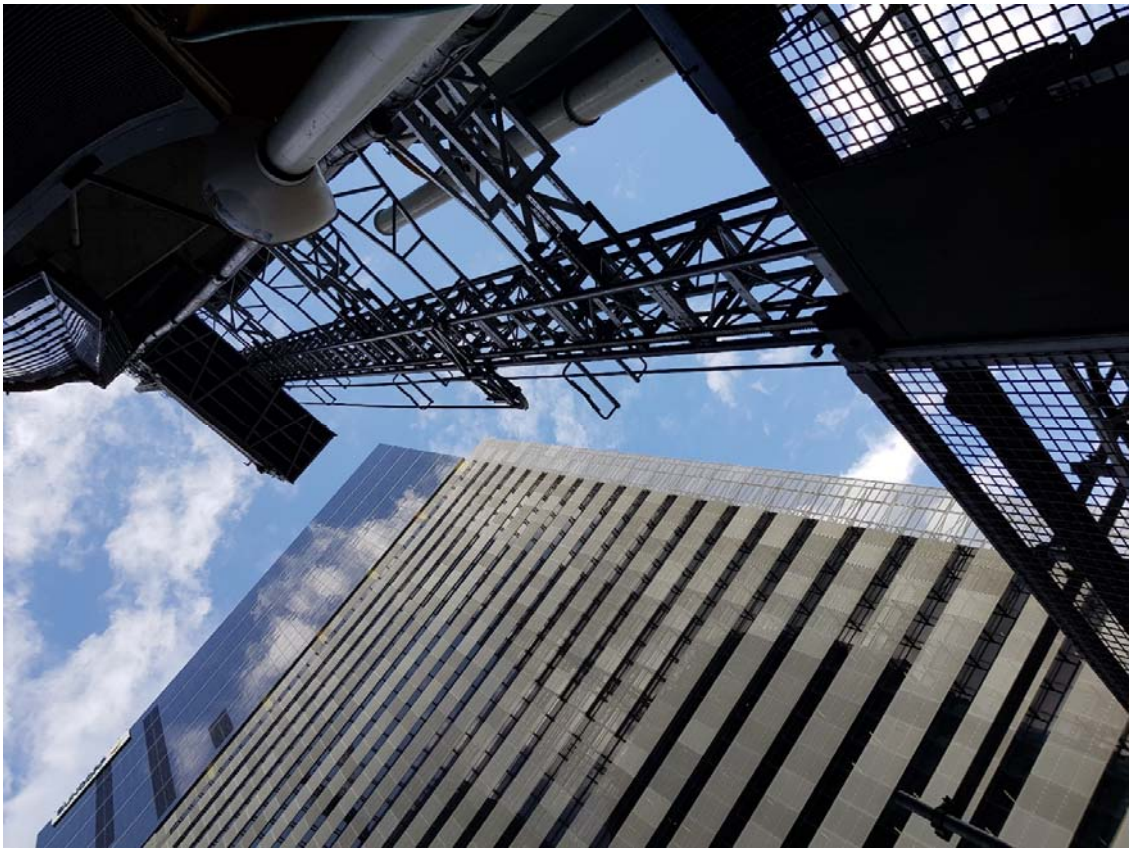

Engagement with Regional School Students through Virtual Construction Site Tour – An Immersive Experience

Authored by:

Dr Fiona Lamari

MARCH 2019

NAWIC IWD Scholarship Report 2020

FOREWORD

Thank you Dr Fiona Lamari for bringing to the attention of the construction industry, much needed insight into the awareness and career selection rates of young females into the industry we admire.

We all know that an improved balance in gender participation is the right thing, but we haven't investigated in the first instance, the how we should and the why we should. Why bother?

Dr Lamari's research paper brings to our attention some staggering statistics which should concern the Queensland industry. This combined with Construction Skills Queensland recent announcement of their own statistics, that on average 3,160 electricians, 960 plasterers and 840 tilers will be needed each year until 2023 to meet industry demands in Queensland – the chronic shortage of skilled people is a warning sign for the industry. Additionally, QUT statistics of gender balance in the School of Civil Engineering and Built Environment (now School of Civil Engineering and Environment and School of Built Environment) have been stagnant for several years. With these basic statistics in mind, the future state of the construction industry needs a significant shift. It needs to be better prepared for what's ahead to meet demand to support our future economy. This is partly the 'why'.

Australian Bureau of Statistics stipulates:

- In 2017-18, the industries with the highest proportion of women are 'health care and social assistance' (79%) and 'education and training' (72%), while men dominated the 'construction' (88%) and 'mining' (84%) industries
- In 2017–18, three in every four 'clerical and administrative workers' are women (75%) and nine out of ten 'machine operators' are men (91%), which has remained largely unchanged over the last decade

It is important to note that the careers females are selecting are just as important to our economy. Yet, I think it is also important to note that a construction career would be equally satisfying as a health, teaching or administrative career. And these also form the 'why'.

Are our young women ready to make the decision toward a satisfying, financially rewarding career with tangible outcomes? Are they ready to build Queensland's future? Not quite yet, but Dr Lamari's research is an example of a concrete (pardon the pun) and practical process for making a significant shift for the potential future construction industry. Her Virtual Construction Site Tour is ready. Are we, the construction industry, ready?

Jennifer Gillett
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NAWIC Queensland President

ACKNOWLEDGEMENTS

Thank you to the NAWIC IWD Scholarship panel for believing in this research project. The IWD Scholarship has not only supported this research journal financially, but it has also given me a real boost of confident to pursue my vision in the Virtual Construction Site. Thank you!

This project wouldn't have been possible without the Multiplex and 300 George Street project team. Thank you for sharing with us a day of your life in the construction industry. My sincere thanks to the eMPS team from QUT for making the Virtual Construction Site happen. I have learnt so much during this process!

Thanks also to the schools who participated in this study.

Finally, I want to acknowledge the continuing support from the School of Civil Engineering and Built Environment in Science and Engineering Faculty at QUT, and colleagues who have offered their ears and critical feedbacks over many coffee sessions.

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EXECUTIVE SUMMARY

The aim of this project is to offer clear recommendations and hands-on experience to promote the construction industry to high school - in particular regional - students and increase female participation in construction related careers. Thus, ultimately bridging the gender gap in the construction industry. Given this, student awareness and recognition of construction is essential to stimulate conversation and develop effective engagement strategies in construction with schools.

This project is an innovative approach to engage with high-school female students through a virtual experience that can mimic realistic building construction site – Virtual Construction Site (VCS) Tour. The VCS Tour takes students on a journey to showcase the diversity and integration between onsite professions on a real construction project. During the VCS Tour, students can look around in 360° while hearing the onsite professions as if spoken to on an actual construction site. This project is a proof-of-concept study, and the first step towards creating an innovative engagement tool in the form of a Virtual Construction Site.

KEY FINDINGS

- **99% of participated students enjoyed the Virtual Construction Site Tour experience**
- VCS Tour experience has a **positive impact on changing students' perception in construction** being a male dominated career with a nett 34% improvement overall. Particularly, these findings revealed a nett favourable movement of 40% in regional students.
- Four in five students believe they have an **increased understanding in people's role** in construction after the VCS Tour experience.
- VCS Tour experience **increases students' level of interest** in construction
- The VCS Tour experience can **trigger student's consideration for a career in construction**, an 11% increase in regional students.
- School teachers could see huge potential **in class teaching** using VCS Tour

RESEARCH BACKGROUND

In 2017, women were most likely to have qualifications in Management and Commerce (27%) and least likely to have qualifications in Architecture and Building (1.1%)[1]. Between 2007 and 2017, 1.1% of females graduated in Architecture and Building on average, yet men were ten times more likely to have qualifications in this field (see Figure 1). The number has been steady over the past decade. Without an increase in the flow of female wishing to complete non-school qualification (such as certificate III, tertiary studies) in the Architecture and Building field, it is impossible to close the large gap between males (88.1%) and females (11.9%) employed in the construction industry[1].

