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Innovative vocational training for the Construction Industry

Valerie Francis[1], Vidal Paton Cole[2]

[1,2] The University of Melbourne, Parkville, Victoria,
vfrancis@unimelb.edu.au

Abstract. The advent of the 21st century have resulted in significant population growth across the major Australian cities. Currently, the state of Victoria is the fastest growing amongst Australian states and territories, recording the highest growth of 2.3% in 2017, with forecasts indicating a 50% increase of the state's current population over the next three decades. These demographic changes have necessitated higher demand for critical building and infrastructure services. However, there is endemic shortage of skilled labour across the entire construction industry, which could impact ongoing development and delivering of strategic infrastructure over the coming years. This occupational skills shortage has further economic implications by reducing productivity and delaying development and growth. The lack of investment in training in recent decades, the increase in rework, the decline in interest in site roles and the continued growth in the industry means that it is not well placed to deal with current requirements. This paper outlines the case for an alternative education method and presents an innovative framework to create transformation change for workforce training and skills development for the construction industry through the "Maker Immersion Project". The innovative project, funded by the state government, will developed a world-first fully deployable, technology enhanced education package that creates an immersive learning by blending traditional face-to-face training with Virtual Reality simulations.

Keywords: Construction, Skills shortage, Immersive education, Virtual Reality.

1 Introduction

The necessity to educate and train more construction professionals for an industry facing imminent skills shortages has been the driver for developing better vocational education for the construction industy in Victoria, Australia. The new education package, referred to as the "Maker Immersion Kit (MIK), will develop a fully deployable, technology enhanced education program for the Certificate IV in Building and Construction (Building). This certificate program is taught in vocational collages utilising the traditional "face-to-face" method and is the entry level requirement for those individuals seeking to work in site supervisory roles. The basis of the new program is rooted in the "Maker Movement", and the program will create immersive learning by blending traditional face-to-face training with virtual reality simulations and opportunities to physically construct flat packed building components. The curriculum will include eLearning packages, virtual reality simulations and flat-packed physical building components and will be made available in

both urban and regional locations around Australia. The purpose of this paper is to review the literature identifying the need for the program, outline key aspects of the proposed MIK and briefly describe how the MIK will be evaluated against the normal delivery method[1]..

2 Demographic changes are driving construction demand

There is a growing imperative for the construction workforce to expand to meet the needs of Victoria, Australia and this is expected to continue for the foreseeable future. The State needs new infrastructure to cope with population expansion. According to the Australian Bureau of Statistics [1], for the 12 months period up to Sept 2017, Australia has one of the fastest growing population amongst major OCED countries with a population growth rate of 1.6% and above that of the worlds at 1.1%. Victoria recorded the highest growth at 2.3% with Net Overseas Migration (NOM) being the strongest driver of population change in Victoria accounting for up to 70% of growth [2]. The availability of work opportunities and easy access to amenities has made it a sought-after destination for international migrants. According to current projections [2], by 2031, it is expected that the population of Victoria will be 7.7 million and a further 2.4 million people to be added two decades later by 2051, growing the population to 10.1 million in the next 3 decades. Demographic characterisation indicates that 8.0 million will be in Melbourne, up from 4 million in 2018, and 2.1 million in Victoria's regions [2]. It is thus evident that if Victoria is to cope with these changes in demographic trends over the next 30 years, choices need to be made around how these growths are accommodated [3].

3 Construction is critical

As part of the government strategy to combat the challenges associated with population growth, Infrastructure Victoriatoria was established in October 2015 with a mandate to improve public debate and build consensus on priority infrastructure projects in Victoria. This aligns with recent trend in other Australian jurisdictions to create bodies to advise governments on infrastructure planning [3]. It has set out a pipeline of initiatives to be delivered over the next three decades and the subsequent report [4] recommended decisive action, including:

- increasing densities to make better use of existing infrastructure and bring people closer to jobs and services,
- providing more affordable housing for people at risk and improving communications infrastructure, particularly in regional and rural Victoria.

The report emphasised that cities are expanding, and government must continue to plan and provide infrastructure for new communities [4]. However, the more Victorian cities sprawl, the harder it is for people to get around, and the more onerous the task of providing high quality infrastructure. Importantly, for effective implementation of the initiatives in the infrastructure strategy report, there is a reliance on increasing workforce capability for both build and non-build solutions.

[1] The Program is being developed by Exner Education in conjunction with Real Serious Games, Built and AECOM through funding by the Victorian state government. The University of Melbourne will evaluate the program.

