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Supporting apprentices' safety-related communication confidence, behaviour and mental health: a digital role playing game

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Abstract

Purpose – Effective communication with supervisors is critical to young and inexperienced workers' health and safety (H&S). However, few studies focus on trialling training interventions designed to improve H&S-related communication skills. This study explores the way in which a digital role playing game (RPG) influenced H&S-related communication confidence, behaviour and the mental health of Australian construction apprentices. In particular, two different change pathways were explored to understand the mechanisms through which an RPG can influence outcomes of interest.

Design/methodology/approach – A pre- and post-test design was used. 189 apprentices completed a baseline survey before participating in a 45-minute facilitated session in which they played the RPG and then completed a follow-up survey four weeks later. Paired samples *t*-tests tested for direct effects of the intervention and mixed-effects regression modelling investigated whether the intervention moderated pre-existing relationships in the data.

Findings – A comparison of pre- and post-test mean scores for key dependent variables, i.e. H&S communication confidence, communication behaviour and mental health revealed no direct changes, potentially due to a strong ceiling effect in the baseline data. However, the mixed-effects regression analysis indicated that exposure to the digital RPG training materials strengthened the relationships between aspects of the apprentices' H&S communication confidence and their safety voice and safety citizenship behaviours, as well as their mental health.

Practical implications – In providing apprentices with an opportunity to learn and practise communication skills, the results suggest that digital role play-based training has the potential to increase the transfer of these

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skills into improved H&S communication behaviour in the workplace. Practising communication in an RPG environment may also strengthen the relationship between feeling confident about the ability to communicate and mental health in young and/or inexperienced workers. However, the lack of an observed direct effect suggests that this form of training should not be relied on as the only training method available to apprentices.
Originality/value – The research evaluated a novel digital RPG developed to improve young workers' H&S communication confidence, communication behaviour and mental health. These are all areas in which young workers are known to be vulnerable. The results revealed that benefits associated with exposure to digital role play-based training reflected an amplification of pre-existing positive relationships, rather than direct attitudinal or behaviour change.

Keywords Role playing game, Communication, Confidence, Apprentices, Health and safety, Mental health
Paper type Research article

Introduction

Young and inexperienced workers' health and safety in high risk industries

Young workers (defined as under the age of 25) are a high-risk group for work-related physical injuries (Salminen, 2004; Yang *et al*., 2021) and psychological ill-health (Law *et al*., 2020; Milner *et al*., 2017). Young workers experience higher rates of serious workers' compensation claims than the general working population (Safe Work Australia, 2023). In Australia, between 2016-17 and 2020-21, serious work injury claims among apprentices and trainees rose by 41%, despite the number of apprentices and trainees increasing by only 13%. Half of these claims were in the construction industry (SafeWork Australia, 2023). Pidd *et al*. (2017) also report that levels of psychological distress and substance use for young workers in the Australian construction industry are substantially higher than the national prevalence data for Australians of similar age.

Apprenticeships are a major source of new entrants to the Australian construction industry, with one in ten of the industry's workers currently undertaking an apprenticeship (Master Builders Australia, 2024). Apprentices engage in both classroom and "on-the-job" learning, However, research shows that safety outcomes are worse where learners are employed as apprentices (as opposed to maintaining their student status while engaged in work-based learning) (Grytnes *et al*., 2018). Research also highlights that educational goals can be difficult to achieve in workplaces where work-related performance is often prioritised and apprentices are focused on demonstrating their labour market value to prospective employers (Fjellström and Kristmansson, 2019). Consequently, understanding how apprentices learn work-relevant skills is a topic of importance in the construction management domain.

The majority of people engaged in apprenticeship training are considered vulnerable to workplace injury or ill-health due to their age. For example, in the first quarter of 2025, 76% of people commencing apprentices were under the age of 25 years (NCVER, 2025, see also supplementary materials Figure A1). However, not all apprentices are young. Since 2020, the percentage of people commencing apprenticeships in Australia who are over the age of 25 ranged between 24% to 49% (NCVER, 2025, see supplementary materials Figure A1). Importantly, inexperience determines workplace injury even when controlling for age. For example, Breslin and Smith (2006) report workers who are in their first month in a job have four to six times higher rates of injury compared with workers who have more than one year on the job, irrespective of their age. Breslin *et al*. (2019) reviewed published studies examining the relationship between job tenure and work-related injury and found a significantly elevated risk of injury among new workers (defined as having spent 12 months or less in a job) in four out of the six studies reviewed. Apprentices also experience poor mental health compared to other construction workers, irrespective of their age. For example, Ross *et al*. (2022) found that a third of Australian construction apprentices experienced suicidal ideation in the previous year, linked to the experience of psychological distress, substance use, poor wellbeing, and exposure to suicide attempt. This suggests that apprentices are vulnerable to work-related injury and poor mental health whether they are young, inexperienced or both.

The importance of communication between apprentices and supervisors

Research shows that new entrants to a work environment make sense of the workplace risk culture through their communication with more experienced workers, which shapes what is perceived to be acceptable health and safety (H&S)-related behaviour (Nielsen, 2012). For example, Pek *et al*. (2017) report that supervisors' communication of safety expectations and encouragement of compliance with safety rules are linked to less frequent risk-taking behaviour and fewer injuries among young workers. Research also illustrates the negative impact of poor or ineffective communication with supervisors on young workers' H&S. Zierold and McGeeney (2016) documented how communication breakdowns between supervisors and young workers occur when supervisors are perceived as indifferent or unconcerned about H&S. These breakdowns cause young workers to feel unimportant or dispensable, leading them to dismiss their own safety concerns, engage in dangerous tasks, and not report injuries to their supervisors. Similarly, Breslin *et al*. (2007, p. 788) observed that young workers' concerns about H&S are often "systematically silenced" by supervisors, discouraging young workers from reporting unsafe conditions or seeking assistance. Notwithstanding this, speaking up about safety in the workplace is important. As Tucker and Turner (2015) found, young workers who are able to speak up about H&S issues - and whose supervisors listen to their concerns - experience fewer safety incidents.

Despite the importance of effective communication, young workers often lack confidence and find it difficult to speak up about H&S concerns in the workplace (Clarkson *et al*., 2018). Communication skills and confidence are critically linked to young or inexperienced workers' ability to engage in communication with their supervisors. Consequently, providing communication skills training can have a positive impact on the safety voice behaviour of young and inexperienced workers and help to protect their H&S at work (Manglicmot *et al*., 2021).

Effective communication with supervisors also significantly affects young workers' mental health and well-being (Ullibarriarana-Garate *et al*., 2023). For example, Conway and Foskey (2015) highlighted that apprentices report higher levels of well-being and work engagement when they are in an environment in which they feel comfortable asking for help. Additionally, Hutton *et al*. (2025) identified poor communication with supervisors as a significant contributor to psychological distress among apprentices. These findings highlight the potential H&S benefits associated with providing training to apprentices to improve their communication confidence, skills and behaviour.

The need for effective approaches to improve apprentice-supervisor communication

While many interventions have been developed to protect the H&S of young and/or inexperienced workers, few have specifically addressed their communication capability (Hanvold *et al*., 2019). Turner *et al*. (2022) noted that most training initiatives focus on raising awareness of workplace hazards and educating young workers about their H&S rights. These programs often overlook issues associated with interpersonal communication, limiting their effectiveness (Power and Baqee, 2010).

However, there is evidence that integrating communication skills and self-advocacy into H&S training programs for young workers is effective (Chin *et al*., 2010). For example, in the USA, the "Safety Voice for Ergonomics" program focuses on developing apprentices' communication abilities, helping them to effectively voice safety concerns (Kincl *et al*., 2016). Similarly, the "Attitude to Work" program in Finland aims to equip young workers with the preparedness and confidence to advocate for their H&S in unfamiliar work environments and to be able to tackle setbacks (Nyakänen *et al*., 2019). These programs employ active learning techniques, such as group discussions, problem-solving, and role-playing.

