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Nevan Bermingham
Technological University Dublin, nevan.bermingham@tudublin.ie

Frances Boylan
Technological University Dublin

Barry J. Ryan
Technological University Dublin

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The 4C's of PAL – an evidence-based model for implementing peer assisted learning for mature students

Nevan Bermingham[a], Frances Boylan[b] and Barry Ryan [c]

aFaculty of Arts & Tourism, Technological University Dublin, Dublin, Ireland; bLearning & Development, Technological University Dublin, Dublin, Ireland; cCollege of Sciences and Health, Technological University Dublin, Dublin, Ireland

ABSTRACT

Peer Assisted Leaning (PAL) programmes have been shown to enhance learner confidence and have an overall positive effect on learner comprehension, particularly in subjects traditionally perceived as difficult. This research describes the findings of a three-cycle Action Research study into the perceived benefits of implementing such a programme for mature students enrolled on a computer science programming module on an Access Foundation Programme in an Irish University. The findings from this study suggest that peer learning programmes offer students a valued support structure that aids transition and acculturation into tertiary education whilst simultaneously improving their subject-matter comprehension and confidence. An evidence-based model of PAL implementation for mature students was subsequently developed, underpinned by the associated pedagogic theory and the findings of the study. Our model promotes a student-focused peer educational enhancement framework that is transferable into the wider higher education setting.

Introduction

The term 'peer learning' encompasses a broad range of activities, but at its core it is based on the premises that students who cooperate rather than compete can foster greater learner independence and positive learning outcomes (Boud et al., 2014; Falchikov, 2001; Slavin, 1990). Peer learning, based on the cognitive and social constructivist learning theories of Piaget (1936), Vygotsky (1978), and Rogoff (2008), is broadly defined as the mutual development of skills within a group of people from similar social backgrounds helping each other to learn (Topping, 2005; Topping & Ehly, 1998).

Peer Assisted Learning (PAL) is one form of structured peer learning based on the theoretical framework of Supplemental Instruction (SI), which was developed at the University of Missouri–Kansas City in 1973 as an assistance program to improve student academic performance and retention on modules that are perceived as traditionally difficult (Martin & Arendale, 1992b, 1992a). Underpinned by various learning theories, including Dale (1969) and Kolb's (1974) experiential learning theories, Bandura's and

CONTACT Nevan Bermingham ✉ nevan.bermingham@tudublin.ie 🏫 Faculty of Arts & Tourism, Technological University Dublin, TU Dublin, Park House, 191 N Circular Rd, Grangegorman, D07 EWV4, Dublin, Ireland

Walters ([1977](#)) self-efficacy theory, and Vygotsky's ([1978](#)) scaffolding theories, PAL encourages student collaboration and mutual assistance in high-risk courses with conceptually difficult subject material (Capstick & Fleming, [2004](#); Topping & Ehly, [2001](#)). PAL provides students with regular guided study sessions facilitated by more senior cross-year students acting as tutors. The proximity of these peer tutor to the learners in PAL sessions, sometimes referred to as a 'near-peer' tutors, builds self-efficacy through the learners witnessing demonstrations of competence by people who are viewed as socially and culturally similar to themselves (Bandura & Walters, [1977](#); McKenna & Williams, [2017](#)).

Learning the abstract concepts of computer coding is considered particularly challenging for students to master, resulting in increased attrition in the initial years of computer science programmes, with relatively low prior experience in programming being cited as a possible cause (Bennedsen & Caspersen, [2019](#); Bosse & Gerosa, [2017](#); Sloan & Troy, [2008](#)). Within an Irish context, higher education (HE) computer science students are more likely to not progress in their courses when compared with other disciplines, and reasons for non-completion rates have been attributed to low prior programming knowledge, insufficient mathematical skill and poor social integration (Liston et al., [2016](#); National Forum for the Enhancement of Teaching and Learning in Higher Education, [2016](#)).

The focus of this study was a computer science programming module on the Access Foundation Programme (AFP) within Technological University Dublin (TU Dublin), where mature students reported difficulty with learning to code and attrition was higher than with other modules within the programme. The authors undertook a 3-year Action Research (AR) study to investigate what effect a structured PAL implementation would have on the perceived learning of mature students enrolled on this computer science programming module.

