing the tutorials but also enhance the tutors' own understanding of the content (Kobayashi, 2020). The adoption of the 4C/ID model also proved effective for tutorial development, providing clear guidelines on designing learning content with supportive information and practical exercises (van Merriënboer & Kirschner, 2018). Participants' written reflections frequently mentioned the model's straightforward approach, which clarified the types of support that should be integrated into the online tutorials. Analysis of video recordings and the final online tutorials revealed that scaffolded support tailored to the tutee's needs was effectively incorporated into the tutorials. For instance, the tutorials included questions that adjusted the level of support based on the learner's response time, demonstrating an adaptive and learner-centred approach.

Challenges such as time management and mastering new software were addressed through continuous support and feedback, highlighting the need for well-structured preparatory sessions in future implementations. This structured support helped participants, especially in their roles as peer tutors, to gain confidence in developing educational materials about unfamiliar topics, as collaborative discussions often illuminated diverse perspectives and solutions.

Educational Benefits for Students

The educational benefits of this integrated learning model were multifaceted. As peer tutors, participants noted an increase in confidence when preparing and discussing tutorial content, which enriched their own learning and understanding. This preparation phase was vital in fostering a deeper comprehension of the material, as tutors had to anticipate potential questions and challenges their peers might encounter. The collaborative work among team members provided an opportunity to combine different ideas together. Meanwhile, as tutees, they experienced firsthand the effectiveness of the tutorials, gaining insights into areas

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needing more explicit explanations, modifications or support. In their final written reflections, participants noted the effectiveness of this learning process. However, two students reported that the weekly rotation could disrupt content continuity, particularly during the weeks when they served as tutees. Future studies might consider adjusting the rotation schedule to enhance content consistency and improve overall performance.

Furthermore, the iterative testing process throughout the tutorial development allowed peer tutors to receive immediate and practical feedback, which was instrumental in refining the tutorials. This feedback loop not only enhanced the quality of the tutorials but also provided tutors with a clearer understanding of how learners interact with the material, leading to better instructional designs in subsequent iterations.

Implications for Future Implementation

These findings suggest the dual benefits of the PAL and 4C/ID integration, serving both as a robust framework for developing high-quality educational materials and as a dynamic learning process that engages all participants. The study suggests that future implementations of this model should emphasise the continuous role rotation and iterative feedback mechanisms to maximise learning outcomes and tutorial effectiveness.

Given the positive impacts on participant confidence and competence, future work on this activity during the tutorial might extend the duration of the projects or incorporate additional stages of collaborative feedback to further enhance the educational benefits. Also, an 'outsider' (such as the tutor in the tutorial or other experts) of the two groups could provide some mid-term feedback on the online tutorial to provide more immediate and first-hand feedback outside the learning activity itself. The process has proven to be not just about designing but also about learning through designing, which is a valuable insight for educational programs aiming to integrate practical skills with theoretical knowledge. This approach not only meets the educational objectives but also fosters a comprehensive understanding and application of instructional design principles, benefiting all participants involved.

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