In response to these calls, a novel digital role playing game (RPG) was developed to improve the work-related communication effectiveness and behaviour of apprentices in the Australian construction industry. The development of the RPG has been reported in detail

previously (Zhang *et al*., 2025). The RPG was constructed based upon interview data collected from apprentices and supervisors in an initial discovery phase of the research. These interviews explored the characteristics of communication between supervisors and apprentices that impact on apprentices' confidence in speaking up about safety in the workplace and their safety voice and citizenship behaviours. The interviews also explored the impacts of supervisor-apprentice communication for apprentices' mental health. Subsequently, the scenario structures (i.e. situations and conversations), supervisor-apprentice dialogue and decision consequences reflected in the RPG were designed to improve apprentices' communication skills, confidence and behaviour specifically in relation to workplace issues with the potential to impact their safety or wellbeing. The RPG was filmed utilising motion capture technology and transferred on to the Stornoway interactive video platform. Figure 1 shows an example screenshot from the RPG. The complete RPG can also be accessed at: https://player.stornaway.io/embed/4b02305a

Research gap. There is growing interest in the extent to which serious games can support learning and behaviour change in many safety-critical contexts, including emergency evacuation (Rahouti *et al*., 2021), underground mining (Gürer *et al*., 2023), and military exercises (Korteling *et al*., 2017). The efficacy of serious games for teaching safety concepts to civil engineering students has also been evaluated (Kazar and Comu, 2021). Importantly, training can only be considered to be effective if knowledge, skills or abilities are both learnt and successfully transferred in the workplace (Tonhäuser and Büker, 2016). Previous research indicates that time spent practising the use of new knowledge, skills and abilities is positively linked to both the depth of learning attained and the ability to transfer concepts to real-life settings (Coleman *et al*., 2025). Consequently, being able to practise the use of knowledge, skills and abilities in the virtual environment of a serious game should support learning outcomes, as well as the transfer of training into workplace behaviour. Importantly, most previous evaluation studies of game-based training do not examine the theoretical mechanisms through which training has an impact. Thus, the primary aim of the research presented in this article was to explore two theoretically-based mechanisms through which exposure to the RPG could potentially change apprentices' H&S-related communication confidence, communication behaviour and/or their mental health.

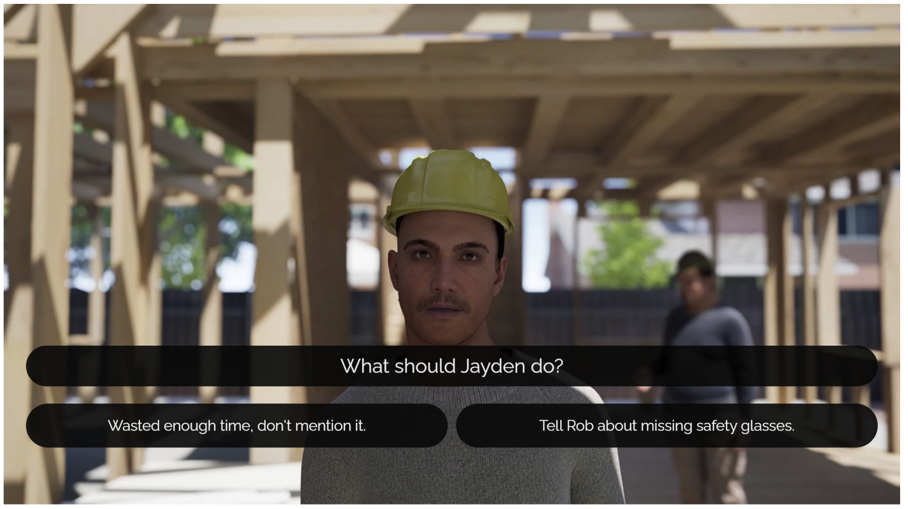

Figure 1. Screenshot from role playing game

The rationale for developing a digital RPG is first presented and the two theoretical pathways of change explained. The research methods are then described and the results are presented and discussed.

Role playing games as a vehicle for learning. There is growing interest in the use of digital game-based training approaches for occupational H&S in the construction industry (Tay *et al*., 2024; Zaman *et al*., 2025). However, these applications typically focus on the development of technical safety skills, e.g. design for safety or hazard recognition, and do not incorporate a role playing element.

Role playing is an effective and engaging method for teaching skills necessary for difficult conversations (Jackson and Back, 2011). For example, it has been widely used in training medical professionals to help them gain an understanding of the emotional impact of how they communicate for themselves and others (for instance, Jackson and Back, 2011; Lane *et al*., 2007). A role playing game (RPG) is defined as "a game where each player takes on the role of a character. The character's story evolves based on the player's decisions and choices" and often involves "complex interaction among players (social interaction) or between a player and computer-controlled characters" (Greco, 2009, p. 159). Digital RPGs are increasingly used to help enhance interpersonal skills (e.g. communication, empathy, negotiation) and/or offer realistic experiential learning, using an engaging and interactive medium. For example, digital RPGs have been employed to promote empathy in trainee nurses (Ma, 2021) and to familiarise new students with life on a university campus (Wang, 2020). In particular, Oblinger (2004) argues that digital games can be powerful learning tools for young, digitally literate learners, who are accustomed to a media-rich environment for communication and information processing. Bouvier *et al*. (2014) also argue that digital game-based learning creates stronger emotional, cognitive and behavioural connections with training content, increasing participant engagement and improving learning outcomes. Given the applicability of RPG-based training to the development of communication skills, this approach was considered well-suited to the present study that sought to develop these skills in construction apprentices.

Research has demonstrated that RPGs can be a promising tool for training young people's social skills, including empathy, social self-efficacy, peer relatedness, and interpersonal strength (Zheng *et al*., 2021). However, evidence regarding the effectiveness of RPGs in developing communication competence and skills remains limited, with only a few studies having explored this potential. For instance, Fioravanti *et al*. (2022) implemented an RPG called SharkTankEDU in an entrepreneurship course for university students to enhance their communication and negotiation abilities. In this game, students were required to present and pitch their business ideas to a panel of investors to secure funding. The effectiveness of this intervention, however, was assessed only through qualitative observations and post-game reflections.

Similarly, Karcı *et al*. (2024) examined the use of an RPG to develop nursing students' professional competence and patient-communication skills. Due to the small sample size, the study relied on qualitative interviews to capture participants' learning experiences with the RPG, providing limited evidence of training effectiveness. Ziebarth *et al*. (2014) also designed an RPG to train medical students in patient-centred communication during clinical interviews. Students' learning was facilitated by retrospective reflections, i.e. the role play was recorded, and the transcript of conversation was automatically analysed and annotated with feedback. In terms of evaluation, the study primarily gathered participants' perceptions of the game design via a questionnaire survey, rather than measuring improvements in participants' communication skills or behaviours.

To address these limitations, the present study contributes to the body of knowledge by employing a pre- and post-training evaluation design with a large sample to provide empirical evidence about the mechanisms through which training delivered through an RPG can potentially improve communication confidence and behaviour among construction apprentices in a vocational training context.

Theoretically-based pathways of change

Two different pathways of change were identified: first, exposure to the RPG could directly increase apprentices' H&S-related communication confidence, communication behaviour and/or mental health; and second, exposure to the RPG could strengthen the relationship between apprentices' pre-existing H&S-related communication confidence and their H&S-related communication behaviour and/or mental health.