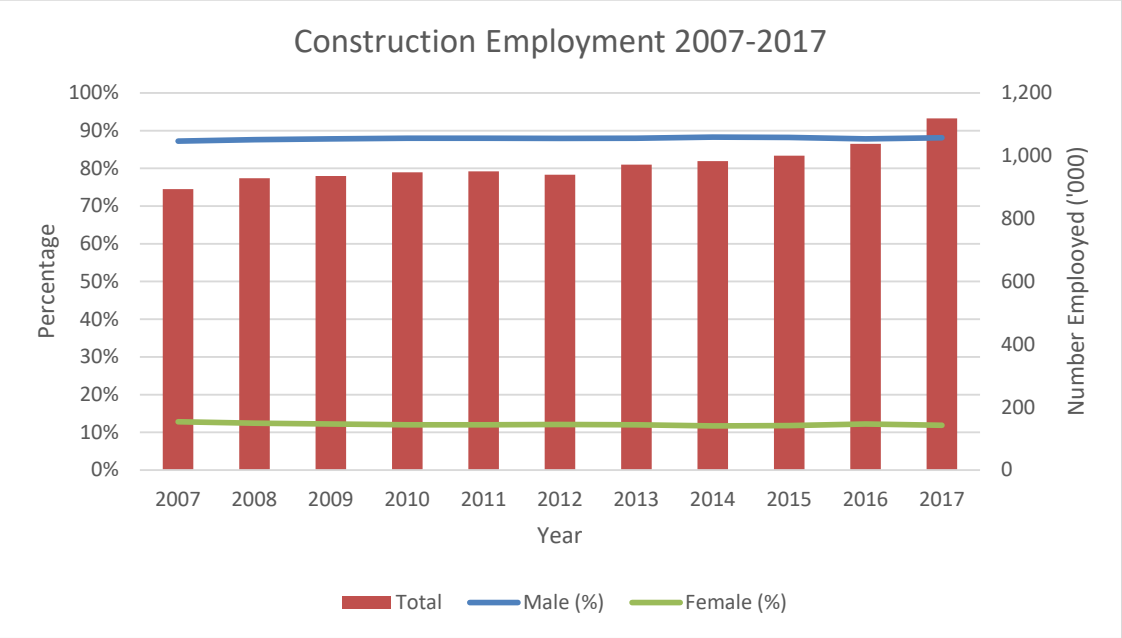


Figure 1: Architecture and building study, by Sex, 15-64 years, 2007-2017[1]

[1] ABS (2018). Gender Indicators, Australia, Sep 2018. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4125.0~Sep%202018~Main%20Features~Education~5

Generally, students do not ask any questions if they do not have an appreciation of the subject matter. Similarly, female students disregard studying a construction related course if they are unaware of career pathways in construction[2]. Worse still, these students have a negative perception on construction work and construction workers. We need to demystify the construction professions and build awareness of the construction industry in high school students and the community. We want to ignite the curiosity and thinking of construction in female students.

Construction is the third largest industry in Australia, employing 1,167,200 construction workers in FY 2017-18[1]. As of FY 2017-18, construction industry has the highest number of male employees and is largely male dominated (88.1%). Over the five years to November 2017, over 188,800 new jobs were added, representing a 19.3% increase in employment[3]. Females account for 12% of those employed and there has been no change over the past five years.

The Australian Government and construction industry such as NAWIC have both recognised the gender imbalance issue and implemented initiatives to alleviate the situation; however, the percentage of women engaged in construction has not changed much in the past ten years. As of 2019, only 11.9% of the workforce in the construction industry was female.

When making a career pathway decision, a high school student's career decision-making process is influenced by the level of interest and desire to work in a profession or a sector. Direct engagement and communication between female students and industry professionals might be the key to bridging the gender gap in the construction industry.

There is a noticeable gap between the achievements and opportunities of regional students with the urban students[4]. Regardless of location or circumstances, every young person should have access to quality education and opportunities. The Virtual Construction Site Tour, created through this project, provides a medium for the industry to engage and

[2] Bigelow, B. F., Bilbo, D., Mathew, M., Ritter, L., & Elliott, J. W. (2015). Identifying the Most Effective Factors in Attracting Female Undergraduate Students to Construction Management. *International Journal of Construction Education and Research, 11*(3), 179-195. doi: 10.1080/15578771.2014.1002639

[3] Department of Jobs and Small Business (2018). Australian Jobs 2018. Retrieved from https://docs.jobs.gov.au/system/files/doc/other/australianjobs2018.pdf

[4] The Department of Education and Training (2018). Independent Review into Regional Rural and Remote Education—Final Report. Commonwealth of Australia.

support the education sector, reach out to regional high-school female students through immersive technology, and highlight diverse role models to prospective students.

The overarching aim of this project is to demystify the construction industry to high-school female students through an immersive experience, Virtual Construction Site Tour. As such this project also evaluates whether the Virtual Construction Site Tour experience has an impact on students' perception of the construction industry and students' consideration of a construction career.

RESEARCH METHODOLOGY

The goal of this project is twofold. Firstly, the development of the Virtual Construction Site (VCS) Tour and secondly, the deployment and evaluation of the immersive experience. The research undertakes a mixed method approach (survey, direct observation and semi-structured interview) to evaluate whether the immersive experience has a positive impact on female high-school students' perception of the construction industry and their consideration of construction career pathways.

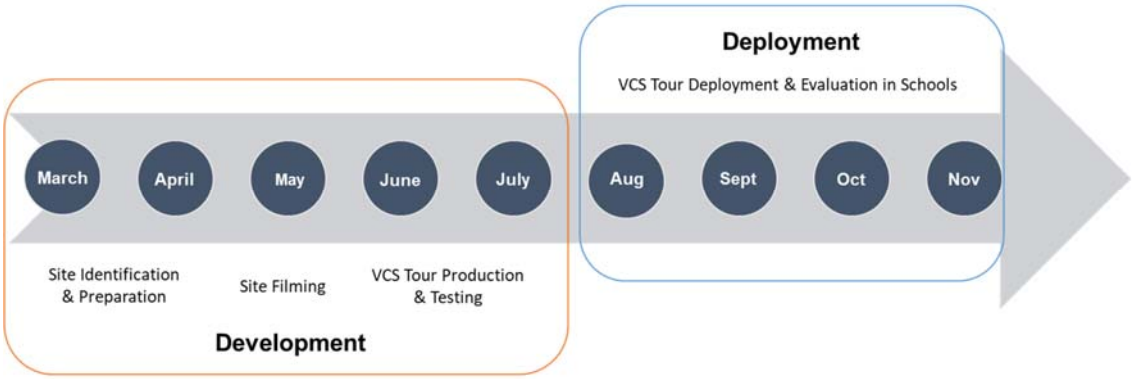


Figure 2: VCS Tour Production & Deployment Timeline

DEVELOPMENT OF THE VIRTUAL CONSTRUCTION SITE TOUR

The project aim is to demystify the construction industry by promoting the exciting diverse career options for high school students through immersive virtual experience. The first task was to select a suitable building site to create the experience. I want to plant a seed and create a 'wow' effect in the students through the VCS Tour experience. As such, a high-rise building project in Brisbane CBD was used in this pilot project for the VCS Tour production. 360° filming was carried out in mid 2019 when the building project was in its construction phase.