The TU Dublin AFP is designed to encourage greater participation in tertiary education by under-represented socioeconomic groups, including mature adults with low prior educational attainment, and prepare them for undergraduate programmes (McMullin, [2017](#); Murphy, [2009](#)). Mature students typically experience increased financial, psychological, academic, health and social risk factors when returning to formal education (Leonard, [1999](#); Skillen, [2019](#)). These risk factors can be compounded by mature students choosing to enrol in modules that are particularly prone to higher attrition rates, such as computer science programming (Fleming et al., [2017](#)). However, peer relationships and peer support have been shown to reduce the chance of mature students withdrawing from HE, and recent studies have shown that peer mentoring programmes, such as PAL, can be a viable strategy to improve mature student retention, provide practical strategies tailored to each students' learning needs, and to enhance motivation (Abbott-Chapman et al., [2004](#); Fleming et al., [2017](#); Garcia-Melgar et al., [2021](#); Penketh & Goddard, [2008](#); Shahzad et al., [2021](#)).

While PAL programmes primarily focus on improved academic outcomes, they also provide more intangible benefits such as providing collaborative learning communities and increased learner confidence (Black & MacKenzie, [2008](#); Packham & Miller, [2000](#)). Similarly, the PAL leaders improve their own subject knowledge and higher-level personal and professional skills (Keenan, [2014](#)). There is evidence that students participating in PAL initiatives build better relationships through collaboration with peers in the PAL environment, resulting in students feeling less isolated, more supported, and having better access to the 'hidden curriculum' of course expectations and norms (Bailey, [2021](#); Capstick &

Fleming, 2004; Ginty & Harding, 2014; Herrmann-Werner et al., 2017; McKenna & Williams, 2017). In particular, PAL has been demonstrated to be an effective tool for novice-level computer programming students by providing an environment that increases cognitive learning through active learner engagement (Altintas et al., 2016). The study was guided by the following research questions:

(1) What are the effects of structured PAL programmes on the perceived learning of Foundation Level mature students in computer programming?
(2) Do structured PAL programmes promote a community of learning?
(3) What are the characteristics of the PAL implementation that make it successful?

This paper will present the findings and themes of a qualitative three-cycle AR study and describes a novel evidence-based, sustainable, best-practice and transferable model of PAL implementation suitable for all learners within HE.

Materials and methods

An AR approach was chosen for this study as it fundamentally reflects the social constructivist thinking of peer learning through iterative cycles of 'plan, act, observe, and reflect' to simultaneously transform reality and generate new knowledge (Coghlan & Brannick, 2005). The initial AR cycle was predicated by a reconnaissance pre-step phase to shape and provide context to the study, followed by three distinct AR cycles in which a semester-long PAL Programme was provided to students enrolled on the AFP computer coding module. This study adopted an interpretivist epistemological worldview that is subjectivist and constructivist in nature, accepting that research is value laden. Each cycle examined and reflected on the findings of that PAL implementation which in turn informed changes for subsequent cycles.

A PAL programme based on the SI model was implemented for each cycle during the second semester of the academic year from 2018 to 2020, with each cycle aligned to the computer science module delivered to AFP computer science students at TU Dublin campus. Each PAL session was 2 hours in duration, included as part of student timetable and course delivery, and run twice per week on campus over the 12 weeks of the semester. A purposeful sampling strategy was used to select and invite eligible students to participate in the study at the start of term, and former AFP students who had successfully completed the module and enrolled in a computer science undergraduate programme at the time of the study were asked to volunteer as cross-year PAL leaders. Eligible participants were mature students – in an Irish context at least 23 years old – and enrolled on the AFP computer science programming module. PAL Leader eligibility criteria included having successfully completed the same computer science programming module and were currently undergraduate students within TU Dublin at the time of the study. Successful PAL Leader applicants were provided with a one-day activity-orientated training course based on the SI Training model that aimed to build understanding of group dynamics, organisational and leadership skills, and build self-confidence (Arendale, 2014; Arendale & Lilly, 2014). The PAL leaders were also provided with an on-line cloud-based repository of materials and coding problems aligned to the course subject matter to create their own activities and lesson plans. Table 1 illustrates the number of participants in each cycle who met the eligibility criteria for this study.

Table 1. Participants and timeframes of each AR cycle.

AR Cycle	Timeframe	Student Participants	PAL Leaders	Total
Cycle 1	Semester II, January – May 2018	9	4	13
Cycle 2	Semester II, January – May 2019	7	4	11
Cycle 3	Semester II, January – May 2020	3	7	10
Total		19	15	34

Participation in the study was optional, voluntary and informed consent was obtained at the start of each cycle. The study was evaluated and approved by TU Dublin's Research Ethics and Integrity Committee (approval number REC-19-53). From an ethical aspect, access to the PAL sessions was provided to all students participating in the research study and to those who were not, such as non-mature students enrolled on the module, ensuring that no student was disadvantaged by not participating in the study either by choice or by not meeting the eligibility criteria. The PAL leaders volunteered their time freely and did not receive any remuneration for their role. The WhatsApp mobile app was chosen by both students and PAL leaders for the purpose of organising and communicating outside the PAL sessions.

