School Based Research Project

Final Report

St Philip's Christian College

St Philip's Christian College
The Way
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The Life
For the Whole of Their Life

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The Effect of Project Based Learning on Year 8 students' abilities to improve critical thinking, written and oral communication.

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Executive Summary

This research question "Is Project Based Learning effective in enhancing the development of critical thinking and communication in a manner that leads to growth in academic outcomes for Year 8 students?" is being posed in response to a continued backdrop of the need for pedagogical change within the modern teaching environment. Teachers realise the need for the development of greater transformative skills in students, but have not had the strategies to enable this change and so have invariably, reverted to presenting information so that students can remember knowledge for recall in examinations.

This research has been born out of the recognition that schools need to progress towards embedding capabilities into staff where they are able to foster in students, transformative lifelong skills such as critical thinking, written communication and oral communication.

The direct aims of the research was to measure the effectiveness of Project Based Learning (PBL) in fostering improvements in critical thinking and written and oral communication. Linked to these measurements of skills acquisition, the research also wanted to measure the implications of the effects on student academic grades. In doing so, allowing for an evaluation process of the effects of implementing PBL on student knowledge acquisition.

A quantitative methodology was implemented across two school campuses within the year 8 cohort. Campus 1 comprising of 135 students of 5 classes; mixed gender, mixed ability, all undertaking the PBL pedagogy.

Campus 2 comprising of 75 students of three classes; one class undertaking PBL who were mixed gender, mixed ability. One class being mixed ability and mixed gender and the third class was mixed gender and a graded group based on higher English abilities.

Students were engaged in PBL pedagogies employed in group work to develop end products for co-curricular units for English/ Human Society and Its Environment and for co-curricular units Science/Personal Development Health, over a minimum of 12 weeks. According to the research results students gained positive skill development in their abilities to think critically and to orally communicate. The results were less clear for written communication with students exhibiting no

decline but little statistically significant growth. Academic outcomes for students were positive for one Campus 1 and somewhat unclear for Campus 2.

The results of this study have shown that PBL has had a positive effect on the acquisition of critical thinking, oral communication; and based on observations, have enabled students to have more autonomy over directing their learning. This research information has affirmed the research participant schools to make clearer decisions on future practices; encompassing PBL as an embedded pedagogy for Campus 1 and a future pedagogy for Campus 2.

Introduction/Background

Rationale

The focus of this study is to investigate the effects of project-based learning on the development of critical thinking and communication skills for middle school students in Australia.

Critical thinking and communication skills are key 21st Century skills. They are important process skills that enable students to not only function effectively as a citizen, but are the very enabling skills students need to be able to learn effectively in school.

As a result, in 2013 the new Australian Curriculum and the Board of the Australian Curriculum Development and Reporting Authority (ACARA) have incorporated 21st Century skills, such as Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Intercultural understanding, and Ethical understanding. These are identified as 'general capabilities' which are to be implemented across Key Learning Areas.

The theoretical framework for this study is premised on Dewey (1910)conception of *learning by doing* and the theory of constructivism. The importance of learning content as opposed to skills related to making sense of the world students live in has long been debated. Few would argue against the need for the integration of both content and process skills, however, the relationship is rarely emphasized in schools and often curriculum and approaches to teaching reflects a preference of one over the other (Haefner & Zembal-Saul, 2004). The notion of learning by doing is encapsulated in constructivist theory, which argues learners actively construct their own understanding by reflecting upon their experiences (Vygotsky, 1980). Reflection is a process where individuals attribute a meaning and importance to the what and how they learn. Constructivism would describe learning as a process where a person is engaged in authentic activities, tasks, or problems. These act as a stimulus for activating prior knowledge and clarifying assumptions. When previous knowledge is not enough to make sense of a new experience this can cause dissonance and the motivation to learn new ideas or to reconstruct existing cognitive schema (Derry, 1996). Constructivist theory also asserts learning happens in a social context, where meaning is negotiated

through social processes and learners collectively develop their solutions or response to the stimulus (O'Grady, Yew, Goh, & Schmidt, 2012).

Anecdotal reports from teachers indicate that project-based learning can be a valuable form of *"learning by doing",* because it encourages students to be active, rather than passive, in their learning. It invites students to actively engage in learning content in a deep fashion through the provision and emphasis of both learning skills and content knowledge. However, the quality of student learning from projects is dependent upon how well projects are conceptualized in the curriculum (Gude, 2013). This study reports on a carefully staged and strategic implementation of PBL (over a period of 18 months) that have also been accompanied by longitudinal research that seeks to evaluate and further inform the application and use of PBL to support student learning.

An increased focus in transformative skills has been highlighted by the inclusion of these skills in current NSW Educational Standards Authority National curriculum documents.

Teachers at SPCC are aware of a variety of Teaching and Learning styles, however, there has been a tendency to rely on traditional teacher–directed techniques, particularly to deliver mandated curriculum content. Teachers in the school have begun to question whether traditional teacher–directed techniques are appropriate for students to acquire transformative skills like critical thinking and communication and this has led to the school establishing programs such as The SPCC Learning Framework at Newcastle Campus and utilising the Habits of Mind at Port Stephens Campus, both of which have had mixed results.

The focus of this study has been Stage Four students. Experience from our Network School; Parramatta Marist High School that has implemented PBL across years 9 to 11 and from related literature, have suggested that, transformative skills are attained from long-term strategic interventions. Transformative skills are developed by educational processes reiterated throughout a student's educational journey. By introducing PBL in Stage Four, a foundation will be laid for transformative skills to become embedded and then further developed in subsequent years. Thus,

facilitating the continuation of processes that would reinforce transformative skills over the course of their studies. The experience of Parramatta Marist High School also suggests that the benefit of embedded transformative skills will flow through as the student progresses in their education journey, where they continue to hone and apply these skills to increasingly complex sets of knowledge.

Students in Stage Four, and staff within the study, have been exposed to an immersive curriculum based on PBL. This differs from past practice in that students have been required to address real life problems and, through a process of inquiry, develop authentic and relevant end products. Engagement and assessment around PBL processes can manifest achievement towards syllabus and transformative skills outcomes. The most significant outcome will be that student learning will occur through forming their own understandings rather than relying upon teacher delivery.

Literature Review

Project Based Learning

Educational Researchers (Hendry & Viney, 2012; Wagner, 2014) have suggested that the skills and learning attitudes that are needed by 21st Century Learners (otherwise known as transformative skills) are in contradiction to traditional teaching methods. These skills include: critical thinking, problem solving, collaboration, leading by influence, agility and adaptability, initiative, oral and written communication, accessing and analysing information, curiosity and imagination (Wagner, 2014). Whilst traditional approaches to teaching have yielded results in standardised testing, there is growing criticism from industry and peak professional bodies that secondary and tertiary curricula are "failing to equip graduates with the problem-solving skills required for a life time of learning" (Brodeur, Young, & Blair, 2002, p. 1). Consequently, there is a need for pedagogies that ensure students understand and apply knowledge and not just acquire it in a surface manner (Brodeur et al., 2002). Research suggests PBL is well situated to do this (Barell, 2010; Bell, 2010; Rotherham & Willingham, 2010; Visconti, 2010).