Having selected the site, the next step was is to create the tour itinerary. The VCS Tour must offer an authentic experience similar to what one would have at the physical site visit. To provide a sense of authenticity, the VCS Tour started at the street level, next stop the personnel hoist and up to the top deck where the safety talk was given. From here, the VCS Tour captures a logical sequence of construction activities and stages in typical vertical construction:

- Jump form
- Formwork
- Wet area set down
- Interior wall framing and services
- Waterproof and interior finishes
- Display suite

The VCS Tour takes students on a trip in a personnel hoist to the top of the jump form and finishes at the display suite. During the eleven and a half minutes VCS Tour, students met with a diverse range of professions on the project and hear their career journeys in the construction industry – cadet, site engineer, supervisor, personnel hoist operator and construction manager.

Students participated at the VCS Tour using the virtual reality headsets and met with different professions in both genders, from tradesman to site engineer to construction manager, all in different stages of their career. Through this immersive experience, students saw snippets of construction professions' daily work and real workplace, heard from construction professions whilst through the guided VCS Tour. To create the true site visit experience, it is crucial that the VCS Tour production was filmed on a real construction project, at the time when everyday activities happened.

The VCS Tour delivery platform and the choice of headset were carefully considered. To bring the immersive experience to high-school students (on school ground) within the allocated timeframe, it is important for the headsets to be portable and quick to set up. The viewing screen must also have high-resolution display with stereo sound. Another consideration is school internet can be patchy and the download speed often varies. To ensure a smooth experience without interruptions, the VCS Tour was delivered offline, preloaded on the headsets. The VCS Tour was delivered using Gear VR 2017 with Samsung Galaxy S8 and over-ear headphones to block out any background noise. The VCS Tour was delivered through wireless virtual reality headsets with over ear headphones in seated position. The wireless virtual reality headsets allowed students to freely look around the construction site in 360° during the VCS Tour.

DEPLOYMENT AND EVALUATION OF THE VIRTUAL CONSTRUCTION SITE TOUR

The Virtual Construction Site Tour was offered to high-schools through NAWIC QLD's In-School Experience program. In the first stage of research, three high-schools from three different Queensland regions participated in this research project in August to November 2019. From the three participating schools, two were all-female schools from regional Queensland and one was co-education school from Brisbane. The Virtual Construction Site (VCS) Tour was designed to provide students an immersive construction site tour experience. As such the VCS Tour was delivered through wireless virtual reality headsets with over ear headphones in seated position. The wireless virtual reality headsets allowed students to freely look around the construction site in 360° during the VCS Tour.

Students participated at the VCS Tour were invited to complete an optional VCS Tour pre & post experience survey. Students were instructed to complete Part A of the VCS Tour Experience Survey before beginning the VCS Tour, and complete Part B of the survey after completing the VCS Tour. Throughout the VCS Tour activity, a teaching staff was present with the student participants at all-time. 76 students participated in this study. The second stage of the research provides exploratory insight into the impact of VCS Tour through teachers' perspective. Three teachers from a Townsville all-female high school participated for 20-minutes interviews.

Figure 3: VR Headset used

The research that informs this document was collected from a range of sources. All research involving human participants took place in accordance with international standards for ethical human research[5].

Queensland region definitions are based on a combination of ABS Statistical Divisions and Queensland Government classifications. Figure 4 provides an approximate visual representation of participating school in the Queensland regions.

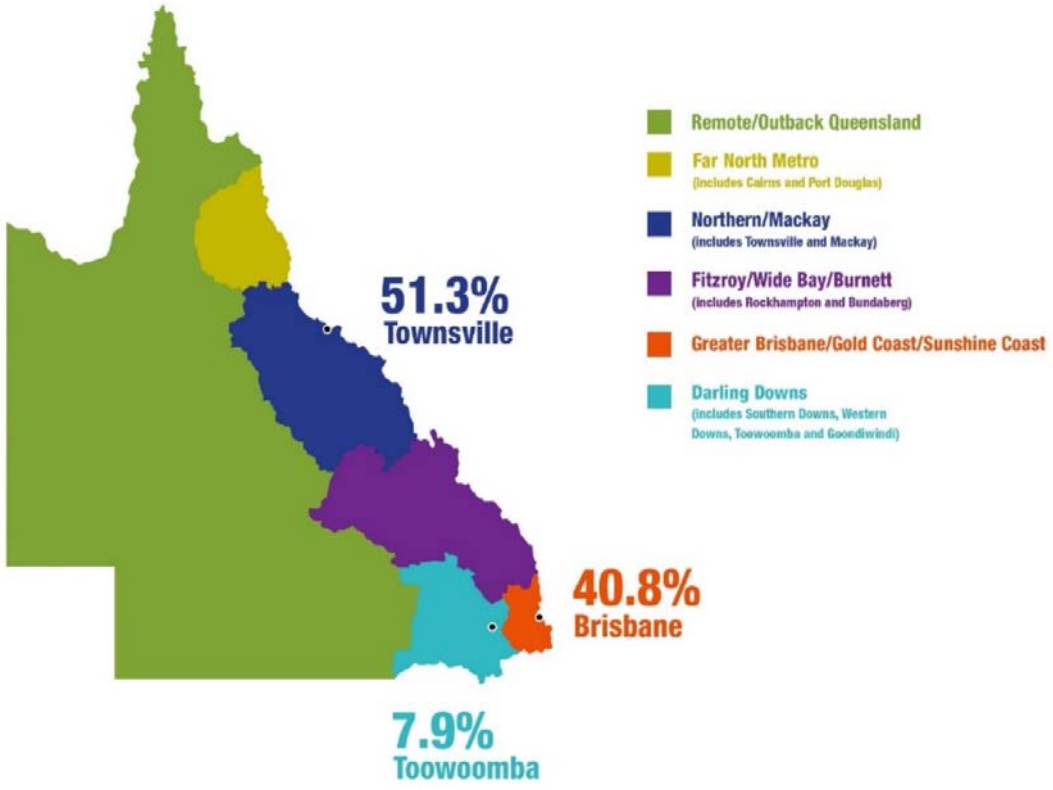


Figure 4: Six Broad Queensland Regions

Remoteness classifications referenced throughout the report are based on The Australian Statistical Geography Standard (2016) Remoteness Structure. Townsville is classified as outer regional and Toowoomba as inner regional, with Brisbane classified as a major city (see Figure 5). 76 students participated in this study.

[5] Queensland University of Technology Human Research Ethics approval number for the project is 1900000595.

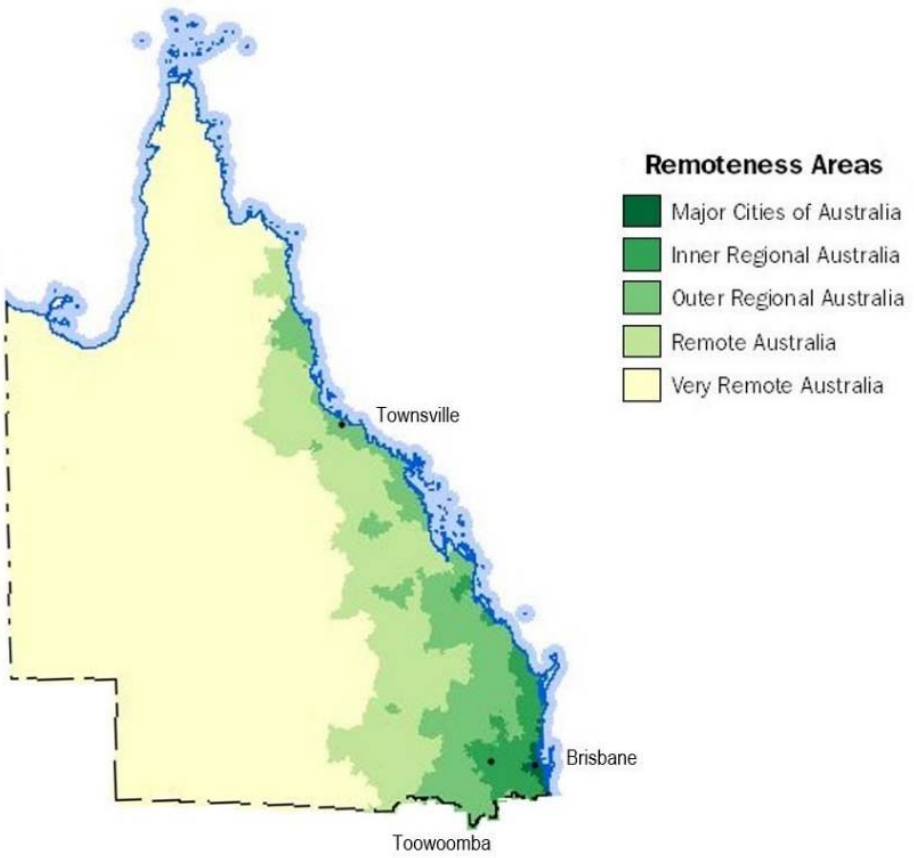


Figure 5: Remoteness Classification (Queensland)