The findings from each AR cycle presented in this paper emanate from semi-structured interviews conducted at the end of each semester with all participants as well as reflective researcher and PAL leaders' journals during the semester. Reflective journals provided a disciplined means for capturing experiences close to the event and for participants to use these reflections to create further actions (Coghlan & Brannick, 2005). These weekly PAL Leader and researcher reflective journals were used for triangulation of data as a common validation strategy that utilises more than one source of data in a study of a research phenomenon (Creswell & Poth, 2017). Braun and Braun and Clarke's (2006) Thematic Analysis approach was chosen to analyse the qualitative dataset providing a flexible inductive method that seeks rich descriptions and themes through the systematic analysis of the findings. Member-checking, a technique for establishing credibility and challenging researcher bias, was used in both weekly feedback sessions and in a focus group at the end of the final cycle to bring researcher interpretations back to the participants so they could confirm the credibility of the narrative account (Lincoln & Guba, 1985).

Findings

Data from the semi-structured interviews with the participants and reflective journals of PAL leader participants were thematically analysed. The major themes that were generated through interpretative engagement with data across the three AR cycles are illustrated in Figure 1 and explored in the following sections.

RQ1: What are the effects of structured PAL programmes on the perceived learning of Foundation Level mature students in computer programming?

Due to limited prior exposure to computer coding, students reported difficulties in understanding some of the basic concepts of computer coding. Motivation to attend the PAL sessions was based on a perception of value they placed on attending PAL
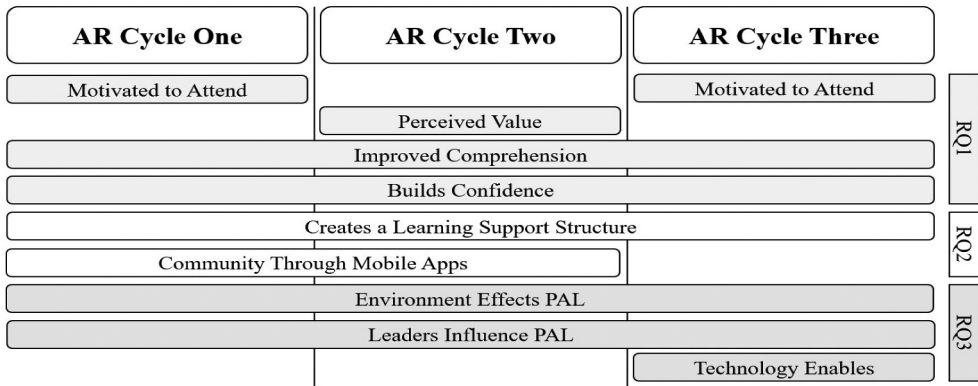
Figure 1. Major themes that emerged across each AR cycle aligned to the three research questions that guided the study.

sessions to improve their learning and provide an opportunity for non-native speakers to improve their language skills. The concept of value was most pronounced in the second cycle where students elected to voluntarily replicate the PAL structure observed in the computer science module to another course module in the belief it had value to their learning of troublesome concepts.

Common to all three cycles was the effect attending PAL sessions had on improving the learner's perceived self-confidence and comprehension of the course material. Confidence, built on near-peer bonds of trust and mutual respect, improved self-esteem and self-belief in one's ability to succeed in the module. PAL leaders similarly experienced an improvement in confidence and leadership skills by undertaking the role of PAL leader and were motivated to by a desire to help students. Findings suggest that the guided active learning environment of PAL can develop metacognitive skills resulting in students being able to address areas they most need help with and fostering a deeper understanding of the fundamental concepts in coding.

RQ2: Do structured PAL programmes promote a community of learning?

Findings from all AR cycles suggest that social interactions with peers of similar social and culture status were integral to the learning process. Engaging in group learning, where students can share and learn from each other, encourages them to revise their existing cognitive systems through reflection on peer perspectives. Participating in PAL offered students an opportunity to build mutually supportive networks that enhanced the social relationships and made their learning more enjoyable. These social interactions created a sense of belonging which underpinned a supportive learning community. The PAL leaders provided a 'model student' role for the students to imitate and learn from. The mutual support aspect of this community of learning expanded beyond the physical PAL sessions through mobile applications such as WhatsApp. PAL leaders also offered students access to the 'hidden curriculum' through advice and guidance that helped foster a clearer understanding of the course and expectations.