In attempting to meet the changes in skills required by the modern learner, there has been greater emphasis placed on student's abilities to think critically as shown by the inclusion of critical and creative thinking in the (Australian Curriculum Assessment and Reporting Authority, 2013). Higher School Certificate Examinations papers, over the last decade, have moved to a greater emphasis on requiring students to apply their knowledge more critically, rather than just the recall of knowledge.

Australian Curriculum Assessment and Reporting Authority (2013) points out that "students need to negotiate and communicate effectively with others; work in teams; positively contribute to groups and collaboratively make decisions; resolve conflict and reach positive outcomes."

PBL is a pedagogy that is suited to enable students to grow in these areas.

As Masters (2016) highlights, two of the current trends in curriculum is the increasing emphasis on learners' abilities to apply what they learn to real-world situations, as well as an increasing focus on the general skills and attributes required for contemporary life and work. These two trends are influencing all levels of education and training.

Transformative 21st Century Skills

Transformative skills development is broad, The Melbourne Declaration on Educational Goals for Young People (2008) identifies essential skills for twenty-first century learners – in literacy, numeracy, information and communication technology (ICT), thinking, creativity, teamwork and communication. In addressing the ideas of increasing students' abilities in communication.

Wilczynski (2009) states:

> "Powerful speech indeed, communication skills include not only reading, writing, and listening, but also an often and paradoxically neglected part of our language arts — speaking. Paradoxically because speaking is what most of us do most! Notwithstanding the wonders and efficiencies of technological and electronic communication — e-mailing, texting, twittering, etc. — there's nothing more powerful and effective in the hierarchy of human communication than face-to-face verbal communication. Without a sound foundation of oral communication and presentation skills, core 21st Century Skills goals would likely go unrealized."

Oral Communication Skills

Developing effective oral communication skills is foundational for student success.

Within the document from the Australian Curriculum Assessment and Reporting Authority (2013), the Literacy Continuum outlines that in composing texts, students use expressive language, and involves students composing different types of texts for a range of purposes as an integral part of learning in all curriculum areas. These texts include spoken, written, visual and multimodal texts that explore, communicate, and analyse information, ideas, and issues in the learning areas. Many secondary and tertiary educators attest to the need for education to provide students with essential life skills of written and oral communication (Emanuel, 2016). There is a greater expectation that students can confidently present a point of view and orally substantiate their ideas to a deeper level.

When reviewing research on STEM education and Project Based Learning , (Capraro, Capraro, & Morgan, 2013) notes that students in tertiary STEM education are required to work in groups to

solve complex problems situated within larger projects. Students are required to explain their solutions and to be able to justify the suitability of a proposed solution to the specifications of the PBL.

Studies through tertiary education have firmly stated that university graduates require the ability to be able to present their ideas orally; effective oral communication is critical for the advancement and sharing of scientific knowledge. There is increasing recognition within tertiary institutions of the need for Science graduates in particular to develop better presentation skills (Chan, 2011).

Critical Thinking

The Melbourne Declaration on Educational Goals for Young People (2008) recognises that critical and creative thinking are fundamental to students becoming successful learners. Critical Thinking is a skill that (Ennis, 2011) describes as "reasonable reflective thinking focused on deciding what to believe or do. In deciding what to believe or do, one is helped by the employment of a set of critical thinking dispositions and abilities (which is a *conception* of critical thinking)".

The literature on Critical Thinking (CT) acknowledges that although it is a goal of education systems, definitions are still unclear, research is continuing, and educational bodies have made attempts, and not always successful efforts, to incorporate CT into their curricula (Ennis, 1993; Mason, 2007; Noddings, 2010). These studies suggest it is often difficult in a traditional classroom setting to give students time and opportunities to engage in CT as described by Ennis (1993, p. 180) where a person characteristically needs to, interdependently, do the following:

- Judge the credibility of the sources.
- Identify conclusions, reasons, and assumptions.
- Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence.
- Develop and defend a position on an issue.
- Ask appropriate clarifying questions.
- Plan experiments and judge experimental designs.

- Define terms in a way appropriate for the context.
- Be open-minded.
- Try to be well informed.
- Draw conclusions when warranted, but with caution.

Collaboration

There is increasing recognition of the importance of skills and attributes such as collaborating and working in teams, communicating, researching, creating and innovating, and thinking critically, required by high school students (Masters, 2016).

Bell (2010) states that "In the future, children must enter a workforce in which they will be judged on their performance. They will be evaluated not only on their outcomes, but also on their collaborative, negotiating, planning, and organizational skills. By implementing PBL, we are preparing our students to meet the twenty-first century with preparedness and a repertoire of skills they can use successfully."

Written Communication Skills

Written communication is a crucial skill for all aspects of life. It is a primary basis for the transition of coherent ideas in a meaningful way. As per the Australian Curriculum Assessment and Reporting Authority (2013) the complexities of written communication increases, "as subject-based learning proceeds, particularly in the middle and later school years, the texts that students need to understand and produce take on increasingly formal and academic features, employing technical, abstract and specialised 'written-like' language forms, in order to communicate complexities of meaning. These texts include precise, densely packed information and place increasing cognitive demands on the student."

Some Australian schools are turning to PBL as an immersive pedagogy that enables students to grow in transformative skills, whilst maintaining academic rigor.

Project-Based Learning (PBL) has a long tradition in America's public schools, extending back to the 19th century to the work of Francis W. Parker and John Dewey (Capraro et al., 2013). In 1918, Kilpatrick defined 'the project method', which became popular in the progressive era worldwide (Fallik, Eylon, & Rosenfeld, 2008).

Project Based Learning has been defined as: students engaging in complex tasks, based on challenging questions or problems; students are involved in design, problem-solving, decision making, or investigative activities; as giving students the opportunity to work relatively autonomously over extended periods of time; culminate in realistic products or presentations (Bradley-Levine & Mosier, 2014; Jones, Rasmussen, & Moffitt, 1997; Thomas, 1999, 2000b).

Krauss and Boss (2013, p. 5) have suggested the potential of Project Based Learning:

"In project–based learning, students gain important knowledge, skills, and dispositions by investigating open-ended questions to 'make meaning' that they transmit in purposeful ways."

Ashgar, Ellington, Rice, Johnson, and Prime (2012) noted that Project Based Learning points out that "Effective learning is linked to opportunities to "explore, inquire, solve problems, and think critically" as cited in Bradley-Levine and Mosier (2014, p. 1). PBL projects require students to apply the knowledge and skills they learn and these transformative skills are the focus of the curriculum rather than an added supplement given at the end of traditional instruction. The entire PBL process is organized around an open-ended driving question that teachers use to connect content to current and relevant issues or problems. Through this process, students develop their own questions to drive learning; study concepts and information that answer those questions; and apply that knowledge to products they develop. In addition, PBL encourages more rigorous learning because it requires students to take an active role in understanding concepts and content, and it enables them to develop 21st century skills, which foster an enduring curiosity and hunger for

knowledge. Since students are able to apply classroom content to real-life phenomena, PBL also facilitates career exploration, technology use, student engagement, community connections, and content relevancy (Blumenfeld et al., 1991; Bradley-Levine & Mosier, 2014; Buck Institute for Education, 2012).