Pathway 1: social cognitive theory

Social cognitive theory (SCT) describes a model of triadic reciprocity, i.e. one in which cognitive factors, environmental influences, and behavioural processes operate interactively to determine human functioning (Bandura, 1986; Wood and Bandura, 1989). SCT has previously been used to explain behavioural learning and change in relation to H&S in the workplace (Cheung and Chan, 2000; Nykänen *et al*., 2020). Self-efficacy is a key concept in SCT and refers to people's confidence in their ability to effectively organise and perform actions to achieve desired outcomes (Bandura, 1989). It reflects individuals' beliefs about their "capabilities to exercise control over events that affect their lives" (Bandura, 1989, p. 1175). Exposure to training can contribute to desired behaviour change by increasing participants' self-efficacy as new knowledge is learnt and skills are developed (Casey *et al*., 2018; Okun *et al*., 2016).

H&S-related communication confidence refers to an individual's appraisal of their self-efficacy in being able to successfully speak up about H&S concerns or request information needed to work safely (Nykänen *et al*., 2019). Previous research has linked self-efficacy with desired H&S-related communication behaviour. For example, Sun *et al*. (2022) found that an individual's confidence in their ability to speak up about safety issues (i.e. their perceived self-efficacy) positively affects their safety voice behaviour.

The digital RPG depicted scenarios in which apprentices were faced with unsafe or challenging situations in which they were prompted to speak up about a safety issue and/or initiate a difficult conversation (i.e. requesting time off work for personal reasons) with a supervisor. Making choices in these situations was specifically intended to develop young workers' confidence in engaging in H&S-related communication with their supervisors.

It was expected that the RPG would increase participants' confidence in their ability to successfully speak up about H&S concerns in the workplace and that this would, in turn, improve their H&S related communication behaviour (Nykänen *et al*., 2019). Two aspects of safety communication behaviour were considered: (1) safety voice behaviour; and (2) safety citizenship behaviour. The former describes ". . . acts of communication aimed at preventing physical harm through communicating safety concerns to others" (Noort *et al*., 2019, p. 375). The latter includes proactive initiative-taking to improve workplace safety, helping co-workers with safety responsibilities, and voicing concerns to protect the safety of co-workers and organisations (Curcuruto *et al*., 2023).

Hypotheses informed by SCT were:

H1. Exposure to the RPG improves apprentices' confidence (perceived self-efficacy) in communicating with their supervisors about issues that have the potential to impact their H&S;

H2. Exposure to the RPG improves apprentices' safety voice behaviour; and

H3. Exposure to the RPG improves apprentices' safety citizenship behaviour.

According to SCT, self-efficacy can also influence human functioning through an affective process whereby confidence in the ability to perform a valued action has a positive impact on a person's emotional state (Bandura, 1989). People with high self-efficacy tend to perceive a high level of control over external threats to their health, safety or wellbeing. As a result, perceived risks in the workplace are less likely to produce psychological strain (Jex and Bliese, 1999). Of

particular relevance to the present study, Loeb *et al*. (2016) report the importance of social and emotional self-efficacy for effective team functioning and psychological wellbeing, and recommend that these forms of self-efficacy are integrated into workplace health promotion initiatives. Given this prior research, it was also hypothesised that improved H&S-related communication confidence would have a positive impact on apprentices' mental health:

H4. Exposure to the RPG improves apprentices' mental health.

Pathway 2: theory of planned behaviour

While most previous studies have examined the direct influence of intervention programs on young workers' H&S efficacy (Guerin *et al*., 2019; Nykänen *et al*., 2018, 2019), it is also possible that training can impact behaviour indirectly by strengthening the link between participants' confidence and the actions they take.

This mechanism of change is supported by the theory of planned behaviour (TPB) (Ajzen, 1991). Perceived behavioural control (PBC) is a key determinant of behaviour suggested in the TPB. PBC refers to "*people's perception of the ease or difficulty of performing the behavior of interest*" (Ajzen, 1991, p183). According to Ajzen (2002), PBC includes both self-efficacy and the level of control that a person perceives they have in relation to a behaviour. Kidwell and Jewell (2003) suggest that the former is primarily related to internal control, whereas the latter is related to external control. External control factors include resources and opportunities supporting a behaviour in a particular context, that increase the likelihood that people will attempt to perform a behaviour (Kidwell and Jewell, 2003). While an individual with higher self-efficacy should theoretically display a higher likelihood of performing a behaviour, external control factors in a particular context can either facilitate or impede the translation of self-efficacy into behaviour. Therefore, Kidwell and Jewell (2003) proposed that research should examine the moderating influence of external control, in particular its potential to alter the relationship between an individual's appraisal of their self-efficacy (operationalised in our study as communication confidence) and their behavioural intention or actual behaviour.

In facilitating role playing interactions between apprentices and supervisor characters, the RPG was specifically designed to enable apprentices to practise their communication behaviour in a virtual environment in which there is no risk of irreversible consequences. It was anticipated that, by providing resources and opportunities to support desired H&S-related communication behaviours, this practise element of the RPG would increase apprentices' PBC. According to the TPB, this would potentially make it easier for apprentices to translate their communication confidence (self-efficacy) into H&S-related behaviour. Thus, the relationship between apprentices perceived communication confidence and their behaviour would be strengthened. Consequently, the following hypotheses were developed:

H5. Exposure to the RPG strengthens the relationship between apprentices' perceived communication confidence and their safety voice behaviour.

H6. Exposure to the RPG strengthens the relationship between apprentices' perceived communication confidence and their safety citizenship behaviour.

Finally, social skills, such as interpersonal communication skills, have previously been linked to mental health via one's ability to attain social support (Segrin *et al*., 2016). It is also possible that being able to practise interpersonal interactions in an RPG environment increases participants' PBC in relation to being able to garner social support in the workplace, thereby strengthening the relationship between the possession of social (communication) skills and mental health. Thus, the following hypothesis was also tested:

H7. Exposure to the RPG strengthens the relationship between apprentices' communication confidence and their mental health.

The hypothetical pathways to change are shown in Figure 2.

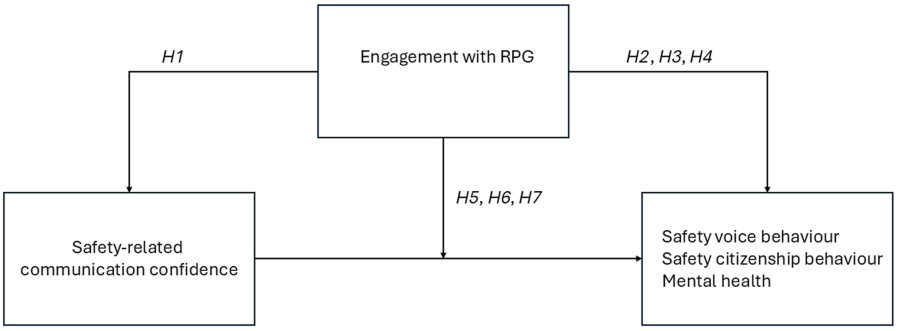

Figure 2. Hypothesised relationships to be tested

Research methods

Evaluation design

The outcomes of exposure to the RPG were explored using a pre- and post-test research design in which the RPG was delivered to construction apprentices registered with three Registered Training Organisations (RTOs) in New South Wales and Victoria, Australia. The research process is depicted in Figure 3. Apprentices attended training organisations for formal learning in small groups at different times, requiring the RPG to be delivered over an

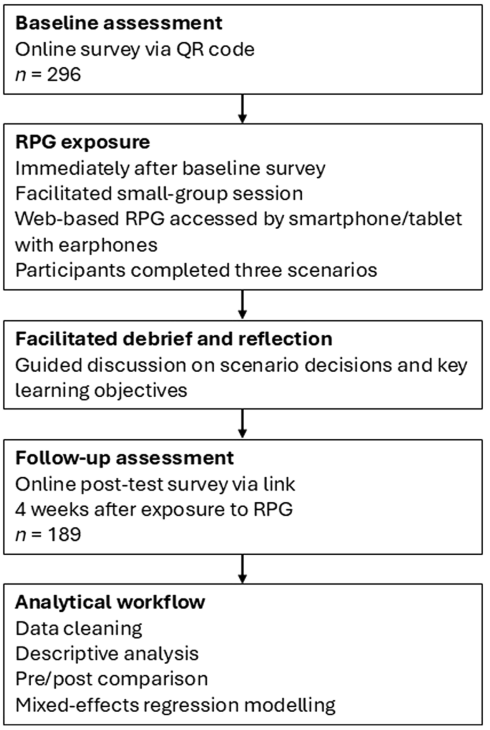

Figure 3. Research process

extended period, i.e. from August 2022 to June 2023. In total, 19 implementation sessions were conducted.