Similarly, PAL leaders created their own community of practice, seeking to share and support each other in the role by sharing and learning from each other which in turn improved their own coding skills. This community of practice was enhanced by the creation of a PAL Supervisor role in the third AR cycle that moved this governance role away from one traditionally occupied by faculty staff in the SI model, to one that was undertaken by previous PAL leaders. This 'model leader' role created a more sustainable student-centred PAL that re-used the acquired experience of prior PAL leaders to provide greater support to the current PAL Leaders.

RQ3: What are the characteristics of the PAL implementation that make it successful?

A relaxed and inclusive 'safe space' environment, where students could ask questions without fear of reproach, was seen as central to the perceived success of PAL. Students perceived greater value in the PAL sessions if they were organised into regular slots on the course timetable and attendance made mandatory. Providing multiple sessions each week offered necessary flexibility to accommodate student's existing commitments and learning styles. Students reported that smaller group size PAL sessions could better encourage informal and dynamic interactions, with facilities to encourage active learning tasks, such as whiteboards and audio-visual equipment.

However, consistent in the findings across three cycles was that PAL Leaders had the most influence on the perceived success or failure of the PAL implementation. Students reported that authoritative PAL leader behaviours had a profoundly negative effect on their confidence and learning. PAL leader personality traits and teaching style were considered decisional factors in choosing which sessions to attend, and PAL leaders in turn valued training that promoted better facilitation techniques and clear role definition.

Based on the findings of the previous cycle, the third cycle introduced internet-connected Android tablet-devices for the PAL leaders to facilitate easier communications and provided leaders with essential real-time remote access to learning materials during PAL sessions.

Discussion and development of the 4C's model of PAL

The findings from this study support the concept that computer programming is a conceptually difficult subject to master, in particular for students with no prior exposure to the discipline (Bennedsen & Caspersen, 2019; Topping & Ehly, 2001). The structured PAL programme provided mature students with supportive social networks and communities of learning that expand beyond the PAL session through mobile communication applications (Black & MacKenzie, 2008; Fleming et al., 2017). In line with other studies, all three cycles suggest that PAL can have a positive effect on learner confidence, comprehension and foster a sense of belonging, particularly for novice-level computer programming students (Altintas et al., 2016; Capstick & Fleming, 2004; Ginty & Harding, 2014; Shahzad et al., 2021). The influential effect of the 'near peer' as a model student who offers guidance and access to the 'hidden curriculum' helps students understand the expectations of the course (McKenna &
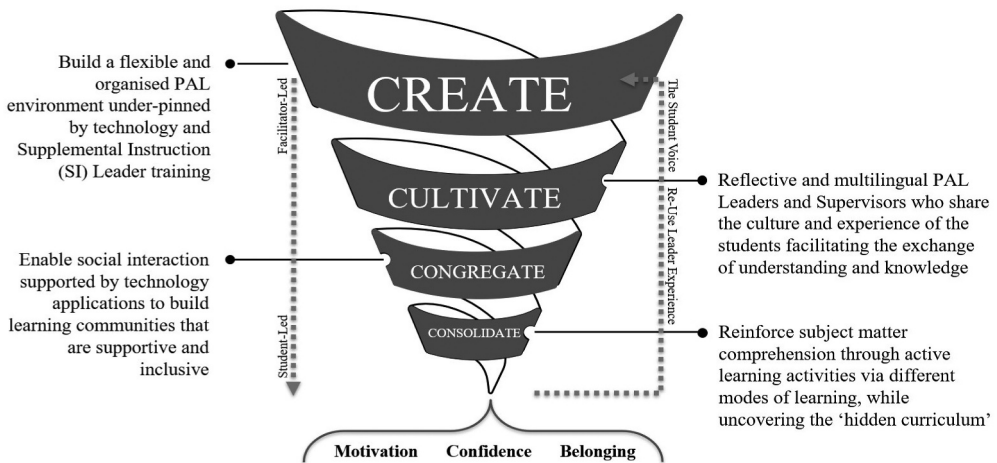
Figure 2. The 4C's of PAL Model illustrating the four key stage components and outcomes of a successful PAL implementation.

Williams, 2017). Underpinned by these findings, the authors propose a novel best-practice model of PAL implementation that would be transferable into any HE context, as shown in Figure 2.

Create

Build a PAL structure that generates a perception of value among the students built on an ethos of inclusion and mutual respect. Provide facilities that promote active learning tasks within a timetabled framework that is sensitive to the life-commitments of the students. Making the sessions mandatory can encourage participation as well as creating an increased perception of their value among students. Empower PAL leaders with the tools they need to create meaningful and organised sessions, including cloud-based-storage repositories of material and mobile smart technology. Confident and capable PAL leaders are helped by bespoke training aligned to the tried-and-tested SI Training model that focuses on setting expectations, role-playing, modelling behaviours and facilitating team building. Promote early student ownership of the PAL initiative by incorporating the 'student voice' into the planning and preparation stages, acknowledging that everyone has something to offer and something to share.