	Major City	**Regional**	
		Townsville	Toowoomba
Male	16	-	-
Female	15	6	39
Total	**31**	**45**	

Table 1: Demographic Data - Region, Gender

FINDINGS

Perception of the Construction Industry – Overview

Before VCS Tour Experience

One in two (49%) students considered '*construction is a male dominated career*'. Similarly, one in two students (51% including 29% of students indicating 'don't know') students indicated '*I don't know what people in construction do*'. This is particularly interesting because 79% of students believed '*construction offers many different career pathways*', yet students were unclear on the roles of construction professions.

One in two students consider construction a male dominated career. Construction offers many different career pathways but what people actually do is unclear.

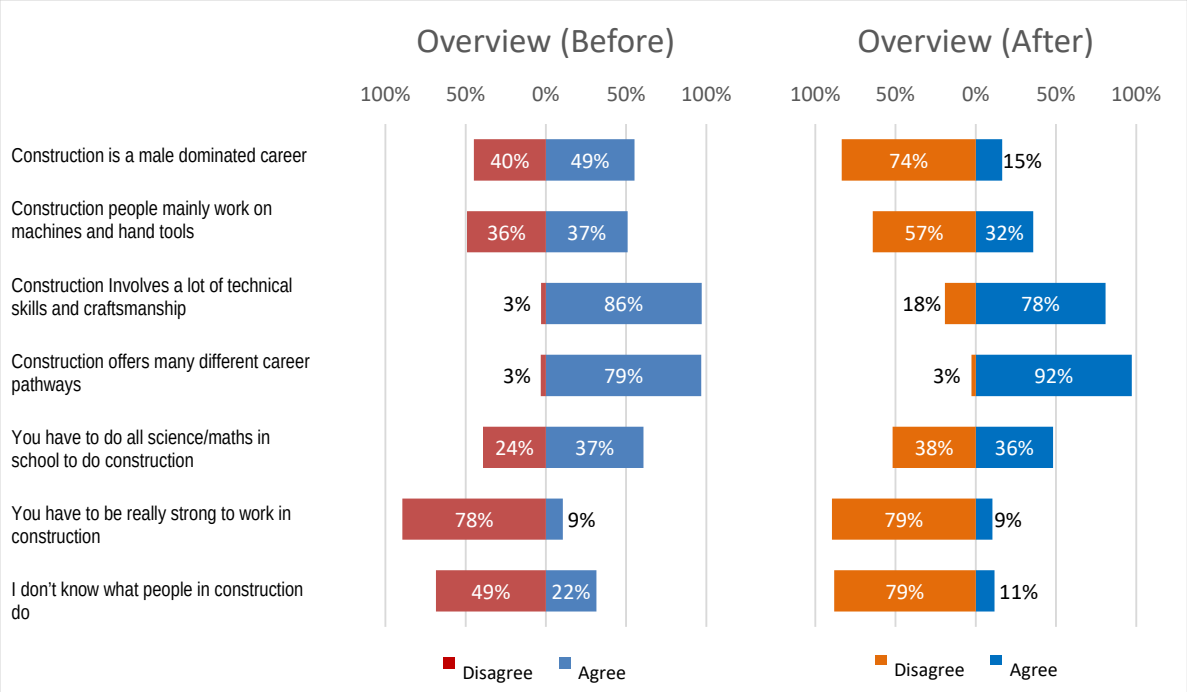
In general, students do not consider physical strength as a requirement to work in construction. One in three (36%) students do not think people in construction mainly work on machines and hand tools. Suggesting students' perception of construction careers is shifting away from traditional roles such as on plant operations, labourer and trade specific skills.

After VCS Tour Experience

There is a noticeable shift in students' perception on construction career. Findings suggested that after the VCS Tour experience, three out of four students (from 40% before VCS Tour to 74%) disagreed 'construction is a male dominant career'. Nine in ten students agreed 'construction offers many different career pathways', a change from 79% to 92%. Four in five students (from 49% before the VCS Tour to 79%) expressed they disagree the statement 'I don't know what people in construction do'. About three in five (57%) students disagreed 'construction people mainly work on machines and hand tools'. Suggesting the

VCS Tour experience enhanced students' level of awareness on the range of career options and job descriptions in construction.

There is a shift in students' perception of construction as a male dominated career. Four in five students believe they have an increased understanding in construction jobs.



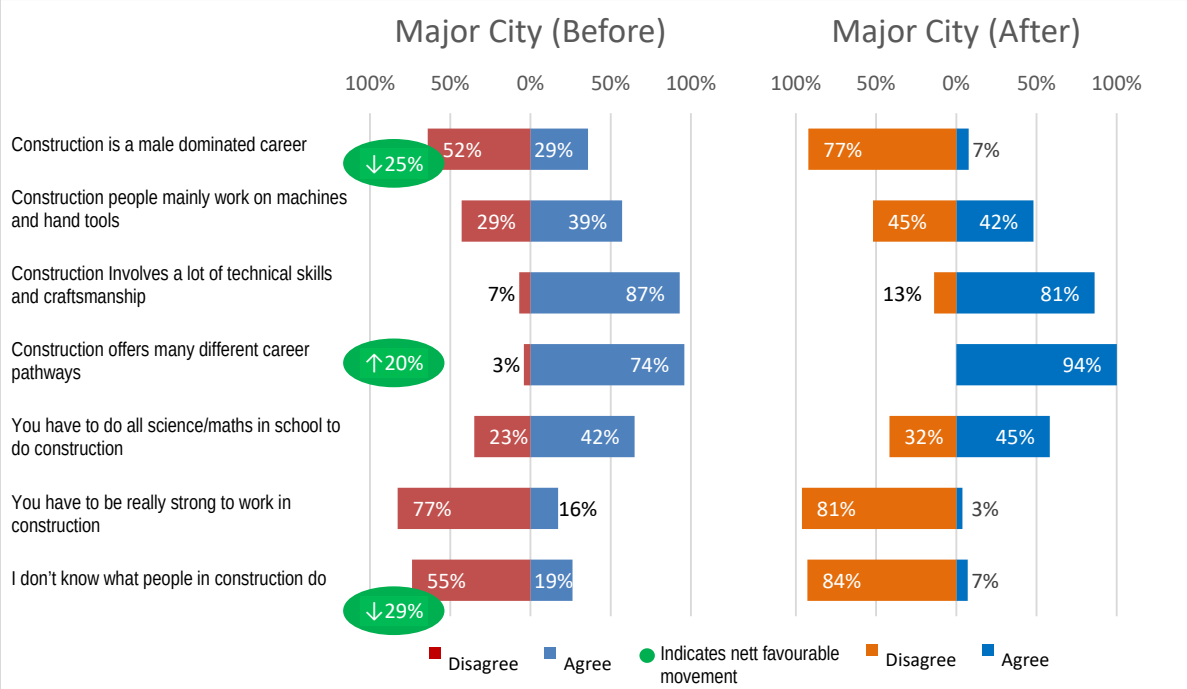
A1., B3. Read the following statements about construction and indicated your agreement or disagreement with each statement
Base: All respondents n=71

Figure 6: Perception of the construction industry – Overview (before and after VCS Tour experience)

Perception of the Construction Industry – by Region

Before VCS Tour Experience

Compare with city students, twice as many regional students consider 'construction is a male dominated career'. Three in five (62%) regional students held the perception that construction career is male dominated, as oppose to one in three (29%) city students. 82% regional students perceived 'construction offers many different career pathways', slightly higher than city students (74%). About one in two (55%) city students and two in five (44%) regional students indicated they are aware of 'what people in construction do'. Interestingly, no regional student disagreed with the statement 'construction Involves a lot of technical skills and craftsmanship' (84% agree, 16% do not know).