While a pre- and post-test design has been previously used to evaluate H&S-related interventions in the construction industry (see, for example, Jeelani *et al*., 2020; Hammer *et al*., 2015), an important limitation associated with this design is an inability to "rule out" possible effects of external factors on key outcome variables over the intervention period (Marsden and Torgerson, 2012; Shadish *et al*., 2002; Cook and Campbell, 1979). The study results therefore need to be considered in light of this limitation.

Delivery sessions lasted 45 minutes and were conducted in-person by a facilitator. The delivery sessions began with participants completing a baseline survey. After completing the survey, apprentices played through the RPG, with approximately 20 minutes of exposure. After completing the game, a guided discussion lasting approximately 10 minutes followed to explore key themes and participants' reactions. Four weeks later, the same participants completed a follow-up survey using the same measures as were contained in the baseline survey. A four-week interval allowed sufficient time for apprentices to apply the communication skills learnt through the RPG training, without being so long as to increase the risk of participant attrition.

On the recommendation of our industry partner, a small monetary incentive was provided as a courtesy acknowledgement of the time apprentices dedicated to participating in the research and to help compensate for any potential loss of work time resulting from their involvement in the research. Monetary incentives are reported to improve response rates in multi-wave panel surveys, without introducing bias associated with systematic differences in rates of attrition (Jäckle and Lynn, 2008). Moreover, empirical research shows that modest monetary incentives can be considered ethical to use as they improve engagement without constituting undue or unjust inducement to participate in research (Halpern *et al*., 2021).

Survey design

Variables of interest were measured using existing validated measures. Participants' confidence in their H&S communication capability was assessed using seven items adapted from a safety communication measurement scale developed by Cigularov *et al*. (2010) and a daily verbal safety communication scale developed by Kines *et al*. (2010). These questions assessed the apprentices' confidence or comfort in communicating with their supervisors across seven aspects of work, including: (1) work tasks; (2) safety at work; (3) health and mental wellbeing; (4) personal life; (5) hours of work; (6) the level of overtime they are expected to do; and (7) taking time off work. Participants rated these seven items on a 5-point scale, from 1 "very uncomfortable" to 5 "very comfortable".

The measure of safety voice behaviour was adapted from Tucker and Turner (2015) and incorporated two items— "I take safety concerns to the supervisor" and "I tell my supervisor about dangerous situations". Participants responded to these two items using a 5-point scale ranging from 1 "never" to 5 "always".

Safety citizenship behaviour was measured using five items adapted from Hofmann *et al*. (2003), for example, "When the need arises, I am confident that I can protect coworkers from safety hazards". A 5-point scale was adopted (1 = strongly disagree, 5 = strongly agree) to assess the items. Mental health was measured using the WHO-5 Wellbeing Index (World Health Organization, 1998) with five items, including "Over the past two weeks, I have felt calm and relaxed". Respondents responded to the items using six options, ranging from 1 "at no time" to 6 "all the time".

Cronbach's α coefficients for safety voice behaviour, safety citizenship behaviour, and mental health were 0.902, 0.927, and 0.882, respectively, for the baseline survey, and 0.849, 0.930, and 0.931, respectively, for the follow-up survey. The Cronbach's α values fell into the suggested range of 0.7–0.95 (Nunnally and Bernstein, 1994), indicating good internal

consistency reliability in the assessment instrument. The research was approved by RMIT University's Human Research Ethics Committee on 7th December 2021 (Ref number 24481).

Data analysis method

Paired-samples *t*-tests were used to evaluate the direct impact of the RPG on participants' H&S communication confidence, H&S-related behaviours and mental health (i.e. testing hypotheses 1–4). To test whether the RPG strengthened the relationship between communication confidence (i.e. their perceived self-efficacy) and communication behaviours and/or mental health (i.e., hypotheses 5, 6 and 7) a dummy variable (0 = before RPG, 1 = after RPG) was created for "exposure to the RPG." An interaction variable was created by multiplying the predictor variable and the dummy variable of exposure to the RPG (i.e., the moderator). The hypothesised predictors relating to perceived H&S communication confidence were standardised (z-scores) before being entered into the model together with the interaction terms. All analyses were conducted in IBM SPSS Statistics 28. Mixed-effects regression modelling effectively addresses the issue of intra-individual correlation or a lack of independence among observations (Field, 2013; Liu, 2015). The suitability of mixed-effects models in repeated-measures designs has also been demonstrated in previous longitudinal research (see, for example, Chen *et al*., 2022).

Results

The sample

A total of 352 apprentices were invited to participate in the study, with 296 completing the baseline survey and attending a facilitated session in which they played the RPG. Of the initial 296 participants, 189 apprentices completed the follow-up survey, reflecting an attrition rate of 36%. This falls within a 30%–70% range reported in longitudinal public health studies (Gustavson *et al*., 2012).

Table 1 presents the demographic characteristics of the 189 apprentices who completed both the baseline and follow-up surveys (i.e. completers) and the 107 apprentices who only completed the baseline survey (i.e. dropouts). A chi-square test was conducted to examine differences between the two groups. The results indicate a significant difference in age distribution, i.e. participants in the dropout group tended to be older than those in the completer group. It is possible that older apprentices face more competing life demands, such as work, family, or other responsibilities, resulting in less time available for participation in follow-up. Independent samples *t*-tests were conducted to compare baseline survey responses between dropouts and completers. No significant differences were observed between the two groups, except for the item "*Confidence in talking with supervisors about work tasks*". Participants in the dropout group reported significantly higher confidence on this item compared to those in the completer group. This higher confidence may be associated with the older age and greater experience or maturity of apprentices in the dropout group. Further consideration of potential attrition bias in the findings is provided in the Limitations and future research section of this paper.

Among the 189 apprentices who completed both the baseline and follow-up surveys, most of the participants were male (N = 174, 92.1%) and under the age of 30 years (N = 163, 86.2%). The majority were in the early stages (stages one and two) of their apprenticeship (N = 138, 73%) and had worked for one training employer since starting their apprenticeship (N = 126, 66.7%).