Attributes of PBL are recognised by teachers. A national survey of public school teachers revealed that they were most likely to use PBL in their classrooms because they believe it teaches abilities beyond academic content, including 21st Century skills as collaboration and presentation techniques (Ravitz, 2008).

In examining the current setting in High schools there has been extensive development of Project Based Learning in America, facilitated by New Tech Network and the Buck Institute of Education (BIE). The New Tech Network (NTN) was founded in Napa, California in 1996, and is made up of approximately 175 schools encompassing 4,400 teachers, 72,000 students in 28 states in the USA. They are now implementing educational change in China and Australia. The Buck Institute of Education (BIE) USA, also provides support in PBL pedagogy. It recently held the PBL World conference at which there were 700 educators, representing a dozen countries and 42 U.S. states.

The extended growth of Project Based Learning within High Schools has led Lee, Blackwell, Drake, and Moran (2014) to state that "the term PBL is commonly used in education reform circles" there are multiple middle and high schools associated with the New Tech Network (NTN) that have built curricula around PBL. Many secondary schools are implementing "PBL as an instructional model, which means that more and more students are entering college with PBL experience."

There are nine schools in Australia that are partnering with NTN to implement a Project Based Learning model. However, to date, there is very little empirical evidence published about the viability and efficacy of PBL in Australian high schools.

(Thomas, 2000a) draws on two studies (Jones et al., 1997; Thomas, 1999) to define Project Based Learning as:

Complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations (Bradley-Levine & Mosier, 2014).

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"Effective learning is linked to opportunities to "explore, inquire, solve problems, and think critically" (Bradley-Levine & Mosier, 2014, p. 1).

In the past, the project method of learning waxed and waned in popularity with educators and came under heavy scrutiny during the 1950s. Driven by the needs of Science and Mathematics it had a brief resurgence in the 1960s; however, it waned again due to a poor understanding of its purpose and its delivery.

A common understanding of the term PBL seems to be inherently and historically confusing which has led to many teachers assuming that they incorporate PBL in their practices when in reality this is often not the case.

Capraro et al. (2013, p. 13) states that

"Lacking a clear definition, educational leaders and teachers often used their 'definitions' [of PBL] to justify classroom activities driven solely by student interest, regardless of the educational value of the activity."

The poorly defined processes of early PBL is strongly spelled out "According to Dewey, the method of surrounding the pupil with materials but not suggesting an end result or a plan and simply letting pupils respond according to whim, was ridiculous" (Capraro et al., 2013; Tanner & Tanner, 1980, p. 185).

The resurgence in PBL within the last decade (BIE, PBL introductory workshops up until 2015, have now been experienced by over 50,000 teachers) has seen the development of PBL pedagogical

models, defining structures for teacher planning and delivery. Greater definition of phases of learning and structures supplied by these current models have given teachers the confidence to plan and deliver academically rigorous learning that can be student centred whilst improving student transformative skills. Augmented by improved research into learning and the development of well-defined models has led to growth in PBL. The growth rate has been such that Larmer and Mergendoller (2015) states:

"With PBL's growing popularity, we worried that if too many teachers and schools jumped on the PBL band wagon without clear guidance and adequate preparation, problems will crop up. PBL could become another fad on the trash heap of failed efforts to transform education."

To counteract poor understanding and implementation of PBL, models are evolving and improving. Models of PBL pedagogy, developed by the Buck Institute for Education (BIE) known as the New Model for the Gold Standard PBL (see appendix 2) and New Tech Network(NTN) (see appendix 1) share commonalities in their requirements; BIE has created two models to support PBL; Essential Project Design Elements, and Project Based Teaching Practices.

Whilst the BIE Model of Essential Project Design Elements have 1. public product, 2. challenging problem or question, 3. sustained inquiry, 4. authenticity, 5. student voice and choice, 6. reflection 7. critique and revision. NTN's model of Project development uses a similar framework.

Commonalities between models extend into teaching practices such as trust in their students, allowing for a degree of student voice and choice, aligning the project so that it meets curricula knowledge and skills requirements, a promotion of student's agency(independence), inquiry and curiosity, manage learning activities with students, independently find resources and create products that extend beyond the classroom.

The significant difference between these models is that NTN offers a learning management system known as Echo which enables the scaffolding and accessing of time strategic learning activities for students. As well NTN uses a model of school implementation for PBL that is supported by school development coaching, which supports school leadership in the implementation of change. The implementation of the NTN PBL model is differentiated for each school as part of their coaching support.

The NTN model is being utilised by 9 PBL schools within Australia, and as mentioned previously is being used to develop PBL units by 4,400 teaching staff in the USA alone.

BIE has played a role over the past two decades aiming to build an authentic and rigorous process for PBL pedagogy. Producing in 2010 "7 Essentials for Project Based Learning" which has been subsequently updated. BIE's extensive and detailed collaboration with their stakeholders continues to maintain their central position. In having said this Larmer, Mergendoller, and Boss (2015, p. x) states that "it's time to step it up a notch with a more comprehensive, research-based model for PBL" .

As previously mentioned NTN offers an online LMS known as Echo which enables the scaffolding of learning materials using "the project brief cases" for the use of strategic resources for PBL units by staff and students. This project brief case uses strategic concepts of; a project launches the purpose of which is to gain student investment into their learning, followed by activities of content knowledge building, content application and production of an end product. Central to this process is collaboration and student reflection. The creation of an end product aims to instil a relevance to student learning beyond the classroom. Each stage of a continuum seeks to foster the achievement of significant learning with formative assessment tasks known as Benchmarks which assist students towards the completion of important curriculum outcomes. Benchmarks are designed so that they will be utilised by the student to build knowledge and skills to produce their real-world end product. The process of understanding the planning and delivery of PBL units is very complex and is embedded in an overarching philosophy which relies on clear PBL models.
Other PBL models have been developed by the Illinois Mathematics and Science Academy, the Instructional Sequence in Project-Based Instruction (Mifflen) and the Onondaga-Cortland-Madison Board of Cooperative Educational Services New York.

Each of these models draws upon common principles of engaging students by requiring them to learn by doing and being reflective about the processes they engage in. The students value the

process and skills they learn by engaging in PBL because these are the means by which students acquire knowledge.

Studies of PBL and Critical Thinking in High Schools

A study of fifth grade Science found that PBL was "appropriately efficient and effective" in science learning achievement, science process skills, and analytical thinking for all students (Bradley-Levine & Mosier, 2014; Panasan & Nuangchalerm, 2010, p. 252).

Studies have revealed that PBL has a positive effect on the development of higher-order thinking skills in specific groups of students. In particular, students with average to low verbal ability and students with little previous content knowledge learned more in PBL-taught classes than in traditionally-taught classes (Mergendoller, Maxwell, & Bellisimo, 2006). Another study demonstrated that PBL positively impacts low-ability students, who increased their use of such critical-thinking skills as synthesizing, evaluating, predicting, and reflecting by 446% as a result of being immersed in PBL-taught classrooms (Horan, Lavaroni, & Beldon, 1996). High-ability students increased their use of those skills as well by 76% Bradley-Levine and Mosier (2014); (Horan et al., 1996).