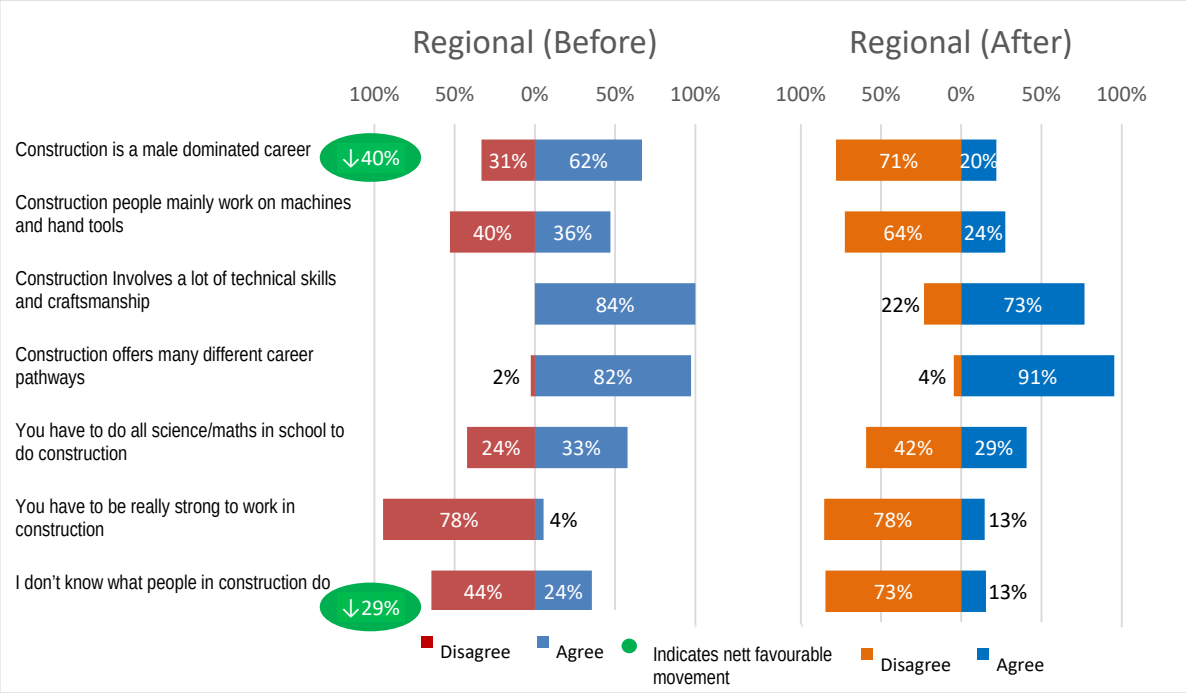


A1., B3. Read the following statements about construction and indicated your agreement or disagreement with each statement
Base: All respondents n=31

Figure 7: Perception of the construction industry – Major City (before and after VCS Tour experience)

After VCS Tour experience

Overall, there is a nett favourable movement of 29% in both city and regional students' understanding on 'what people in construction do'. The percentage change in the perception of construction as a male dominated career is substantially higher in regional students than city students, with a nett favourable movement of 40% (regional) and 25% (city). Regional students have a clearer view towards 'construction involves a lot of technical skills and craftsmanship' in regional students, from 16% indicating 'don't know' down to 5% after the VCS Tour experience.



A1., B3. Read the following statements about construction and indicated your agreement or disagreement with each statement
Base: Regional n=45

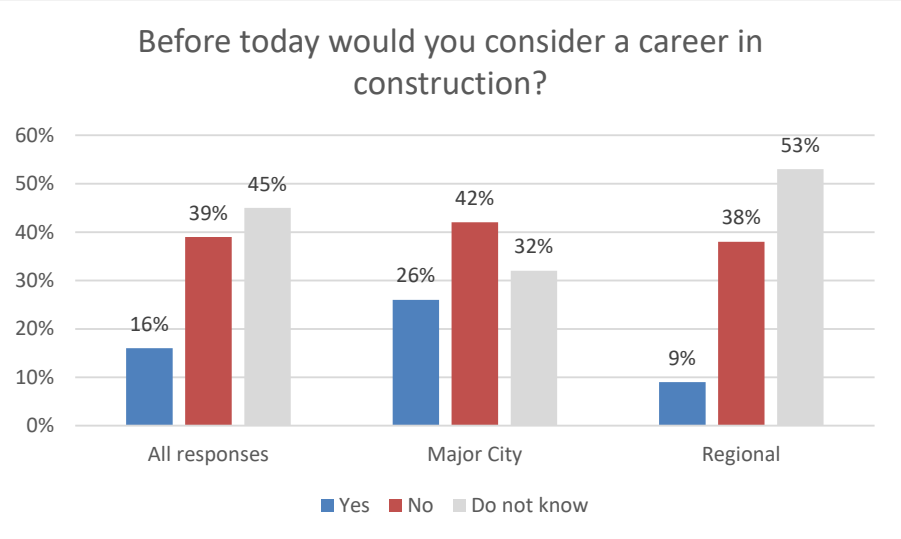
Figure 8: Perception of the construction industry – Regional (before and after VCS Tour experience)

There is a substantial favourable movement in regional students' perception of construction as a male dominated career.

Career in Construction

Overall, 20% regional students would consider a career in construction after the VCS Tour experience, an 11% increase from 9% (before VCS Tour) to 20%.

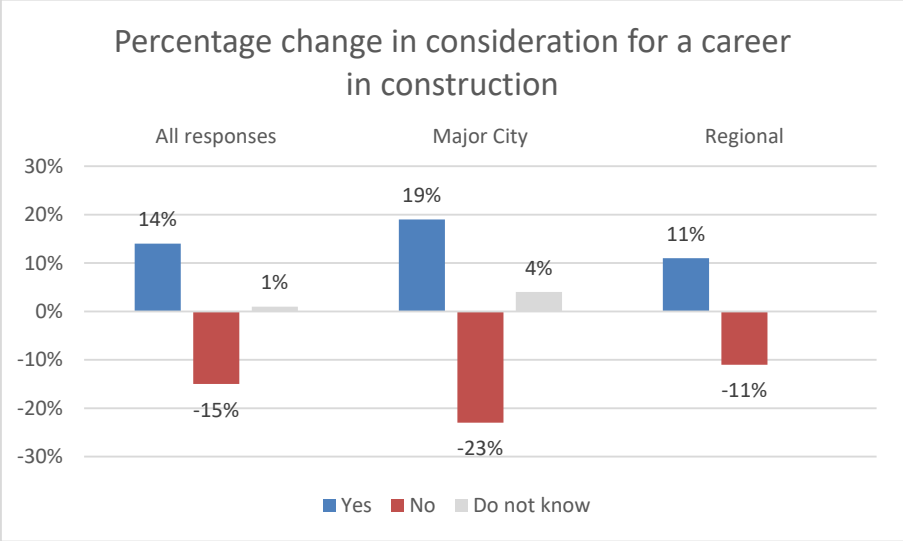
One in four (26%) city students would consider a career in construction prior to the VCS Tour experience. After the experience, almost one in two city students (45%) would consider a construction career.