Pre- and post-test comparison

Inspection of skewness and kurtosis values for the difference scores indicated no substantial departures from normality (Supplementary materials Table A1). Given the relatively large sample size (N = 189), the paired-samples *t*-test is also considered robust to minor deviations

Table 1. Profile of study participants

Demographic information	Detail	*N* (%) – completers	*N* (%) – dropouts	χ^2 (*df*)	*p*
Gender	Male	174 (92.1%)	100 (93.5%)	2.564 (3)	0.464
	Female	13 (6.9%)	4 (3.7%)		
Age	15–19	39 (20.6%)	7 (6.5%)	26.560 (3)	<0.001*
	20–24	72 (38.1%)	30 (28.0%)		
	25–29	52 (27.5%)	60 (56.1%)		
	30 and over	26 (13.8%)	10 (9.3%)		
Stage of apprenticeship	Stage one	85 (45.0%)	51 (47.7%)	5.439 (3)	0.142
	Stage two	53 (28.0%)	20 (18.7%)		
	Stage three	44 (23.3%)	27 (25.2%)		
	Stage four	7 (3.7%)	9 (8.4%)		
The number of training employers the apprentices have worked for	One	126 (66.7%)	75 (70.1%)	2.785 (3)	0.426
	Two	38 (20.1%)	17 (15.9%)		
	Three	15 (7.9%)	6 (5.6%)		
	More than three	9 (4.8%)	9 (8.4%)		

Note(s): There were two missing data points (1.0%) for gender and one missing data point (0.5%) for the number of training employers have worked for among completers. There were three missing data points (2.8%) for gender among non-completers. *$p < 0.05$

from normality (Field, 2013). Table 2 presents the results of the paired-sample *t*-tests. None of the differences in mean scores for the communication confidence variables was statistically significant, except for "*confidence in talking with supervisors about work tasks*". For this variable, confidence declined rather than increased between the baseline and follow-up surveys. No significant differences were found in mean scores between baseline and follow-up surveys for any of the hypothesised outcome variables, i.e. safety voice behaviour, safety citizenship behaviour or mental health. Based on these results, hypotheses 1–4 were not supported. Cohen's d values also indicated that the magnitude of pre-post differences was small, suggesting limited change across variables. As a robustness check, non-parametric Wilcoxon signed-rank tests were also conducted, yielding results consistent with those obtained from the paired-samples *t*-tests (see Supplementary materials Table A2).

Table 2. Results of the paired-samples *t*-test

Variable	Mean (before)	SD (before)	Mean (after)	SD (after)	*t*	*p*	Cohen's d
Confidence in talking with supervisors about							
Work tasks	4.51	0.67	4.39	0.77	2.292	0.023*	0.17
Safety at work	4.28	0.88	4.26	0.83	0.461	0.645	0.03
Health and mental wellbeing	3.93	1.04	4.04	1.01	−1.549	0.123	−0.11
Personal life	3.95	1.01	3.90	1.00	0.589	0.557	0.04
Hours of work	4.17	0.85	4.20	0.85	−0.717	0.474	−0.05
Levels of overtime expected to do	4.16	0.90	4.04	0.89	1.641	0.103	0.12
Taking time off	4.05	0.97	3.94	0.98	1.343	0.181	0.10
Safety voice behaviour	4.14	0.93	4.24	0.87	−1.251	0.212	−0.09
Safety citizenship behaviour	4.34	0.59	4.31	0.58	0.910	0.364	0.07
Mental health	4.61	0.86	4.71	0.97	−1.536	0.126	−0.12

Note(s): *$p < 0.05$

A further examination of the data revealed a pronounced ceiling effect present in the baseline survey data (Supplementary materials Table A3), which potentially explains the lack of significant change observed in the paired-sample *t*-test results. Baseline survey responses were predominantly positive, leaving little to no room for measurable improvement in the follow-up survey (Staus *et al*., 2021). This pronounced ceiling effect severely impedes the ability to measure change in targeted variables of interest.

The amplification effect of the digital RPG training

Spearman's rank-order correlations were conducted to examine associations among the key variables at baseline (Supplementary Table A4). All correlations were statistically significant and in the expected direction, indicating consistent associations across variables.

Tables 3–5 present the results of the mixed-effects regression analysis which tested whether exposure to the RPG strengthened existing relationships between apprentices' communication confidence and their safety voice behaviour, workplace safety citizenship behaviour, and mental health. A significant interaction effect indicates that, after playing the RPG, the strength of associations between predictor and dependent variables changed, with a positive interaction effect indicating that the RPG strengthened the relationship between communication confidence and the outcome variables.

Table 3. Mixed-effects regression analysis results for the dependent variable of safety voice behaviour

Predictors	Dependent variable: Safety voice behaviour			
	b	SE b	95% CI	*p*
Confidence in talking with supervisors about work tasks (WT)	0.33	0.07	0.20, 0.46	<0.001*
Engagement with training materials	0.17	0.06	0.06, 0.29	0.003*
WT × Engagement with training materials	0.07	0.07	−0.06, 0.21	0.275
Confidence in talking with supervisors about safety at work (SW)	0.46	0.06	0.35, 0.57	<0.001*
Engagement with training materials	0.12	0.06	0.00, 0.23	0.044*
SW × Engagement with training materials	0.13	0.06	0.01, 0.25	*0.035**
Confidence in talking with supervisors about health and mental wellbeing (HMW)	0.45	0.06	0.33, 0.56	<0.001*
Engagement with training materials	0.05	0.06	−0.07, 0.17	0.384
HMW × Engagement with training materials	0.08	0.06	−0.05, 0.20	0.223
Confidence in talking with supervisors about personal life (PL)	0.32	0.06	0.20, 0.43	<0.001*
Engagement with training materials	0.12	0.06	0.00, 0.24	0.045*
PL × Engagement with training materials	0.11	0.07	−0.02, 0.24	0.092
Confidence in talking with supervisors about hours of work (HW)	0.34	0.06	0.21, 0.46	<0.001*
Engagement with training materials	0.11	0.06	−0.00, 0.22	0.056
HW × Engagement with training materials	0.16	0.06	0.03, 0.28	*0.015**
Confidence in talking with supervisors about level of overtime expected to do (LO)	0.27	0.06	0.15, 0.39	<0.001*
Engagement with training materials	0.16	0.06	0.05, 0.27	0.006*
LO × Engagement with training materials	0.20	0.06	0.08, 0.33	0.001*
Confidence in talking with supervisors about taking time off (TTO)	–	–	–	–
Engagement with training materials	–	–	–	–
TTO × Engagement with training materials	–	–	–	–

Note(s): *$p < 0.05$

Table 4. Mixed-effects regression analysis results for the dependent variable of safety citizenship behaviour

Predictors	Dependent variable: safety citizenship behaviour			
	b	SE b	*95% CI*	*p*
Confidence in talking with supervisors about work tasks (WT)	0.15	0.05	0.06, 0.24	0.002*
Engagement with training materials	−0.02	0.04	−0.11, 0.06	0.554
WT × Engagement with training materials	*0.11*	*0.05*	*0.02, 0.20*	*0.016**
Confidence in talking with supervisors about safety at work (SW)	0.25	0.04	0.17, 0.33	<0.001*
Engagement with training materials	−0.03	0.04	−0.11, 0.05	0.410
SW × Engagement with training materials	*0.09*	*0.04*	*0.00, 0.18*	*0.041**
Confidence in talking with supervisors about health and mental wellbeing (HMW)	0.22	0.04	0.14, 0.29	<0.001*
Engagement with training materials	−0.06	0.04	−0.14, 0.03	0.171
HMW × Engagement with training materials	0.08	0.05	−0.01, 0.16	0.100
Confidence in talking with supervisors about personal life (PL)	0.16	0.04	0.08, 0.24	<0.001*
Engagement with training materials	−0.03	0.04	−0.11, 0.05	0.444
PL × Engagement with training materials	0.08	0.05	−0.01, 0.17	0.073
Confidence in talking with supervisors about hours of work (HW)	0.18	0.04	0.10, 0.27	<0.001*
Engagement with training materials	−0.05	0.04	−0.13, 0.04	0.257
HW × Engagement with training materials	0.12	*0.05*	*0.03, 0.21*	*0.013**
Confidence in talking with supervisors about level of overtime expected to do (LO)	0.20	0.04	0.12, 0.28	<0.001*
Engagement with training materials	−0.01	0.04	−0.09, 0.07	0.817
LO × Engagement with training materials	*0.10*	*0.05*	*0.01, 0.19*	*0.030**
Confidence in talking with supervisors about taking time off (TTO)	0.21	0.04	0.13, 0.29	<0.001*
Engagement with training materials	−0.01	0.04	−0.09, 0.07	0.844
TTO × Engagement with training materials	*0.15*	*0.04*	*0.06, 0.23*	*0.001**

Note(s): *$p < 0.05$

Safety voice behaviour. Table 3 shows a statistically significant strengthening effect on the relationship between safety voice behaviour and its predictors of:

(1) confidence in talking with supervisors about safety at work (b = 0.13, 95% CI [0.01, 0.25], $p = 0.035$);

(2) confidence in talking with supervisors about hours of work (b = 0.16, 95% CI [0.03, 0.28], $p = 0.015$); and

(3) confidence in talking with supervisors about the level of overtime apprentices are expected to do (b = 0.20, 95% CI [0.08, 0.33], $p = 0.001$).

