TECH TALK FOR PRINCIPALS

ScopeIT Education – Term 1, 2020

Edition #14

Computational Thinking skills - does your school measure up?

What is Computational Thinking?

The Australian curriculum defines Computational Thinking as a problem-solving method that involves various techniques and strategies that can be implemented by digital systems.

The four components of Computational Thinking are as follows:

1. **Decomposition** - breaking a problem into smaller parts
2. **Pattern generalisation** - finding similarities between things
3. **Abstraction** - pulling out specific differences to make one solution work for multiple problems
4. **Algorithmic thinking** - getting to a solution through the clear definition of the steps needed.

It is more important than ever that we develop Computational Thinking skills in our students today

Not only is it an important part of the Australian curriculum but it is imperative that Computational Thinking skills are developed as early as possible in students, starting in early primary school. This can help students develop an interest in STEM subjects as well as a positive approach to their learning, which can be carried throughout their schooling and into their future careers.

According to *The Future of Jobs Report 2018* from the World Economic Forum, employers will require their future employees to have skills such as critical thinking, problem solving and collaboration skills, plus tech skills including technology design and programming.

This issue of TTFP will focus on a deep-dive into what Computational Thinking is, how to measure growth of these skills in your students as well as a case study with Oatley Public School in Sydney, Australia. The case study provided some interesting results, particularly in relation to improvements in female students, and highlights how the implementation of a robust digital technologies program significantly increased students' problem-solving, working memory and Computational Thinking skills.

Comparing skills demand, 2018 vs. 2022, top 10

2018	Trending, 2022	Declining, 2022
• Analytical thinking and innovation	• Analytical thinking and innovation	• Manual dexterity, endurance and precision
• Complex problem-solving	• Active learning and learning strategies	• Memory, verbal, auditory and spatial abilities
• Critical thinking and analysis	• Creativity, originality and initiative	• Management of financial, material resources
• Active learning and learning strategies	• Technology design and programming	• Technology installation and maintenance
• Creativity, originality and initiative	• Critical thinking and analysis	• Reading, writing, math and active listening
• Attention to detail, trustworthiness	• Complex problem-solving	• Management of personnel
• Emotional intelligence	• Leadership and social influence	• Quality control and safety awareness
• Reasoning, problem-solving and ideation	• Emotional intelligence	• Coordination and time management
• Leadership and social influence	• Reasoning, problem-solving and ideation	• Visual, auditory and speech abilities
• Coordination and time management	• Systems analysis and evaluation	• Technology use, monitoring and control

Source: Future of Jobs Survey 2018, World Economic Forum.

Implementing a robust digital technologies program presents some unique challenges, some of which we outlined previously in Issue 11 of Tech Talk for Principals. To effectively develop Computational Thinking skills in students requires systemic change, teacher engagement and significant resources.

ScopeIT Education can work with you to develop a pathway designed specifically for your school's needs and goals. We believe in laying the foundations for algorithmic thinking, collaboration and problem solving techniques, working memory as well as reinforcing many STEM concepts that will feature heavily as content gets more technical.

How can we measure improvements in Computational Thinking skills?

Previous studies have proven that Computational Thinking skills are able to improve individual higher-order thinking skills, which is a crucial element to survive in the 21st century, especially in the future workforce. ScopeIT Education has developed a specialised quiz and evaluation rubric to measure Computational Thinking skills for primary and early high school students.

The aim of this quiz is to be able to measure student improvement in the following areas:

Digital technologies content specific knowledge
Has the student shown growth regarding their overall digital technologies concept understanding and content knowledge?

Algorithmic thinking
Does a student begin to view simple tasks as a sequence of smaller steps - indicating growth in instinctive algorithmic thinking?

Decomposition
Can a student decompose a large task and assess/consider small components individually before creating and articulating a step-by-step process that takes varied factors into account?

Pattern generalisation and abstraction
Does a student begin to use pattern generalisation and abstraction when viewing the world around them?

Working memory
Is a student able to temporarily retain and process separate pieces of information in order to anticipate and enact an outcome? Working memory is important for reasoning and the guidance of decision-making and behaviour.

Problem solving
Does a student view something going wrong as a problem to be solved by following a logical process (find, fix, test, repeat)? The pre- and post-tests use identical questions comprising mostly open-ended questions with some multiple choice questions wherever authentic.

Case Study - Oatley Public School

Overview of research findings

The study showed that implementation of the ScopeIT program significantly increased students' levels of 21st century skills including problem-solving, working memory and the four elements of Computational Thinking.

Guiding research questions

1. What role can a ScopeIT Education digital technologies program play in the enhancement of 21st century skills for students?
2. Does coding as a specific component of the digital technologies curriculum significantly increase skills such as problem solving, working memory and Computational Thinking?

Research method

This study utilised a pre-test, post-test method.

Data collection process

- The quiz was sent electronically to classroom teachers with instructions for students to complete prior to their first lesson with ScopeIT Education instructors.
- Students completed one digital technologies focused unit of work consisting of 1x 40 min lesson every week for 10 weeks.
- The same quiz was re-sent to classroom teachers for their students to complete after their last lesson with ScopeIT Education instructors.
- Students used a computer to sit the quiz and submitted individual work.

Sample size and research limitations

In total, 271 students were targeted from one school in order to eliminate variables such as environmental factors, social differences and location.