Base: All respondents n=76, Major City n=31, Regional n=45

Figure 9: Consideration towards a career in construction

Overall, the proportion of students to consider a career in construction has doubled since the VCS Tour experience (from 16% to 30%). Figure 10 below presents the percentage change in students' consideration for a career in construction before and after the VCS Tour experience.



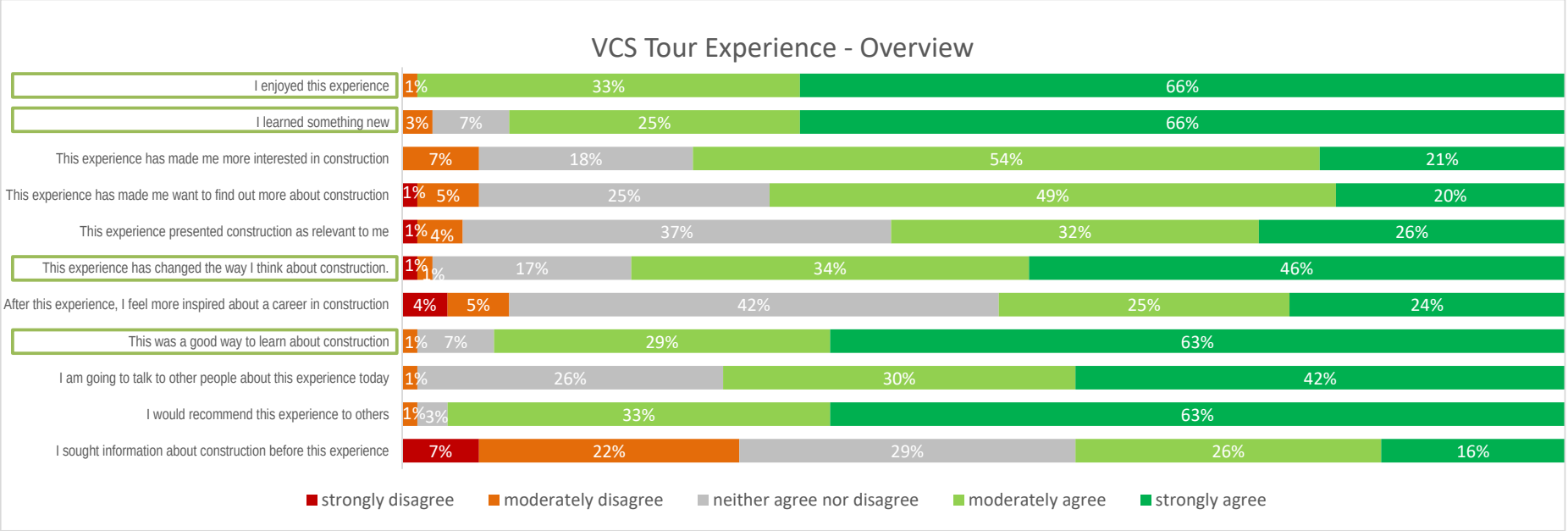
A3. Before today would you consider a career in construction?
B5. After today would you consider a career in construction?
Base: All respondents n=76, Major City n=31, Regional n=45

Figure 10: Percentage change in consideration of a career in construction (before and after VCS Tour experience)

Interestingly, the biggest change in consideration for a career in construction comes from students who previously would not have considered the industry. Furthermore, students who would not have considered the industry has now moved to the unknown zone. There is no significant change in the students who were undecided of the industry.

Feedback on VCS Tour Experience

Overall, 99% of students enjoyed the VCS Tour experience and nine in ten (96%) students would recommend the VCS Tour experience. Nine in ten (91%) students believe they have learned something new from the experience. Eight in ten (80%) students indicated the experience has change the way they think about construction.



B1: Help us improve the activity by telling us what you think about the VCS experience.
Base: All respondents n=76

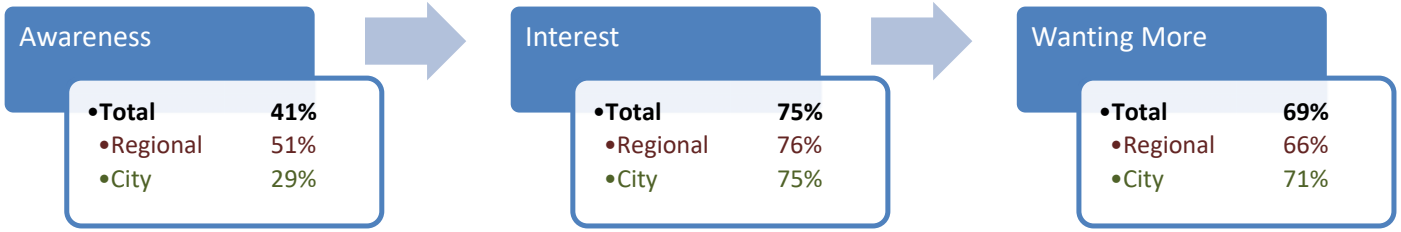
Figure 11: VCS Tour Experience - Overview

In terms of learning, nine in ten (92%) students consider the VCS Tour as a good way to learn about construction. Almost four in five (75%) students find the experience has made them more interested in construction. 69% of the students indicated they want to find out more about construction after the experience. A teacher described the VCS Tour experience as 'a good eye opener as to what actually happens in the construction site'.

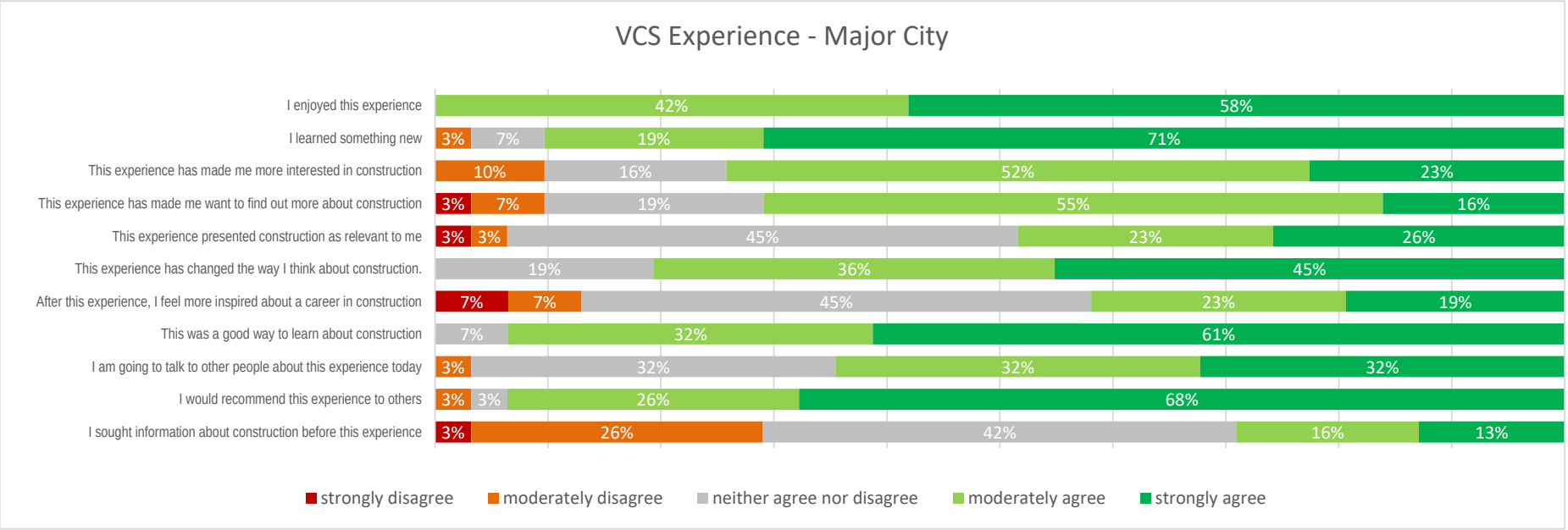
"It was a good eye opener as to what actually happens on the construction site."