It is worth noting that the results for modelling confidence in talking with supervisors about taking time off work and safety voice behaviour failed to converge when including random effects, while simplifying the model (i.e., removing random effects) was found to generate a statistically significant moderation effect (b = 0.27, 95% CI [0.12, 0.43], $p < 0.001$).

Safety citizenship behaviour. Table 4 shows a statistically significant strengthening effect on the relationship between apprentices' safety citizenship behaviour and its predictors of:

Table 5. Mixed-effects regression analysis results for the dependent variable of mental health

Confidence in talking with supervisors about H&S issues	Dependent variable: Mental health			
	b	SE b	95% CI	*p*
Confidence in talking with supervisors about work tasks (WT)	0.25	0.06	0.13, 0.36	<0.001*
Engagement with training materials	0.13	0.06	0.02, 0.25	0.025*
WT × Engagement with training material	0.08	0.07	−0.05, 0.21	0.230
Confidence in talking with supervisors about safety at work (SW)	0.28	0.05	0.17, 0.38	<0.001*
Engagement with training materials	0.10	0.06	−0.02, 0.21	0.091
SW × Engagement with training materials	*0.15*	*0.06*	*0.02, 0.27*	*0.019**
Confidence in talking with supervisors about health and mental wellbeing (HMW)	0.37	0.05	0.27, 0.48	<0.001*
Engagement with training materials	0.06	0.06	−0.06, 0.17	0.344
HMW × Engagement with training materials	0.10	0.06	−0.02, 0.23	0.096
Confidence in talking with supervisors about personal life (PL)	0.33	0.05	0.23, 0.44	<0.001*
Engagement with training materials	0.11	0.06	−0.01, 0.23	0.062
PL × Engagement with training materials	0.11	0.06	−0.02, 0.24	0.088
Confidence in talking with supervisors about hours of work (HW)	0.25	0.06	0.14, 0.35	<0.001*
Engagement with training materials	0.07	0.06	−0.04, 0.18	0.230
HW × Engagement with training materials	0.12	0.06	−0.01, 0.24	0.064
Confidence in talking with supervisors about level of overtime expected to do (LO)	0.28	0.05	0.17, 0.38	<0.001*
Engagement with training materials	0.13	0.06	0.02, 0.24	0.027*
LO × Engagement with training materials	0.12	0.06	−0.01, 0.24	0.070
Confidence in talking with supervisors about taking time off (TTO)	0.35	0.06	0.24, 0.46	<0.001*
Engagement with training materials	0.12	0.06	0.01, 0.23	0.030*
TTO × Engagement with training materials	*0.13*	*0.06*	*0.02, 0.25*	*0.028**

Note(s): *$p < 0.05$

(1) confidence in talking with supervisors about work tasks (b = 0.11, 95% CI [0.02, 0.20], $p = 0.016$),

(2) confidence in talking with supervisors about safety at work (b = 0.09, 95% CI [0.00, 0.18], $p = 0.041$),

(3) confidence in talking with supervisors about hours of work (b = 0.12, 95% CI [0.03, 0.21], $p = 0.013$),

(4) confidence in talking with supervisors about level of overtime apprentices are expected to do (b = 0.10, 95% CI [0.01, 0.19], $p = 0.030$), and

(5) confidence in talking with supervisors about taking time off work (b = 0.15, 95% CI [0.06, 0.23], $p = 0.001$).

Apprentice mental health. Table 5 shows a statistically significant strengthening effect on the relationship between apprentices' mental health and its predictors of:

(1) confidence in talking with supervisors about safety at work (b = 0.15, 95% CI [0.02, 0.27], $p = 0.019$), and

(2) confidence in talking with supervisors about taking time off work (b = 0.13, 95% CI [0.02, 0.25], $p = 0.028$).

These results indicate partial support for hypotheses 5 and 6 and suggest that exposure to the RPG strengthens the relationship between some facets of communication confidence and mental health. In other words, the benefit associated with pre-existing communication confidence appears to have been amplified by exposure to the RPG.

Discussion

Pathways to change

Young worker' ability to engage in H&S communication with supervisors has been identified as a key issue affecting their H&S experience (Linker *et al*., 2005). However, Tucker and Turner (2013) report that many young workers take a "wait and see" approach in unsafe situations rather than raising H&S concerns with their supervisors. There is a clear need for effective interventions and strategies to develop young workers' ability to advocate for workplace H&S and empower them to practise H&S behaviours (Chin *et al*., 2010; Grant-Smith and McDonald, 2015). Self-advocacy similarly refers to individuals publicly articulating their interests, needs and rights (Chin *et al*., 2010). According to Test *et al*. (2005), effective communication with others involves negotiation, assertiveness, and articulation, and these are key to self-advocacy. Moreover, safety citizenship behaviour describes behaviour that extends beyond advocating for one's own personal safety to advocating for others in the workgroup (Test *et al*., 2005). With increased ability to advocate for their own safety, apprentices would arguably be more likely to engage in H&S-related communication that would provide broader benefits for H&S in the workplace This is consistent with the claim that "*when taught how to self-advocate, youth can positively impact the environments in which they work and contribute in more meaningful ways to their jobsites*" (Chin *et al*., 2010; p. 572). These critical communication skills were intentionally integrated into our RPG as learning goals that were focused on encouraging apprentices to advocate for their own personal safety and advocate for the safety of others in the workgroup (Test *et al*., 2005). The research explored the extent to which these behaviours were impacted by exposure to the RPG, and the mechanisms of any observed effects.

Previous studies have assessed the direct impact of H&S training programs on young workers' H&S efficacy and their subsequent H&S-related behaviours and outcomes (see for example, Guerin *et al*., 2019; Nykänen *et al*., 2019; Nykänen *et al*., 2018). However, in our study, the paired samples *t*-tests revealed no significant improvement between the scores for communication confidence, behaviours or mental health between the baseline and follow-up surveys (i.e. Hypotheses 1–4 were not supported). As such, our study failed to provide evidence that the RPG had a direct effect on participants' communication confidence, safety-related communication behaviour or mental health. Consequently, the change pathway aligned with social cognitive theory was not supported.

However, the present study provides new insights into an alternative pathway through which RPG-based communication training might influence H&S-related communication behaviour and mental health of construction apprentices. While the direct effect pathway to behaviour change was not supported, the results indicated that exposure to the RPG significantly strengthened the relationship between apprentices' H&S communication confidence (i.e. their self-efficacy) and their H&S-related behaviour and mental health (i.e. Hypotheses 5–7).

Specifically, the evaluation results indicated that exposure to the RPG training materials strengthened the relationship between construction apprentices' confidence in communicating with their supervisors about safety at work, negotiating work hours and overtime expectations, and speaking up about safety behaviours (Hypothesis 5, Table 3). The results further reveal that exposure to the digital RPG training materials strengthened the relationship between

apprentices' confidence in communicating with their supervisors about issues that have the potential to impact their H&S (e.g. work tasks, safety at work, workhours, and overtime expectations) and their safety citizenship behaviour (Hypothesis 6, Table 4). Exposure to the RPG training materials also strengthened associations between apprentices' confidence in discussing aspects of work related to H&S with their work supervisors, e.g. taking time off work and work tasks, and their mental health (Hypothesis 7, Table 5).