Cultivate

Recruit cross-year 'near-peer' PAL leaders with traits central to success such as academic ability, emotional intelligence, motivation and multilingual communication skills. PAL leaders that share the culture, experience, and life-journey of the students will be perceived as 'model students' to be emulated and trusted, and multi-lingual ability fosters greater inclusion. Promote PAL leader ownership by recognising, respecting, and trusting them with the role they are undertaking. Embed reflective practice into the core of the

PAL structure that encourages PAL leaders to critically reflect on behaviour as it happens. Re-use the accumulated experiences and bonds of trust that previous PAL leaders have developed by positioning them in the role of PAL Supervisor in future iterations to govern and guide the PAL leaders. These supervisors continue the essential tenet of the 'near-peer' influence within an effective PAL programme and will have a more profound effect to its success than any professional faculty member can.

Congregate

Promote the format and ethos of PAL among students to encourage early participation and foster a social and inclusive 'safe space' for students to congregate that promotes the sharing of learning. Ensure that the leaders facilitate discursive sessions with small group sizes that contributes to the formation of supportive learning communities and communities of practice that address barriers to inclusion. Empower the students to reflect and share their understanding with each other in the PAL session by ensuring everyone's voice is heard. Promote the use of multimedia capable mobile communication apps to expand a supportive learning community beyond the confines of the physical PAL sessions.

Consolidate

Students consolidate the construction of new knowledge within the PAL sessions through different modes of learning and planned activities that promote critical thinking. Built on a foundation of trust and friendship, the community of learners grows to support the students academically and socially within the PAL sessions and beyond it. Students begin to emulate the inspirational behaviours of the 'near-peer model student' PAL leaders, gaining advice and guidance that enables them to uncover the 'hidden curriculum' of course expectations. Through the bonds of friendship nurtured in the PAL sessions they create a strong social network that will support them beyond the course.

As each stage of the model is implemented, students begin to take more responsibility for, and ownership of the PAL sessions, moving from a facilitator-led implementation to one that is more student-led. The outcome of these four stages is students feel a greater sense of belonging and improved motivation in the course. The increased learner confidence improves student self-esteem and fosters greater self-belief in their ability to succeed.

Conclusion

Findings from our three-year AR study suggest that structured PAL initiatives can have a positive effect on mature students, particularly with courses perceived as traditionally difficult-like computer coding. By utilising 'near-peer' PAL Leaders to guide experiential learning activities, students reported increased learner confidence and a greater understanding of the abstract concepts of programming languages. Through informal and inclusive environments that are separate from the class environment, PAL sessions can foster the development of learning communities and communities of practice that continue to support beyond the confines of the PAL session through mobile communications apps. This study also found that PAL leader

behaviours and personality traits were central to the student's perceived effectiveness of the PAL sessions, highlighting the importance of in-depth PAL leader training, clear role definition, and equipping the leaders with the necessary technology and facilities to be effective leaders. PAL Leaders help students access the 'hidden curriculum' of the course, offering them an imitable role model and guidance to help them acculturate better to HE. The findings of this study challenge the established SI model by recommending the adoption of a new mode of the PAL supervisor role that re-cycles the acquired experiences of previous PAL Leaders to improve long-term programme sustainability and student-led autonomy of the PAL initiative. While the focus of this study was mature students, the findings of this study have important implications for educators and educational institutions. Underpinned by these findings, the authors propose the '4C's of PAL' model of implementation as a novel theoretical contribution to the PAL literature that offers practitioners a transferable and evidence-based guide to PAL implementation in other HE environments.

Finally, we accept that there are limitations to this study. The objectivity and generalisability of the conclusions should be interpreted within the context in which they are presented in this study. This study is restricted to a small sample size within one computer science programming module of the TU's Dublin Access Foundation Programme and based on students' own self-reporting, hence findings may not be representative of larger populations.

Disclosure statement

Notes on contributors

Nevan Bermingham is a lecturer in business and computer science at Technological University Dublin with an industry background in telecommunications, technology and strategic management.

Frances Boylan works with the Learning Teaching and Assessment team at Technological University Dublin providing leadership in enhancing and transforming the student learning experience.

Barry Ryan is an applied biochemist at Technological University Dublin with a proven expertise in practitioner use of alternative research-based pedagogies in a modern higher education setting.

ORCID

Barry Ryan 🄳 http://orcid.org/0000-0001-7213-3273

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