The construction industry itself is one of the key economic drivers in the Victorian state economy, employing hundreds of thousands of Victorians and a significant state economic contributor. As infrastructure would be a critical driver for effective operation of the state, planning and implementation of the necessary structures is imminent to better manage disruptions and ensuring Victorians access necessary services. Thus, for successful implementation of infrastructure initiatives, it is imperative that the construction workforce capability be continually improved through efficient training. Construction has always been and remains very much reliant on a skilled motivated workforce.

4 The construction workforce

Forecasts for 2046 indicate that the construction industry in Victoria will need to more than double its employment, with an annual growth of 3% [3]. The construction workforce has two major groupings – those who manage the process and those who carry out the physical work, with reports indicating that the number and skill level of those undertaking construction worker roles has declined [5], resulting in skills deficits at all levels, including those in site supervisory roles. Several studies have been undertaken to better understand apprenticeship training in Australia has been reported that Australia has experienced a sustained decline in apprentice training rates [5]; declining completion rates [6]; cancellations of apprenticeships [7]; and apprentices with multiple episodes of training [8], with the residual effect contributing to shortages in core vocational occupation such as the construction sector [5]. Besides the financial, social and economic loses to the apprentices, Bilginsoy [9] describes the high cancellation rates as a costly disincentive to employers, despite employers benefitting from providing these apprenticeship places through increased productivity [10].

The Infrastructure Victoria report [4] highlighted the need for workforce development, including an increase in the quality and efficacy of training being crucial over the next decade. The shortage of occupational skills has several negative consequences. Firstly, the skills shortage has lengthened construction times, particularly in the volume building industry [11]. Workers tend to transit between building and high utilisation of low skilled workers, with or without training, by sub-contractors has become a common practice. As a result, the second conseqence of skills shortage becomes apparent, namely defects. There have been numerous complaints associated with construction workmanship and subsequent defects characterised by poor quality of work conducted on-site, deficient supervision skills, wrong application of materials and inadequate skills [12]. Skills shortage across the construction industry is therefore linked to poor work quality and workmanship that leads to construction defects.

Love [13] defined rework which addresses these defects as “the unnecessary of redoing a process or activity that was implemented incorrectly the first time”. Several researchers have attributed rework in the construction industry as a chronic problem [14]. Rework has three significant consequences. First and secondly the cost and time overruns due to the necessity to remediate the work. Research has revealed that direct rework costs during construction could range from 2–5% of contract value [15]. They [15] suggested that direct rework costs could amount up to about 6.6% of the contract

value and as profit margins are ultimately tight rework cost could put contractor's profit at risk and further impact productivity. A third consequence can be the impact on safety. In addition, when rework requirements go undetected, they may lead to building failures that can have negative consequences, including severe injuries and possible fatalities. It is therefore evident that there is need for better skills training for the construction sector, not only to improve the capabilities of construction trades but also the skills of site supervisors.

5 Current vocational training of site supervisors

The Certificate IV in Building and Construction (Building) qualification was originally designed to meet the needs of builders and managers of small to medium-sized businesses in the building sector of the construction industry. The Vocational Education and Training (VET) qualification is currently offered through what is known as the TAFE[2] sector and by various private training organisations. Its primary purpose is to provide supervisory skills for managing a construction site or running a domestic building company and competencies required to meet builder registration requirements in various States and Territories [16]. An new educational program is being developed through the MIK program.

From the late 1980s vocational education and training (VET) moved towards a competency- based training approach [17]. Competency-based education and training came to prominence in the 1960s and 1970s and was implemented in Australia as part of the National Training Framework aimed at increasing Australia's business competitiveness [18]. This approach is quite prescriptive enabling consistency across the Australian states and territories providing VET. Each unit of competency has a list required elements which "describe the essential outcomes of the unit" and performance criteria which describe "the performance needed to demonstrate achievement of the element". In addition, a list of skills and knowledge required for each unit is outlined.

The Certificate IV document [19] states that "training and assessment leading to recognition of skills must be undertaken in a real or very closely simulated workplace environment and this qualification requires all units of competency to be delivered in this context." Anidotal advice indicates the majority of the current VET education is undertaken in a classroom situation.

6 Issues with current educational models

Around 75% of the construction industry employers identified technical and job specific skills as lacking in the industry [10]. This lack of skills was reportedly affecting operating costs, increasing the workload for other staff and result in subsequent loss of business to competitors, which will evidently impact productivity. In addition, 37% of employers agreed that that the construction industry candidates were lacking job ready skills. As a mean of employees developing the necessary and/or required skills, in 2016,

[2] TAFE is the acronym for Technical and further education. It relates to post-secondary (high school) level education and provides a range of vocational based programs.

63% of the construction industry employers supported training through private training providers, TAFEs and/or industry association [10]. These training reportedly yielded a positive contribution to productivity and success, with 75% of employers agreeing on the positive return on investment with an enhanced impact on productivity. This therefore raises questions about the effectiveness of the current traditional construction training methods and adequacy of delivering vocational education training.