An experimental study of seventy six teachers who utilized PBL in their classrooms revealed that, compared to the control group of students in traditional classes, their students scored higher on standardized exams, as well as ability tests that measured problem- solving skills and content application to real-world problems Bradley-Levine and Mosier (2014); (Finkelstein, Hanson, Huang, Hirschman, & Huang, 2010). Some sceptics of PBL have suggested that although skills development maybe a strong attribute of the PBL process , the gaining of knowledge may suffer due to the emphasis on skills development (Dods, 1997; Van den Bossche, Gijbels, & Dochy, 2000). There have been many studies to show that this may not be the case, as this is a crucial criticism of the PBL process, there are in depth descriptions, following, of research results completed in schools.

Hernández-Ramos and De La Paz (2009) also examined technology and PBL in the Middle School setting, comparing the outcomes of students who participated in a technology-assisted PBL experience to those who received more traditional instruction during a six-week History unit. From an analysis of teacher- created assessments, the researchers determined that students in the PBL-taught class, who learned the material by working in groups, creating multimedia projects, and listening to other groups' projects, learned more than students who received traditional instruction. The researchers also found that students from the PBL classroom performed better on state- administered assessments as cited in Bradley-Levine and Mosier (2014).

Further study by found that "their pilot study's results indicated that PBL has promise in the elementary school classroom. The significant growth in the experimental group's content knowledge and the comparable content test scores in the comparison and experimental groups four months after the teaching of the unit suggest that content knowledge may not be compromised when using PBL".

Drake and Long (2009) also cited that a study of 10th-grade Earth Science students corroborated that PBL instruction improved their knowledge of the material as measured on an achievement test as compared to their peers in more traditional classes Chun-Yen (2001).

A longitudinal study of Mathematics instruction in secondary education compared the effectiveness of PBL versus traditional teaching and found that more pupils at the project-based school passed the national examination than traditional school pupils (Boaler, 1998; Kaldi, Filippatou, & Govaris, 2011).

In measuring basic academic subject proficiency, standardized testing shows that students engaged in PBL outscore their traditionally educated peers (Geier et al., 2008, p. 922).

In one British study, over the course of three years, students were taught using traditional Maths programs at one school and PBL at another school. Three times as many PBL students achieved the highest possible grade on the national exam than the students taught at a traditional school. Students at the PBL school were equally able to answer procedural questions that used formulas,

but they were superior in answering applied and conceptual problems (Boaler, 1999). This researcher concluded that students acquired a different kind of knowledge from using a PBL approach cited by Bell (2010).

At an inner city, racially diverse school in Boston that implemented a PBL program called Expeditionary Learning, eighth graders exhibited the second highest scores in the district on the Stanford 9 Open Ended Reading Assessment (Thomas, 2000a, 2000b). Similar findings in Maine concluded that a middle school using a PBL approach showed significant increases in all achievement areas on the Maine Educational Assessment Battery after only one year using the approach. The gains made by this school were three to ten times higher than the state average (Bell, 2010; Thomas, 2000a, 2000b). Authentic projects require different measures of success; however, in PBL, students solve real-world problems. For example, in one study, students were asked to apply the concepts of Geometry to Architecture and submit designs for a new playhouse for a community centre. Upon evaluating these designs, 84 % of the submissions were judged to be accurate enough to build. This is an impressive measure of achievement. Moreover, students were able to revise their designs after consulting resources, which demonstrates a high level of motivation that is uncommon in traditional learning settings. Furthermore, these students demonstrated a solid grasp of the concepts and were able to perform well on traditional tests (Bell, 2010; Thomas, 2000a, 2000b).

A study of Year 8 Middle School Mathematics students in Turkey carried out by Koparan and Güven (2014) states that Post-test findings showed that the experimental group performed better than the control group. In other words, the students who were educated by PBL had more positive attitudes towards statistics than those who were educated by instruction based on student textbooks.

In reviewing the studies above, it would seem that the acquisition of knowledge through PBL pedagogy remains strong, and can be used to support statements such as PBL has several positive effects on student content knowledge, students immersed in PBL taught classrooms emerge with more useful, real-world content knowledge that can be applied to a variety of tasks (Boaler, 1997).

To summarize these extensive studies Larmer et al. (2015, p. 55) compares the impact of PBL and Traditional Instruction K-12 Classrooms in dozens of studies involving thousands of students. They state:

“there is no evidence in K-12 studies that PBL students score lower on assessments than traditionally taught students.”

Measuring the Efficacy of Transformative Skills and PBL

Approaches to measuring students development in transformative skills over time can be challenging Amrein-Beardsley (2008); however, it is possible to measure learning gains Bereiter (1963); (Lord, 1956) by comparing the magnitude of a change in performance from pre- to post treatment as suggested by (Pentecost & Barbera, 2013). In deciding how to measure these skills pre and post PBL led the authors to reviewing measuring tools for CT in middle school students. It became clear that there are several extensive tests that individual students can take; however, they are costly.

The NTN have developed rubrics that are used to assess students’ abilities in Critical Thinking and Oral and Written Communication (see appendix 4).

The NTN learning protocols have addressed the need for rigorous skill building in an assessment of written communication by implementing as part of the formative and summative assessment, tasks known as “Individual Assessment of Knowledge and Thinking” (known as IAKTs). This system has a stepped approach in students continually building a piece of written communication throughout a project which is supported by teacher feedback. Individual Assessments of Knowledge and Thinking (IAKTs) are robust information synthesis and writing tasks that require students to use their knowledge and literacy skills (Ross, 2017).

Aims and Research Questions

There are four reasons that make this research paper's results compelling to the educational community because they contribute to gaps that exists in the literature:

1. There is very little published work on the Implementation of PBL in a middle school setting within Australia.
2. While there is strong support for PBL there is still limited empirical research that shows any learning gains in CT, written communication, and oral communication particularly whilst also monitoring and comparing these gains to academic grades.
3. The development of tools that can be reliable and valid measures of critical thinking and written and oral communication for an Australian middle school setting.
4. This research is the initial findings of a proposed longitudinal study that will follow the participants (Year 8 students) through to the end of Year 12.

This research will serve as a foundation to promote and ultimately deliver, more comprehensive teaching within SPCC schools and may serve as a model for other schools seeking to reframe their teaching and learning in the context of transformative skills.

Aims:

As a school community, we wanted to explore and evaluate the effects of PBL on students' abilities to acquire transformative skills of critical thinking and communication. In implementing the pedagogy, we also wanted to evaluate the impact of PBL on students' academic outcomes.

- Research questions:

  "Is Project Based Learning effective in enhancing the development of critical thinking and communication in a manner that leads to growth in academic outcomes for Year 8 students?"