Teacher A

Four in five (81%) regional students indicated the VCS Tour experience has changed the way they think about construction. Positively, one in two (54%) regional students felt more inspired about a career in construction. One in two (51%) regional students indicated they 'sought information about construction before this experience'. Two out of three (66%) regional students stated, 'this experience has made me want to find out more about construction'. Similar pattern is observed in the city students, 29% stated they 'sought information about construction before this experience'. Over two out of three (69%) city students indicated they 'want to find out more about construction' after the VCS Tour experience.



Before the VCS Tour experience, 41% of students indicated they sought information about construction. The interesting point is there is a pattern in conversion of interest to wanting to find out more. The industry needs to raise the level of awareness in students.

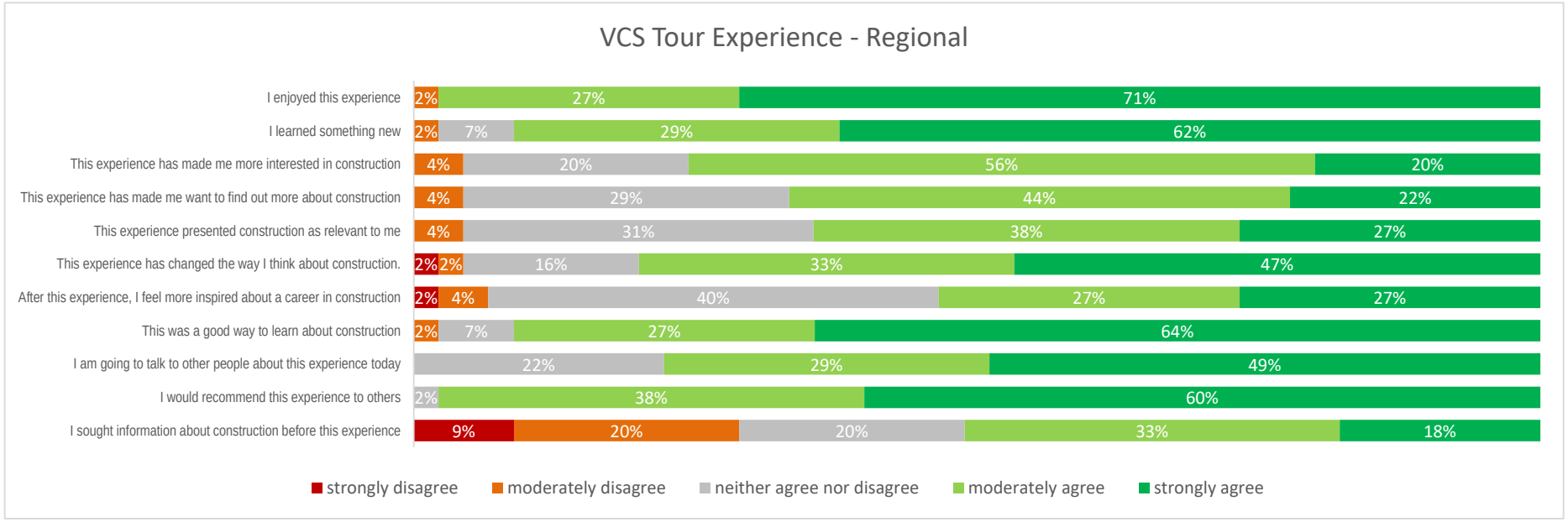


B1: Help us improve the activity by telling us what you think about the VCS experience.
Base: Major City n=31

Figure 12: VCS Tour Experience - Major City

"I think it would be good for the students to see how things are actually done in sequence and in order for a building to occur and also what is required to actually build a building… what are the materials required , what are the different trades required… the logic between the sequence…"

Teacher C



B1: Help us improve the activity by telling us what you think about the VCS experience.
Base: Regional n=45

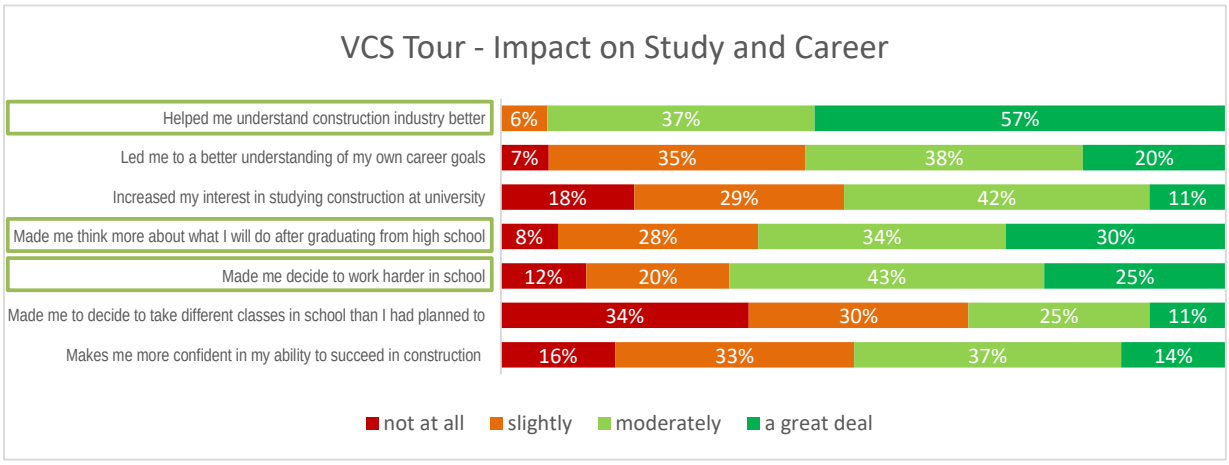
Figure 13: VCS Tour Experience - Regional

VCS Tour – Understanding, Careers and Studies

Nine out of ten (94%) students expressed the VCS Tour experience has a moderate (37%) or great (57%) impact on 'helped me understand construction industry better'. 53% of the students indicated a moderate (42%) to a great deal (11%) of impact that the experience has their interest in undertaking construction studies at university. 68% of students (25% a great deal, 43% moderately) pointed out the experience 'made me decide to work harder at school'. Similarly, three out of five (64%) students indicated the VCS Tour experience has given them more thoughts on what they will do after graduating from high school. This is a positive note which suggest an immersive experience such as VCS Tour is a potential resource for student engagement to increase understanding of career options and the work environment.

"It has made me think that there is a career plan for girls. You know, I hadn't really thought about it much before. When I grew up, my father was in construction but I would have never considered it as a role for me and he would never have considered it as a role for me either."

Teacher A



B2. How much did participating in the VCS Tour impact each of the following?
Base: All respondents n=76

Figure 14: VCS Tour Experience Impact on Students' Study and Career Considerations

A couple of the teachers remarked the VCS Tour changed the way students think about construction, particularly on the logic of the construction process and the variety of roles professions play in the process of construction, as highlighted in the following quote:

> "I think a lot of the students may not know how things are put together and how buildings go up… it might have given them a bit more of an insight in the logic behind it and maybe even the different roles… coz I think most people think of construction as builders laying down bricks or putting pipes down or doing electrical stuff… there's all the surveyors, there's all the foremen and there's a whole lot of roles that everyone plays to complete the building so everyone's got their little role, which is, I think it's a good thing that kids know that"
>
> Teacher C

Students' Interest in Construction

Interest levels in construction are consistent across the regions.