While traits, abilities, and skills explain a substantial proportion of the variation in learning performance, research in these areas have been less successful at providing insights into the specific manner in which students acquire new knowledge. Understanding how different people learn, and the different styles of learning can help in guiding best methods for training. Some learners may benefit more from a spatial or kinesthetic approach that is emphasised in vocational training [20]. The ways in which trainees process information will impact on how engaged they are in the training activities and their own learning [21]. Learning styles refer to the different ways in which people approach learning and they can have a huge impact on ability to absorb training. Trainees will have different styles and research has demonstrated that adjusting training styles to suit individuals can lead to improvement. The most effective approach is to immerse trainees in their own learning and the environment in which that learning takes place [22]. Once trainees begin to understand their own learning style they will find it much easier to engage with training.

Darling-Hammond [23] states that some trainees learn better using a model of watching and then doing which is aligned with the immersive model approach. She advocates for making learning more visible by engaging trainees in cognitive apprenticeships, making the competencies they are learning more explicit during training. One assumption of a cognitive apprenticeship is that trainees are engaged in interesting and challenging tasks that motivate them to develop their craft. Research has indicated that authentic, relevant and collaborative tasks provide learning environments that develop understanding [24].

Trainees who engage in self- regulated learning monitor their own progress toward self-set goals and are therefore are able to reflect on the effectiveness of their learning approaches [25]. These trainees tend to view the learning task as intrinsically interesting and worthwhile while having high levels of self-efficacy and engage in and persist with learning behaviours that maximize the degree to which learning occurs. There is much research which indicates the factors affecting engagement in learners. Studies around immersive learning environments have indicated it can be a positive factor towards engaging learners.

7 The MIK education program

The global “Maker Immersive Movement”, is at the centre of this new educational approach which will look to transform the Certificate VI education of construction supervisors. The program’s key feature is the use of virtual reality (VR) simulations along with e-Learning packages and flat- packed physical building components. The training model focuses on an immersive learning experience. Immersive learning experiences focus on fully engaging students in well-designed activities harnessing the advantages of

technology and collaboration [26]. The advantage of immersive learning, particular when embedded in technology, is that the learner is presented with experiences and learning opportunities in a real life, real time context that may otherwise not be readily available to them [27].

Across the world education and training systems are still mainly organized around subject matter focused curricula and trainers generally just transmit knowledge to learners via lectures and textbooks [28]. The focus is on developing conceptual understandings of a discipline and learners are given little opportunity to apply skills or have the chance to do this collaboratively. The current century revolves around education and occupations that are technology-driven, and that involve increasingly non-routine tasks, collaborative efforts and complex skills [29]. Educators globally have begun to recognize these shifts and are beginning to integrate technology advances and into their curriculum and practices. In addition, to the integration of technology, higher education and vocational training providers need to focus on the skills and competency demands of industry, and how they can attend to various learning styles, and orientate sufficient learning environments to meet these needs.The use of serious games in learning environments is one of the increasingly relevant trends transforming education, because new digital innovations have significantly changed our pedagogical perspectives [30]. Not only can virtual realities contribute to content learning, they can assist in developing skills such as collaboration, since the opportunities for social interactions are provided, and this in turn can produce feelings of relatedness and belonging leading to greater achievement [31]. There is much research to suggest that virtual reality and serious games are effective in learning and training scenarios [32]. However, the focus of the aforementioned studies typically only focusses on learning outcomes without considering feedback, perspectives, and engagement of learners [33]. Empirical evidence of how virtual realities are linked to curriculum, and how engaging and effective they are from the perspective of trainees and trainers is really needed [34].

8 The MIK evaluation

The evaluation will focus specifically on five specific areas, namely: The acquisition and retention of knowledge and skills by students; perspectives of changes in learning and teaching behavior of students and trainers; insight into student reactions to different ways of learning; identifying learning outcomes and student behaviors; and identifying benefits to students, training organisations, government and industry.

The intention is to evaluate: The Intended curriculum – during the development of the modules; The Enacted curriculum – during the delivery of the modules; and The Experienced curriculum – after the completion of the modules.

All modules associated with the Certificate IV will be evaluated, with five undergo a standard evaluation and three being subjected to a more in-depth evaluation comparing the previous mode of delivery with the new mode. In addition to the module evaluations two VR and one flatpack evaluation will be conducted. The Virtual Reality (VR) evaluation will focus on a comparative study between traditional modes of training and modes that involve blended learning via the use of high-end immersive technology in a Virtual Reality setting. Results will be presented in future papers.

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