Research questions:

- Can PBL affect students' growth in critical thinking?
- Is PBL more effective than direct instruction in increasing the growth of critical thinking?
- Can PBL affect students' abilities to communicate orally?
- Can PBL affect students' growth in written communication?
- Can academic growth be sustained as PBL is implemented?

Methodology

Background Information on the Intervention

This research design was based on action research as we needed to impact our student's ability to acquire a greater level of transformative skills and to evaluate the implementation of the new pedagogical practice. Therefore, we employed an intervention design.

Project Design

St Philip's Christian College has been established since 1982 during this time the school has developed from two teachers and twenty-five students to now having five Campuses educating over 3,100 students employing over 400 teaching staff. "Whole of Life Education" is a large part of the St Philip's Vision. In historical terms, the aims of the College have been to strive to meet the needs of present and future students to become active and positive global citizens. Within this, pastoral care with a strong link to biblical values has been a cornerstone of our development and growth. Striving for innovation and excellent pedagogy remains essential to our vision; however, sustainable practice that produces exceptional academic results, along with lifelong skills development, has proven to be both challenging and problematic.

The St Philip's Christian College Organisation comprises of five campuses.

All year 8 2016, 135 students, from Campus 1, participated in the study.

From Campus 2 ,76 Year 8 2016 students participated in the study.

There were two major processes that were involved in this intervention design;

1. Implementation of PBL pedagogy
2. Research Process so that the effects of PBL could be measured.

The intervention design was employed in a number of timely stages.

1. Implementation of PBL Pedagogy

Stage 1 – School wide understanding, for the need for Pedagogical Change 2011- 2013

Current readings by the executive team were undertaken. One of the main impacts on Campus 1 was "The Learning Powered School: Pioneering 21st Century Education" (Claxton, Chambers, Powell, & Lucas, 2011; Wagner, 2014).

A school wide approach for our teaching staff to understand the need for our students to increase their transitional skills was employed across both Campuses.

Subsequently Campus 1 initiated "The Learning Framework" which includes Learning Habits and Campus 2 introduced "Habits of the Mind" based on Learning and Leading with Habits of Mind*: 16 Essential Characteristics for Success.* (Costa & Kallick, 2008). Staff across both Campuses undertook to embed learning habits as part of their teaching strategies. Flexible learning spaces were simultaneously developed and initiated at Campus 1.

Campus 1 was also a member of the Manufacturing Education Program employed by DMO (Defence Material Organisation) as part of their initiative, contacts were made with the Research Network partner school staff and our academic mentor, all had extensive experience with both Project and Problem Based Learning.

Stage 2 – Visionary Process for PBL 2014

Facilitation of school wide understanding of PBL

- Observations of best practice models of PBL at our school Network partner's invitation.
- Organisational wide conference with PBL expert as the key note speaker

- School based workshops with our academic mentor

Stage3 - Establishment of Formalised Partnerships (Term 1 2015)

Formal formation of partnerships with:

- Academic mentor Glen O'Grady from the Centre for Higher Education, Learning and Teaching (CHELT) The Australian National University.
- School Network Partner, Parramatta Marist High School for delivery of staff training.
- New Tech Network USA, this Partnership agreement with NTN allowed our staff and students access to their Learning Management System known as Echo. The Director of ICT was trained in the use and integration of Echo (Learning Management System for the delivery of PBL to students).

Stage 4 (Term 2 2015) PBL Pedagogical Model Development

The development of the PBL pedagogical model with support from our academic advisor.

Stage 5 (Term 1, 2, 3, 4 2015) Staff Training

Staff Training; Nine staff from Campus 1 along with four staff from Campus 2 became the PBL School–Based Teaching Team. This team comprised of staff who had express a commitment to the philosophy of PBL as well as gaining skills in PBL. Our Network school partner supplied staff training. Staff were given release time to train and collaboratively develop PBL units for 2016.

Stage 6 - International Observation of Best PBL Practices (2015 and 2016)

Observations of international best practice in PBL through New Tech Network Annual Conference, Chicago 2015.

Participants were Executive Team members who were involved in the implementation of PBL. These observations would be used to gain models of best practice and to develop and refine the measuring instruments required for the School-based Research.

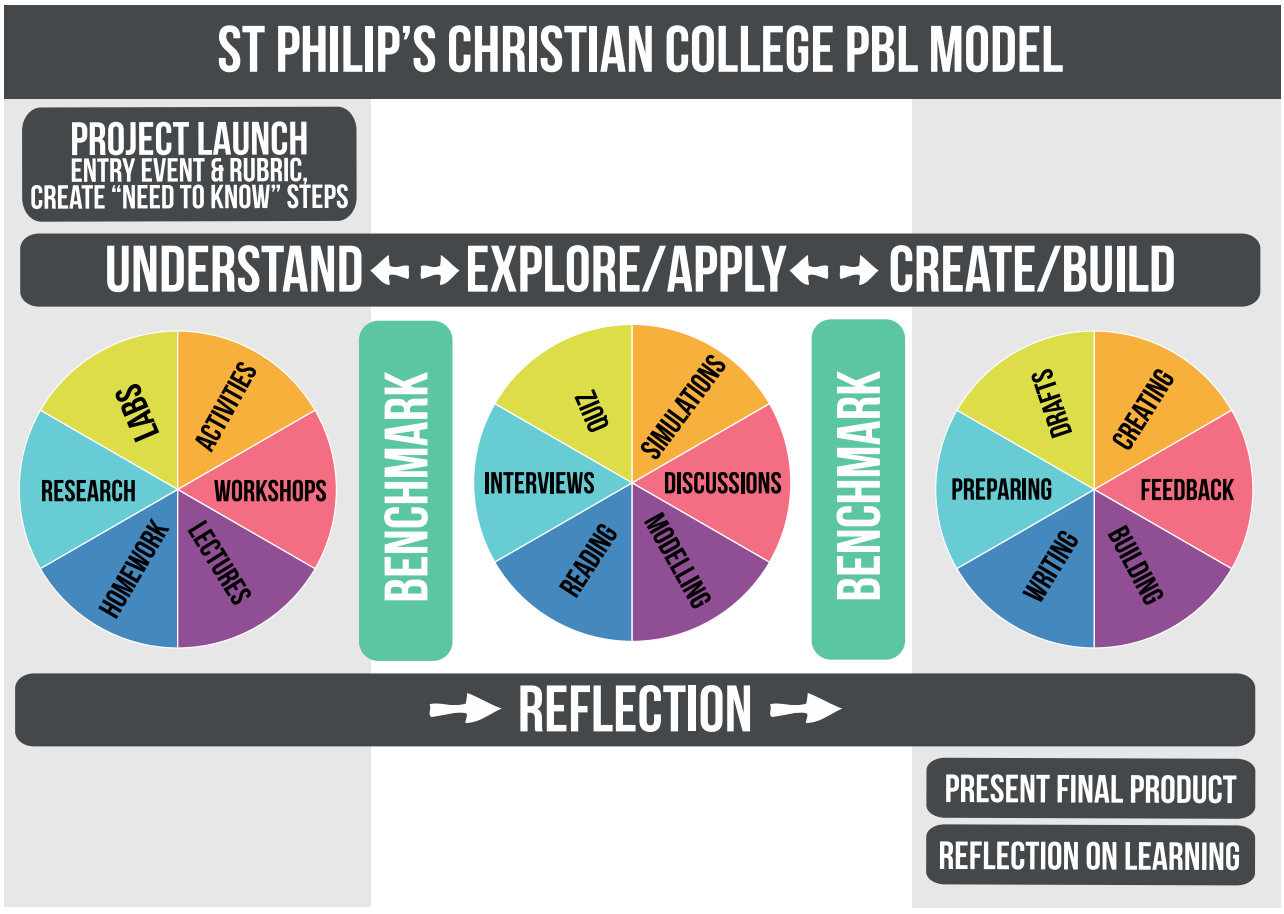
To gain a continuum of enthused and trained staff for 2017. Teachers of PBL in 2016 and future teachers of PBL, participated in The Annual New Tech Network Conference Orlando USA.