These findings support a change mechanism that is theoretically aligned with the Theory of Planned Behaviour (TPB). The TPB suggests that individuals' behaviour is determined by perceived behavioural control (PBC), comprising both internal control (e.g. their self-efficacy) as well as external control (e.g. access to resources and opportunities) (Ajzen, 2002). The relationship between internal control and actual behaviour can be strengthened by the presence of resources and opportunities that support the transfer of capabilities into desired behaviours (Kidwell and Jewell, 2003). The significant interaction effects observed in our regression analysis suggest that exposure to the RPG developed in our study strengthens a relationship between communication confidence and behaviour, thereby amplifying the benefit of pre-existing communication capability. These findings indicate that exposure to the RPG helps to facilitate the transfer of communication skills into desirable behaviours in the workplace, as well as improved mental health.

Taken together, these findings indicate that RPG-based training can be helpful, but also that its effectiveness should not be over-stated. Rather than being seen as a stand-alone training tool, the results reflect that RPG-based training can potentially be helpful in augmenting the benefits associated with other forms of communication-related training focused on the development of foundational skills and self-efficacy.

Interpreting null effect findings

Our study revealed a null effect in relation to the RPG's direct effect on apprentices' communication confidence, behaviour and mental health. It is observed that up to 91% of studies testing the impact of educational interventions report null effect results (Jacob *et al*., 2019). Jacob *et al*. (2019) also suggest null effect findings are most common in trials that test educational interventions in real life settings, such as the vocational education environments in which our study was conducted. A similar observation has been made of intervention studies in prevention science (Axford *et al*., 2022). Rather than being seen as unsuccessful, Jacob *et al*. (2019) argue that intervention studies that produce null effects can be very useful in understanding how to make things work better. Similarly, Axford *et al*. (2022) argue that the wider context of an intervention study should be considered when drawing conclusions from null-effect studies. For example, when an intervention is relatively low cost to implement (such as digital RPG training) and where it deals with an issue of moral and legal consequence (such as apprentices' H&S), it may be undesirable to dismiss an intervention based on a single study yielding null effects (Axford *et al*., 2022).

Many reasons for observing null effects in intervention studies have been suggested. These include the effects of attrition bias, the way that outcomes are measured and the way an intervention is implemented. The direct effects hypotheses (Hypotheses 1–4) were based on a theory of change informed by social cognitive theory (SCT). It is possible that this theory of change was simply wrong. However, Jacob *et al*. (2019) warn against dismissing an intervention on the basis of a single study if there are other plausible reasons for the null effect. It is important to note that the intensity and delivery cost of our intervention was low, with participants experiencing only 20 minutes of exposure to the RPG followed by a 10-minute discussion. It is possible that longer exposure time could have improved direct outcomes. Also, as previously noted, a pronounced ceiling effect was observed in the baseline measurement of dependent variables and analysis showed some systematic differences in loss-to-follow up. Given the limitations inherent in our study, the null effect findings suggest future research

should be conducted to further test whether a direct effect is observed, for example, by selecting more sensitive measures for outcome variables to combat the ceiling effect and/or by increasing the level of exposure to the RPG.

Implications for practice

Notwithstanding the failure to find a significant direct intervention effect, the research findings have important implications for both theory and practice. The SCT-based hypotheses regarding direct effects of the RPG were not supported. However, there was evidence of a significant amplification effect, whereby exposure to the RPG strengthened the relationships between apprentices' communication confidence and their self-reported behaviour and mental health. This is consistent with hypotheses 5–7 informed by the theory of planned behaviour (TPB).

These findings suggest that, in providing participants with an opportunity to practise their communication behaviour in a "safe" virtual environment, the RPG may have acted as an external stimulus that increased participant's perceived behavioural control (PBC) and thereby increased the extent to which they felt able to translate their communication skills and confidence into workplace behaviours. The TPB has previously been used to explain construction workers' training transfer behaviour, with PBC playing a key part in shaping the effective transfer of learnt skills into behavioural intention (Pham *et al*., 2023). For example, Pham *et al*. (2023) report a strong pathway from PBC to intention to transfer safety training in the Australian construction industry.

The results of the present study indicate that the main benefit associated with the RPG was its apparent ability to support the translation of participants' communication confidence into behaviour. The RPG, at least in the way that it was administered in the present study, did not appear to be effective in developing new communication skills or confidence in participants. However, it did appear to increase the likelihood that skills and confidence would translate into communication behaviour in the workplace.

Importantly, Coleman *et al*. (2025) suggest that effective vocational learning experiences include four components: (1) experience, (2) reflection, (3) conceptualisation, and (4) application. The RPG developed in the present study focused heavily on experiential learning related to the practical application of H&S-related communication behaviours. However, the RPG contained little conceptual knowledge about communication styles or approaches, and there was only limited time (10 minutes) made available for reflection after each delivery sessions. It is possible that to achieve more effective learning and transfer outcomes, the RPG would need to be delivered alongside more conceptual learning components and be delivered in a format with more time allocated to reflection.

Limitations and future research

The study has several limitations. First, a single-group pre- and pre-post design does not account for external influences. Ideally a randomised controlled trial would have been conducted. However, it was not possible to implement a control group in this study as it was practically impossible to randomly assign apprentices to treatment and control groups for experimental purposes. Moreover, there would be no way of preventing the sharing of information between the two groups, which would have contaminated the treatment vs control group comparison. In the absence of a control group, we therefore cannot rule out the possibility that effects were caused by extraneous factors. Future studies could adopt alternative experimental designs, such as multiple baseline designs (Hawkins *et al*., 2007). These designs have strong internal validity and have previously been used in construction (Albert *et al*., 2015). However, it is also noted that implementing multiple baseline designs in applied industry settings can be very practically challenging.

The pronounced ceiling effect in the baseline survey data was problematic and significantly impacted our ability to compare pre- and post-intervention measures for key dependent

variables. It is likely that this was associated with social desirability bias evident in participants' responses. Future research should seek to use measurement methods that are less susceptible to this type of effect, for example by offering more gradated response categories and/or being designed to avoid social desirability biased responses (Badejo *et al.*, 2022). In particular, the use of self-report survey data should be supplemented with other data collection methods, such as interviews, observational data and social network analysis that could be utilised to compare pre- and post-test communication patterns.

The outcome variables were also measured using self-report Likert-type format response scales. As such, there is the risk of common method bias. Future research should seek to utilise alternative methods to measure dependent variables, for example asking supervisors to report on apprentices' communication behaviours.

Another limitation was that the RPG was delivered to construction apprentices without involving their supervisors. This was because the apprentices met in a central location to undertake classroom-based learning, while supervisors did not meet centrally and were spread over a much greater geographical area. It is possible that the inclusion of supervisors in the study would have delivered stronger results. The same facilitator managed all of the intervention delivery sessions and used a standardised script. However, it is possible that variability in facilitator delivery, group dynamics, organisational context, and individual characteristics could also have impacted the findings.

We are unable to comment on the extent to which non-response bias was evident in our baseline survey. However, it is likely that this was minimised by the incentives offered and also the fact that participants completed the survey in a classroom setting. However, the results could potentially have been impacted by attrition bias, whereby participants who were lost to follow-up tended to be older than those in the completer group and also reported higher levels of communication confidence in the baseline survey. While this attrition bias may have impacted the results, the fact that participants higher in baseline communication confidence were more likely to drop out of the study before the follow up survey is unlikely to impact the finding that exposure to the intervention strengthened the relationship between communication confidence and behaviours and/or mental health. Given, our study aimed to examine apprentices as a young, inexperienced and vulnerable worker group, the findings are still likely to be a valid representation of this group's experiences.