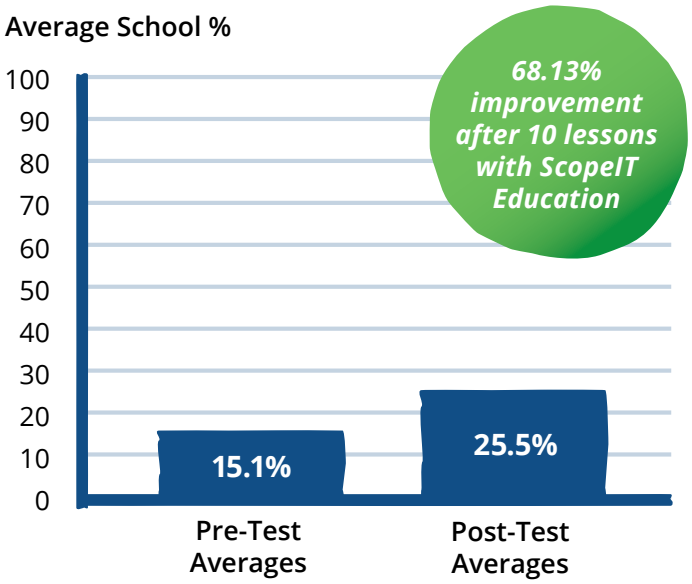
The sample size and therefore the results were impacted due to the need for the same students to sit both the pre- and post-test. As such, the final sample size sat at 171 students total.

Data analysis process

The scores for the test were obtained using a predetermined rubric, in which the way of thinking was focused on, rather than the answer itself. Analysis of the results focused on the mean scores of the pre and post quizzes and was then compared in terms of average.

Figure 1

Research Data Results for ALL Students at Oatley Public School



*Percent increase = [(new value - original value)/original value] * 100*

See below for a further breakdown of the pre and post test results broken into 5 distinct bands.

Figure 2

Competency Totals

% Students Achieving		Pre-Test	Post-Test
0 out of 4	No attempt or incorrect	46.28%	23.30%
1 out of 4	Very little competence	16.74%	14.83%
2 out of 4	Low competence	9.03%	13.27%
3 out of 4	Competent	4.11%	8.86%
4 out of 4	Above Competent	23.80%	39.73%

*Percent increase = [(new value - original value)/original value] * 100*

Research results

Oatley Public School saw growth of 68.13% from their pre-test score for an overall Computational Thinking result. These results are excellent and show great improvement after just one 10 week course. This case study highlights that implementation of the ScopeIT program significantly increased students' levels of 21st century skills including problem-solving, working memory and the four elements of Computational Thinking.

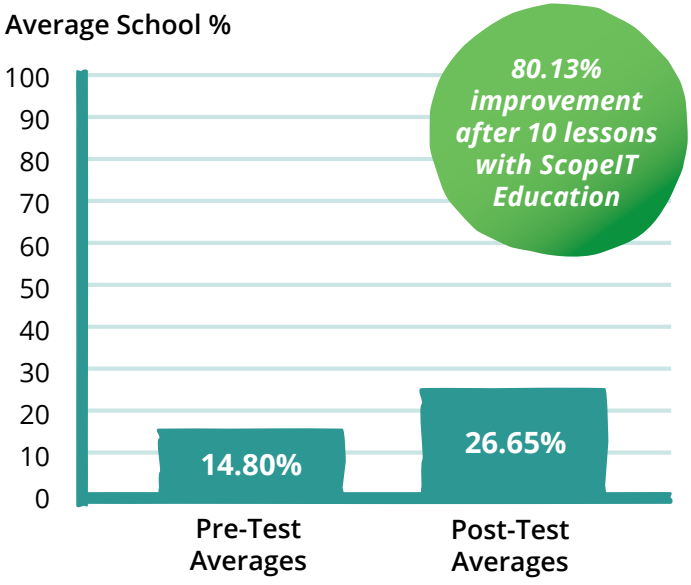
The results of our study offer empirical data/evidence that digital technologies learning in schools is most successful when supported by a continuous, rich and sequenced curriculum. It appears that a poorly executed curriculum in which digital technologies are either not provided or are offered in sporadic and limited amounts, exerts a negative affect on the development of Computational Thinking competencies and problem solving abilities.

Taking our cue from the results of this study, we envision an ideal digital technologies curriculum as one that offers in-depth, carefully sequenced teaching in several digital technologies areas for the entire span of young people's schooling.

Of particular interest was an additional research finding that presented itself. Female students of Oatley Public School experienced a dramatic improvement in their scores. As a collective, these students saw a slightly lower than average pre-test score but after sitting the post-test saw higher than average scores resulting in an impressive 80.13% improvement as a group.

Figure 3

Research Data Results for FEMALE Students at Oatley Public School



*Percent increase = [(new value - original value)/original value] * 100*

Future research opportunities

It is important to note that while the improvement in scores was dramatic, there is still a need for students to continue their learning in this area - clearly reflected by the still relatively low overall score of 25.5%.

Further research opportunities exist for qualitative data collection and analysis as this test has been designed to be sat multiple times over a minimum of 10 lesson intervals.

This is supported through findings of this same study conducted and endorsed by the Malaysia Digital Economy Corporation in a 60 week ScopeIT program at a model school. The results after 1 term showed an increase of 35% in the class score and a further 35% improvement on this score after 1 year. Anecdotally, the Principal at this model school reported that her students were showing a renewed interest and approach to their learning in other subjects.

ScopeIT is listed on the National STEM program Index 2016, a guide available to Principals, funded by the Office of the Chief Scientist as part of the STEM Skills Partnerships programme. If you would like further information on ScopeIT's Computational Thinking assessment or require assistance to help implement a robust digital technologies program in your school, please reach out. Whether it's engaging us to deliver face to face lessons, Professional Development or something in between, talk to us; we are here to help.

Get in touch today to find out how we can help you build your school's technology education strategy.

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