Stage 7 – Year 7 experience their inaugural PBL unit (Term 4 2015)

A two week PBL unit was undertaken by Year 7 in November 2015 at Campus 1 and a similar procedure was followed in Campus 2 Students became familiar with the PBL model and terminology. Students were then asked to present, how they learnt about PBL (using PBL pedagogy) to their parents as part of a parent information night.

Stage 8 Year 8 Application of PBL pedagogy (Terms 1 and 2 2016)

At Campus 1, 135 students took part in the study. At Campus 2 there were three classes, two were mixed ability classes and one class was grouped according to the students' strong abilities in English(graded). One of the mixed ability classes at Campus 2 became the PBL group and the other two classes were taught by traditional means and formed the Non PBL group (see full explanation in experimental design).



PBL Model Used

To measure the effects of PBL the school established its own model of the PBL pedagogy, being influenced by NTN, (O'Grady et al., 2012), and BIE pedagogical models.

Warning: although the below model outlines the process of PBL one needs to know that PBL is more than just a method O'Grady et al. (2012).

All students in the PBL groups engaged in their subject disciplines using the model below.

The Phases of the PBL model:

Phase 1 -Project Launched

This comprises of the "Entry Event". The aim of this process is to give students stimulus material which allows them to see why they need to gain knowledge and skills in the unit they will undertake. This allows for increased situational interest, which can increase student motivation and engagement it aims to get "student buy in" into their learning. A driving question is posed and an entry document is released which describes a culminating product (end product) The end product needs to be an authentic task which will allow students to engage in, to deepen their understanding of the knowledge and skills of the discipline. During this process students establish what they already know, what they need to know and their next steps in moving their learning forward.

This phase should have students resolving the following questions "What is the project asking me to do? What do I need to know?, Why is this important? Who will I be sharing my work with?" (Larmer et al., 2015)

Phase 2 Building Knowledge, Understanding and Skills

From student "need to knows" should come a realisation that the students need to gain content and skills to further their abilities in meeting the needs of their end product. PBL facilitators can then support student "need to knows" by running any of, or a combination of the options e.g. workshops, labs, lectures, set home learning, learning activities depending on student needs. These activities are to enhance acquisition of knowledge that is relevant to the end product. Benchmark

1 will be a formative assessment which allows facilitators to understand how to better support student learning. The knowledge gained at each benchmark enhances the end product.

Phase 3 Explore the Curriculum

This comprises of the application of knowledge in the process of exploring the curriculum. Students use their developed knowledge and apply it to learning activities created by the facilitator. Formative assessment is completed to check and support student understanding. Early development and ideas can be put forward and reviewed by peers or staff. Students then decide if they need to revise or learn more before proceeding to Stage 4.

Phase 4 Resolving the End Product

This consists of students forming collaborative groups (these can also be formed earlier if needed) and complete a collaboration contract with their team. These student groups devise answers to the driving question and choose how to produce and deliver the culminating product. The groups should be able to make their work public and present it in a form to an authentic audience. The teacher facilitates an individual reflection on how the students managed their learning process and how successful they have been in producing a quality project that reflects deep knowledge and thinking.

The criteria for implementing PBL units are centred on the Six A's for making the project rigorous and relevant as suggested by Markham (2003, p. 34). The Six A's require that 1) the project presents an authentic, real-world challenge; 2) the project is academically rigorous, demanding breadth and depth; 3) learners apply learning by using high- performance skills such as working in teams, communicating ideas, and organizing and analysing information; 4) learners engage in active exploration by gathering information from various resources; 5) learners interact and make adult connections; and 6) various formal and informal assessment practices are embedded within the unit. As indicated by these six criteria, a PBL curriculum engages learners in studying real, meaningful problems that are important to them while also advancing their creativity and problem-solving abilities, cited by Lee et al. (2014)

Stage 9 Year 8 Choice of Instruments of measure (Through- out 2015)

Choice and establishment of Instruments of measure

Inherently, measuring the effectiveness of PBL is challenging, given the wide range of variables under which a school operates.

The methodology of the study was to test the effectiveness of PBL by measuring students' capabilities and proficiency in transformative skills pre and post the implementation of PBL. To help determine whether any reported learning gains could be attributed to PBL a control group was also established.

A decision was made to utilise NTN rubrics which were subsequently adapted for Australian learners. The rubrics are accessible, rigorous and could be easily used by teaching staff to model and outline criteria for improved CT for students. New Tech Network developed rubrics to measure the different levels of proficiency for, communication and critical thinking. The NTN rubrics were used in this research study to measure critical thinking, oral and written communication. The rubrics were chosen as they are: rigorous, having been developed with support from Stanford Centre for Assessment, Learning and Equality (Stanford University). They were age appropriate being developed for Year 8 students, user friendly and easy to understand. They have no PBL language, which meant that they could be administered to non PBL groups. As well they have the ability to impactful on long term teaching practices post the research project, as they are easily available.

NTN Explains the Development of Knowledge and Thinking Rubrics

NTN has developed Knowledge and Thinking rubrics for each of the core content areas (English, Maths, Science, and Social Studies) and the rubrics are intended to describe college and career level disciplinary thinking in each of the core areas. The following explanation of how the rubrics were originally development was completed in consultation with Schrader (personal communication, May 1, 2016) from NTN.

These rubrics were developed in conjunction with the Stanford Centre for Assessment Learning and Equity (SCALE) and have their origin in similar rubrics SCALE co-developed with Envision Schools. Envision's rubrics are organized around various types of critical thinking: Research, Analysis, Inquiry and Creative Expression (Stanford Center for Assessment Learning and Equity, 2014). NTN modified this approach by making the rubrics disciplinary in focus. The decision was made as a way to recognize how critical thinking is different in different disciplines, as well as making an easier fit into the NTN existing model. In addition to reorganizing ideas in disciplinary terms, NTN cross walked the rubrics against the US Common Core State Standards to ensure that the performance levels always met or exceeded national guidelines. We also leaned heavily on the work of Linda Darling Hammond (Darling-Hammond & Adamson, 2014) in terms of considering the rubric progressions to be trajectories for skill development.