As previously noted, another possible reason for the lack of observed direct effect includes the limited time apprentices were exposed to the RPG. It is recommended that future explore outcomes associated with different levels of exposure.

Conclusion

The present research sought to evaluate the impact of a digital RPG to determine the extent to which it could improve H&S-related communication confidence, communication behaviour and mental health in a sample of Australian construction apprentices. The main contribution of the work lies in the testing of two theoretical pathways through which the RPG could impact apprentices' communication confidence, communication behaviour and mental health. The research found no evidence for a significant direct effect of the RPG intervention on the dependent variables. That is, no evidence was found that exposure to the RPG directly improved apprentices' H&S-related communication confidence, communication behaviour or mental health. However, an alternative pathway of change was supported. Namely, exposure to the RPG significantly strengthened the relationship between apprentices' pre-existing communication confidence levels and their self-reported H&S communication behaviour and mental health. These results suggest that digital RPG-based training of this type may can help young and/or inexperienced workers to practise these skills and more effectively translate them into workplace behaviour. However, the evidence indicates this training may be most effectively used to augment other forms of training that develop communication skills and confidence.

Acknowledgments
Dr Tinh Doan is now Senior Research Fellow/Senior Economist at the SA Centre for Economic Studies, School of Economics, Adelaide University.

Supplementary materials

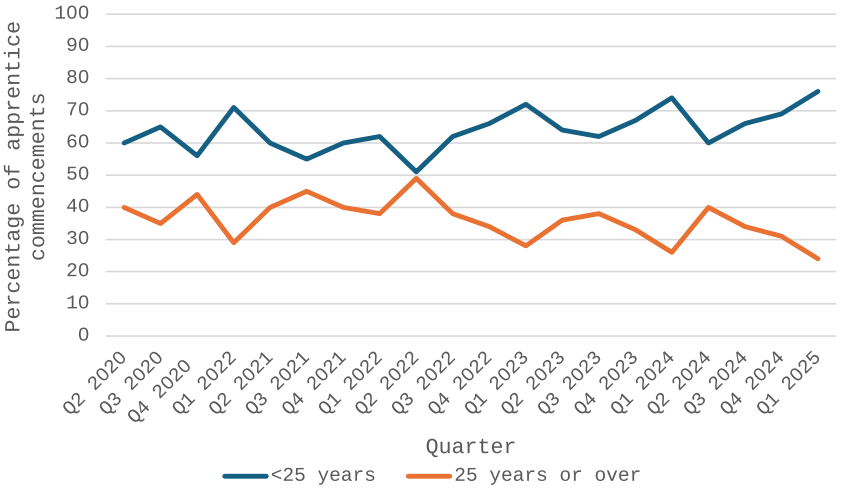

Figure A1. Age of people commencing apprenticeships in Australia, 2020–2025. Source: NCVER 2025, apprentices and trainees 2025 - March quarter databuilder, contract status, Age group by year, quarter. Authors' own work

Table A1. Skewness and kurtosis of difference scores between baseline and follow-up surveys

Variable	Skewness	Kurtosis
Confidence in talking with supervisors about		
Work task	−0.05	3.57
Safety at work	−0.22	1.28
Health and mental wellbeing	0.29	0.51
Personal life	0.35	2.91
Hours of work	0.14	1.89
Levels of overtime expected to do	−0.55	2.87
Taking time off	0.55	3.58
Safety voice behaviour	0.04	2.33
Safety citizenship behaviour	−0.08	0.69
Mental health	0.51	1.54

Source(s): Authors' own work

Table A2. Results of Wilcoxon signed-rank tests

Variable	Median (before)	Median (after)	z	*p*
Confidence in talking with supervisors about				
Work tasks	5.00	5.00	−2.32	0.020*
Safety at work	4.00	4.00	−0.39	0.694
Health and mental wellbeing	4.00	4.00	1.41	0.159
Personal life	4.00	4.00	−0.81	0.417
Hours of work	4.00	4.00	0.68	0.499
Levels of overtime expected to do	4.00	4.00	−1.56	0.118
Taking time off	4.00	4.00	−1.69	0.091
Safety voice behaviour	4.50	4.50	1.20	0.229
Safety citizenship behaviour	4.20	4.00	−0.96	0.335
Mental health	4.80	4.80	1.21	0.228

Note(s): *$p < 0.05$

Source(s): Authors' own work

Table A3. Ceiling effect of dependent variables in the baseline survey

Variable	Mean	SD	Skewness[a]	% Ceiling responses[b]
Perceived H&S communication confidence				
Confidence in talking with supervisors about				
Work task	4.51	0.67	−1.23	92.0
Safety at work	4.28	0.88	−1.24	83.1
Health and mental wellbeing	3.93	1.04	−0.70	67.2
Personal life	3.95	1.01	−0.81	69.3
Your work hours	4.17	0.85	−0.82	77.8
Overtime work	4.16	0.90	−0.81	75.7
Taking time off	4.05	0.97	−0.92	74.6
Safety voice behaviour				
How often do the following apply to you				
I take safety concerns to the supervisor	4.06	1.01	−0.92	72.0
I tell my supervisor about dangerous situations	4.22	0.95	−1.15	77.3
Workplace safety citizenship behaviours				
When the need arises, I am confident that I can				
Protect co-workers from safety hazards	4.36	0.62	−0.43	91.5
Look out for the safety of co-workers	4.42	0.59	−0.43	94.2
Protect co-workers from risky situations	4.38	0.63	−0.51	91.0
Prevent co-workers from being injured on the job	4.33	0.71	−0.85	88.4
Stop safety violations in order to protect the wellbeing of co-workers	4.20	0.78	−0.70	82.1
Mental health				
Over the last two weeks				
I have felt cheerful and in good spirits	4.72	0.98	−0.87	66.7
I have felt calm and relaxed	4.61	1.01	−0.68	61.9
I have felt active and vigorous	4.78	0.97	−0.76	66.3
I woke up feeling fresh and rested	4.25	1.29	−0.67	48.1
My daily life has been filled with things that interest me	4.73	0.98	−0.97	66.1

Note(s): Mental health was measured by a six-point scale and other variables were all measured by a five-point scale, [a]Positive skewness means a pile-up of scores on the left of the distribution (i.e., low scores), whereas negative skewness means a pile-up on the right (i.e., high scores), [b]The proportion of the first two most positive responses (i.e., 5 "most of the time' and 6 "all the time" for mental health variables, and 4 "agree" and 5 "strongly agree" for other variables)

Source(s): Authors' own work

Table A4. Spearman's rank-order correlations among key variables at baseline

Variable	1	2	3	4	5	6	7	8	9	10
Confidence in talking with supervisors about										
1. Work tasks	1.00									
2. Safety at work	0.68*	1.00								
3. Health and mental wellbeing	0.53*	0.61*	1.00							
4. Personal life	0.45*	0.59*	0.70*	1.00						
5. Hours of work	0.50*	0.54*	0.42*	0.39*	1.00					
6. Levels of overtime expected to do	0.54*	0.61*	0.45*	0.40*	0.78*	1.00				
7. Taking time off	0.51*	0.57*	0.47*	0.48*	0.67*	0.69*	1.00			
8. Safety voice behaviour	0.41*	0.57*	0.58*	0.43*	0.40*	0.41*	0.41*	1.00		
9. Safety citizenship behaviour	0.20*	0.42*	0.40*	0.27*	0.34*	0.37*	0.30*	0.51*	1.00	
10. Mental health	0.28*	0.35*	0.51*	0.45*	0.36*	0.40*	0.41*	0.37*	0.45*	1.00

Note(s): *$p < 0.05$

Source(s): Authors' own work

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