> "When the girls came back to the classroom, I was curious about their reaction to it [VCS Tour]… it was all very positive. The girls really liked the experience."
>
> Teacher B

Positively, 75% of students indicated their interest in construction has increased after the VCS Tour experience. This finding is consistent across city and regional school students

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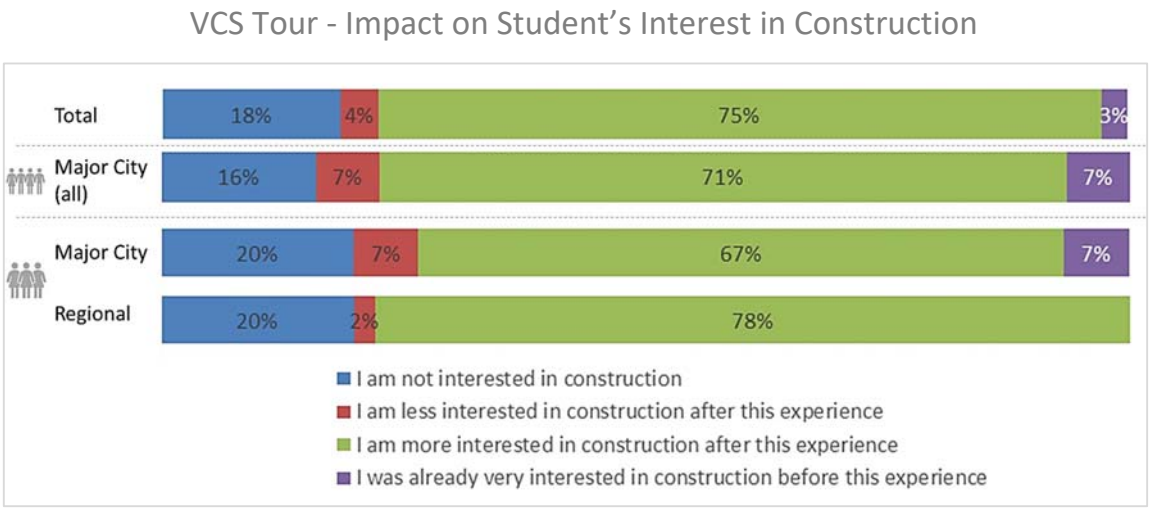
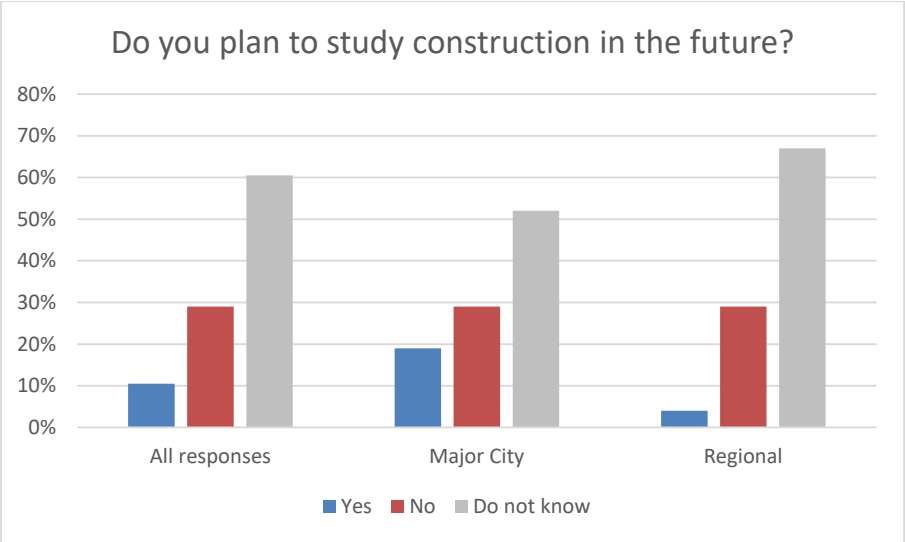


B6. Which of the following sounds most like you?
Base: All respondents n=76; Major City n=31; Major City Female n=15; Regional n=45

Figure 15: VCS Tour Experience Impact on Student's Interest in Construction

Plan to Study Construction

Overall, one in ten (11%) students plan to study construction in the future. 4% of regional students stated that they plan to study construction though 67% was undecided.



Base: All respondents n=76; Major City n=31; Regional n=45

Figure 16: Plan to study construction

Comments on the VCS Tour Experience

Overall, student's comments on the VCS Tour experience was greatly positive. Students found the virtual experience very interesting and 'cool'. Most students did not have previous experience with virtual reality and was excited with the opportunity to see virtual reality in 'action'.

Students were interested to be on the construction site. 'Whoa', 'It was so real' were comments students remarked on the moment they have finished the VCS Tour. Some female students also commented 'there are so many women in construction' and appeared genuinely surprised.

Through observation, it was noted most students maintained a stationary viewing posture for the majority part of the tour. Students seemed to have more head movements and look around more in early parts of the tour. A number of students reached out for things or tried to steady themselves (even though they were seated with both feet on the ground) during the experience. This raises an important point that participants must always maintain a seated position throughout the experience to avoid tripping or falling.

Another observation is a handful of students temporary lifted the headsets halfway through the tour, suggesting students were experiencing early stages of discomfort with the headset. A handful of students also remarked on the surrounding felt bright after removing the headsets.

The Gear VR headset allowed students to adjust the distance between their eyes and the screen. This is particularly useful because spectacles are commonly seen amongst students and spectacles needed to be removed because they would not fit in the headset. A couple of students who had to remove their spectacles commented the screen was blurry even after adjustments, suggesting the ability to wear spectacles with the headsets is an important consideration for any immersive experience which requires the use of headsets. The students who found the screen blurry abandon the experience due to dizziness.

No student commented on the feeling of motion discomfort (motion sickness). No student commented or showed signs of discomfort due to the weight of the headset either.

CONCLUSIONS AND RECOMMENDATIONS

- Virtual experience is an excellent **engagement tool** with high-school students.
- The VCS Tour has the potential to be used as **a medium to generate discussions and class activities** using an actual construction project as the backdrop.
- Opportunities to collaborate with school to clarify career plan in construction – see the working environment and hear what people do in construction.
- The VCS Tour makes the site visit **cost-effective, safe and accessible.** Students can explore the construction site in a safe environment, more so for students from regional locations whom would otherwise be unable to attend the site visit due to cost & distance.
- Immersive technology such as virtual 360 video can offer a powerful and insightful experience to student on 'a day of my life' which can demystify the working environment of the construction site and **increase student awareness** of the industry.
- Industry and universities should take advantage in the **immersive technology space and engage** with students and schoolteachers and provide more clarity on the skills students need and what one can expect from a career in the construction industry.
- Universities should explore opportunities with schoolteachers to develop **teaching activities** using the VCS Tour as the basis for class discussions a case study – e.g. in physics, pre-tensioned reo; material science; as well as essential project skills.
- The VCS Tour expose students to **diverse role models** and projects in an immersive environment and has the impact on changing students' perception and develop career optimism in construction.
- A further extension of the VCS Tour is to provide students the option to **select** the destination, to **pause** and **explore** the project site, such as a closer look at the activities on the formwork deck. The ability to pause during the VCS Tour would allow teacher to facilitate discussions with students on understanding the why and explore some of the related concept in the curriculum.

- A longitudinal study to follow students' senior subject selection, post high-school education and career decision would be advisable for an in-depth understanding on the impact of VCS Tour on students' study and career choice.