NTN's actual process for rubric creation involved piloting the Envision rubrics with a set of teacher designers, and then internally rewriting the rubrics based on teacher feedback and our NTN design goals. The rubric drafts went through multiple rounds of feedback and revision with SCALE content specialists before being shared with network teachers for feedback and suggestions. A final step involved shared scoring of sample student work with the rubrics alongside SCALE specialists to finalize language and begin working on anchor papers.

Within the above rubric there were 4 measurements of Knowledge and thinking outcomes; emerging, developing, proficient and advanced.

Written Communication

The NTN Written Communication Rubric has a diverse background. Many of the ideas were drawn from the Envision rubrics described above and placed under the Written Communication rubric to reflect NTN's approach to grading outcomes distinctly from one another. We also included language and ideas from experience with school designed rubrics for written communication. We cross walked the language that emerged from those sources with the US Common Core State

Standards for alignment and appropriate rigour before field testing with school representatives and then releasing network wide via Echo.

Oral Communication Rubric

The Oral Communication Rubric was designed by NTN specialists with experience designing and reviewing similar rubrics with schools. Organisationally, NTN had been supporting schools in developing rubrics for Oral Communication and Collaboration for more than a decade. The oral communication rubric language drew heavily on the Presentation of Knowledge and Ideas section of the US Common Core Standards for Speaking and Listening (National Governors Association, 2016) and was supplemented by our previous experience with school-designed rubrics for professional presentation and communication. After rounds of internal design and feedback, NTN shared the rubrics with representatives from schools for feedback and trial usage before rolling them out to the full NTN network Schrader (personal communication, May 1, 2016) from NTN.

Adaptation of the NTN Rubrics to fit an Australian Context.

The SPCC school research group, further adapted the knowledge and thinking rubric to an Australian context. This was done by sourcing the language and ideals behind the explanation of Critical thinking given in (Australian Curriculum Assessment and Reporting Authority, 2013).

The rubrics were also trailed with nine Year 8 teachers and the Faculty Head of English to assess their suitability in an Australian setting.

The following changes were made; NTN rubric used four terms as student outcomes measurement of knowledge and thinking outcomes; emerging, developing, proficient and advanced.

The Australian Adaptation included the following outcome levels; previous stage, working towards, at stage, high (new outcome level), exceeding. The adapted rubrics were tested for language and their application to student work samples. Ten staff applied the rubrics over ten work samples checking for the language use and the reliability of applying the adapted measuring tool. The Faculty Head of English and our academic mentor further ratified their use by applying the rubrics successfully to approximately forty random student work samples.

The above was repeated to adapt the NTN written communication rubric to an Australian setting.

2. Research Process so that the effects of PBL could be measured.

Methods and Data Collection Approaches

Experimental Design

A total of 211 students participated in the study, 135 from Campus 1 and 76 from Campus 2.

All 135 students from Campus 1 were immersed in PBL in Semester 1 2016 (5 classes) and are known through this study as Campus 1 PBL group.

Campus 2 research group was made up of three classes;

- 1 class of 24 students known as Campus 2 PBL group. This class was composed of students with mixed academic abilities in English. This class was immersed in PBL pedagogy as outlined in the model above.
- The other two classes (each class consisted of 26 students) were known as Campus 2 Non PBL group. Within Campus 2 Non PBL group there was one class consisted of students with mixed academic abilities in English.

  The other class within Campus 2 Non PBL group were a graded class based on their strong abilities in English. Both of these classes were taught using traditional classroom pedagogies and were known as the Non PBL group.

The age range for students when the study was completed in 2016 was between 12 to 14 years of age (BOSTES Stage Four).

Campus 1 PBL group and Campus 2 (PBL group) undertook PBL as co curricula units with 380 minutes/week of English /HSIE combined Key Learning Areas(KLA) and 240 minutes/week of Science/Personal Development KLA. These units were facilitated over Term 1 and 2 of 2016.

This age group was chosen as it represented a low risk stage in a student's academic passage where there were no high stakes examinations looming. Stage Four is also a time where students are developing formative academic and transformative (21st Century Skills) practices.

Co curricula units of work were developed to suit our PBL model. Learning activities within each program were time framed according to project requirements.

To measure critical thinking and written communication, student work samples from all groups within the study were taken in Term 4 2015, this was prior to any implementation of PBL.
The results gained from this data are known as Phase 0 (baseline data). Baseline data obtained in stage 0 (prior to PBL implementation) was used to establish student's abilities in CT, written communication, and oral communication. Baseline (Phase 0) data sets a level from which growth in students' progress could be measured from initially and all subsequent growth is compared with the baseline data.

Students were subsequently retested at a minimum of 6 weeks of PBL immersion and the data gained now are known as Phase 1.
Retesting occurred again at a minimum of 12 weeks of PBL immersion, this data is known as Phase 2. Measurements on CT and written communication were taken from student's written submissions.
To measure oral communication students from Campus 1 were videoed at Phases 0,1 and 2.
Students from Campus 2 were videoed at Phase 2 only.
The timing and purpose of phases can be summarized as

- Phase 0 - Data taken prior to PBL implementation and thus became the data from which growth of CT, written and oral communication could be measured.
- Phase 1 – Data taken after minimum six weeks PBL immersion a measure of growth in CT, written and oral communication
- Phase 2 – Data taken after a minimum of twelve weeks PBL immersion. This measure became the end of this study.

Data analysis was taken in most cases from Phase 0 (Prior to PBL) and subsequently compared with data gained at Phase 2 (minimum of 12 weeks PBL). Phase 1 data was only used to give an indication of trends in results.
As part of the Campus 2 study a control group was used, as some may wonder if the growth from Phase 0 to Phase 2 could be attributed to student maturation only.

To counter this suggestion growth was measured between the control group Non PBL with the PBL group so that comparisons of the same age group, at the same school, could be made.

Participants

The participants in the research were from across two of the St Philip's Christian College Campuses. They will be known as Campus 1 and the Campus 2.

Campus 1 Year 8 Students as of June 2016 (5 classes)

Characteristics	Numbers of students n =135
Male	69
Female	66
Students accessing disability adjustments.	15

Participants

Campus 2 Year 8 Students as of June 2016 (three classes)

Characteristics	Numbers of students n =76
Male	42
Female	34
Students accessing disability adjustments	12

The age range for students when the study was completed in 2016 were between 12 to 14 years of age (BOSTES Stage 4).

The Year 8 cohort (135 students in 5 classes) were chosen in Campus 1, as the Executive Leadership Team, expressed the view, that it is an equity issue, that is, all students should have access to new and innovative pedagogies.

There was one class of Year 8 students chosen in Campus 2 to access PBL, and the other two classes were delivered traditional teaching practices.

Campus 2 Executive Leadership Team, expressed the view, that innovative practices needed to be implemented conservatively. They also wanted to reflect on the results of the research undertaken before committing to a more extensive PBL program.

Recruitment:

Staff were the initial recruits for the PBL program as there was a need for extensive up skilling in PBL practices and pedagogy. Eighteen months prior to the initial launch of PBL to the student body, relevant staff and executive visited and observed PBL in practice at our Network Organisation Parramatta Marist High School. Staff that would be normally teaching Stage 4 were requested to submit expressions of interest in progressing with further training in PBL practices.

Student recruitment occurred through an introduction to PBL as a two-week unit in the year prior to the planned launch of PBL. Students through this two-week unit became familiar with the PBL model and terminology. Students then presented how they learnt about PBL (using PBL pedagogy), to their parents as part of a parent information night. Shortly after this parent information night, an information letter and ethics clearance was sent to parents.

Communication with parents, the broader school communities and other stakeholders was through school newsletters, and parent and student information evenings.

Data collection and management:

The sources of data were: Videos of student presentations, student essays, Student, and Teacher Surveys (Likert scale 5-27with several free response), student outcomes and grades from reports.

A coded number was assigned to the student and to the work sample. This allowed for work samples produced over time to be matched to previous work samples for the same student. This was done so that measurements on the amount of growth that occurred between different phases for each individual could be undertaken.

A Content Management System was set up by our Director of IT Services so that student work samples after de- identification could be uploaded easily from the two different campuses involved. This allowed the lead researcher easy access to student work samples. Excel spreadsheets were

maintained as the source of recorded data. Only people directly involved in the research were given access to the site ensuring confidentiality.

Data validity was ensured by establishing that the development of the rubrics was rigorous. Reliability checks were undertaken by completing pilot marking to make sure that rubrics were being applied consistently to student work. On the completion of a consistent piloting process then check marking every 5th essay was performed. If there was a consistency of agreement, then every 10TH essay was checked to ensure reliability of the application of the measuring instrument.

Data analysis

In the analysis of quantitative data for critical thinking, written communication, and oral communication, we used two kinds of tests: independent two-sample t-test (one- sided) and paired sample t-test.

Results and Findings

Overview of Results and Findings

The below information commences with an explanation of the statistical analysis: how it was performed and what the quantitative data suggests, followed by tabulated and graphical representations of the quantitative results. Each section examined; critical thinking, written communication, and oral communication, and compares these parameters for growth over time and the PBL groups vs control groups. Interpretation of the tabulated and graphical results are at the end of each parameter.

Preamble on Quantitative data

There are statistical terms used in the results tables below. To allow for lay reader understanding, the terms are explained.

PAIRED SAMPLE T-TEST

A paired sample t-test was used when testing if students improve from phase 0 to phase 2 (in matched data set). For each student, the difference between the scores at two phases is calculated. Then we have a sample of differences. The t-test is testing if the differences are significantly greater than zero. If they are, then we could conclude that there is significant improvement.

The greater the T value, the smaller the p-value is. The smaller p-value is, the stronger evidence we have to support the hypothesis. Statisticians usually use p-value = 0.05 as a standard, i.e. we conclude the hypothesis is true if p-value < 0.05. However, if a p-value greater than 0.95 appears, then the opposite of the hypothesis is true.

The smaller the p-value indicates a stronger evidence we have to support the hypothesis.

“In summary, one can conclude that all tests with p-values with asterisks (no matter how many) are 'significant' and that we have 'strong evidence' to make a statement, and the meaning of asterisks are found below the table.” Gao (personal communication, October, 2016)

Campus 1 – (5 classes) total 135 students, all PBL

Campus 2 – (3 classes) total 75 students, one PBL class (mixed ability), two classes non PBL (one mixed ability the other graded on English)

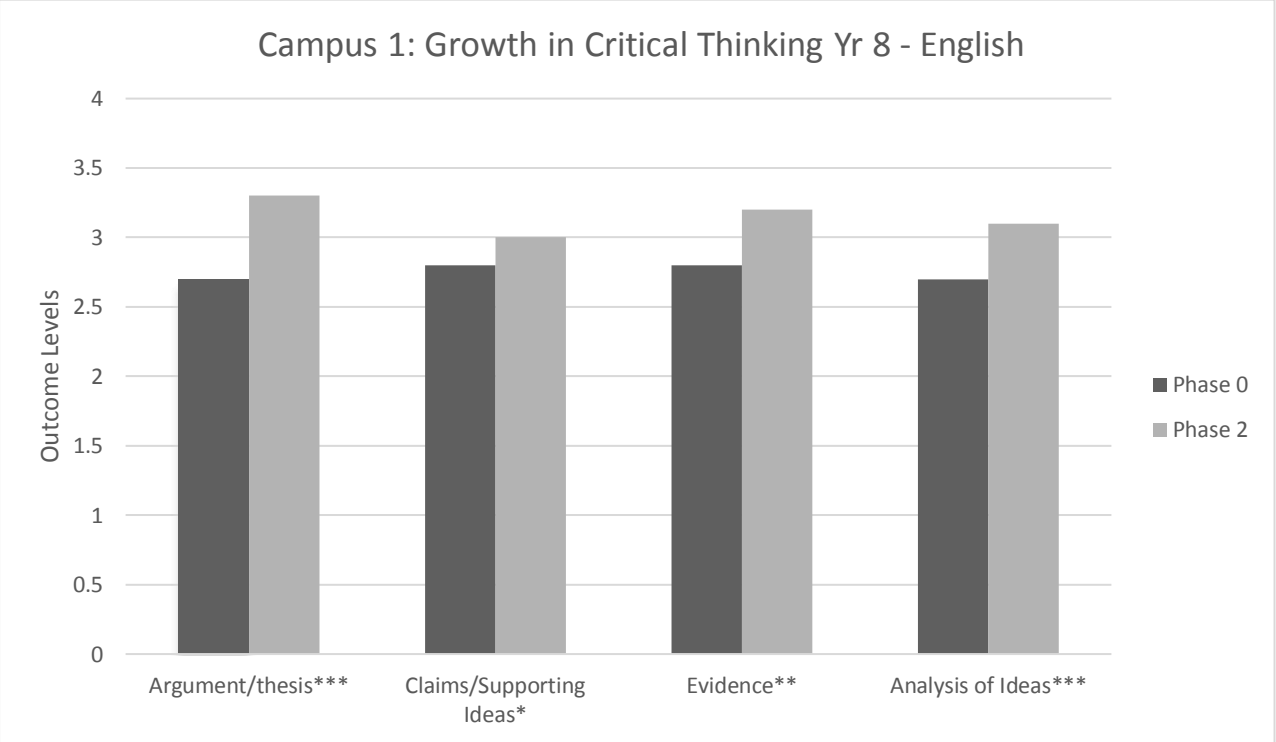
Table 1 Campus 1 - PBL Growth in Critical Thinking

Critical Thinking Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Argument/Thesis	2.74	0.89	3.29	0.98	-6.43 (112) ***
Claims/ Supporting Ideas	2.79	0.77	2.96	1.02	-1.77 (112) *
Evidence	2.81	0.86	3.16	1.00	-3.52 (112) **
Analysis of Ideas	2.70	0.84	3.09	0.92	-4.12 (112) ***

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 1 Campus 1 - PBL Growth in Critical Thinking



The graph and the table reveals highly significant improvements in all four dimensions measured in critical thinking in Campus 1 in the PBL group.

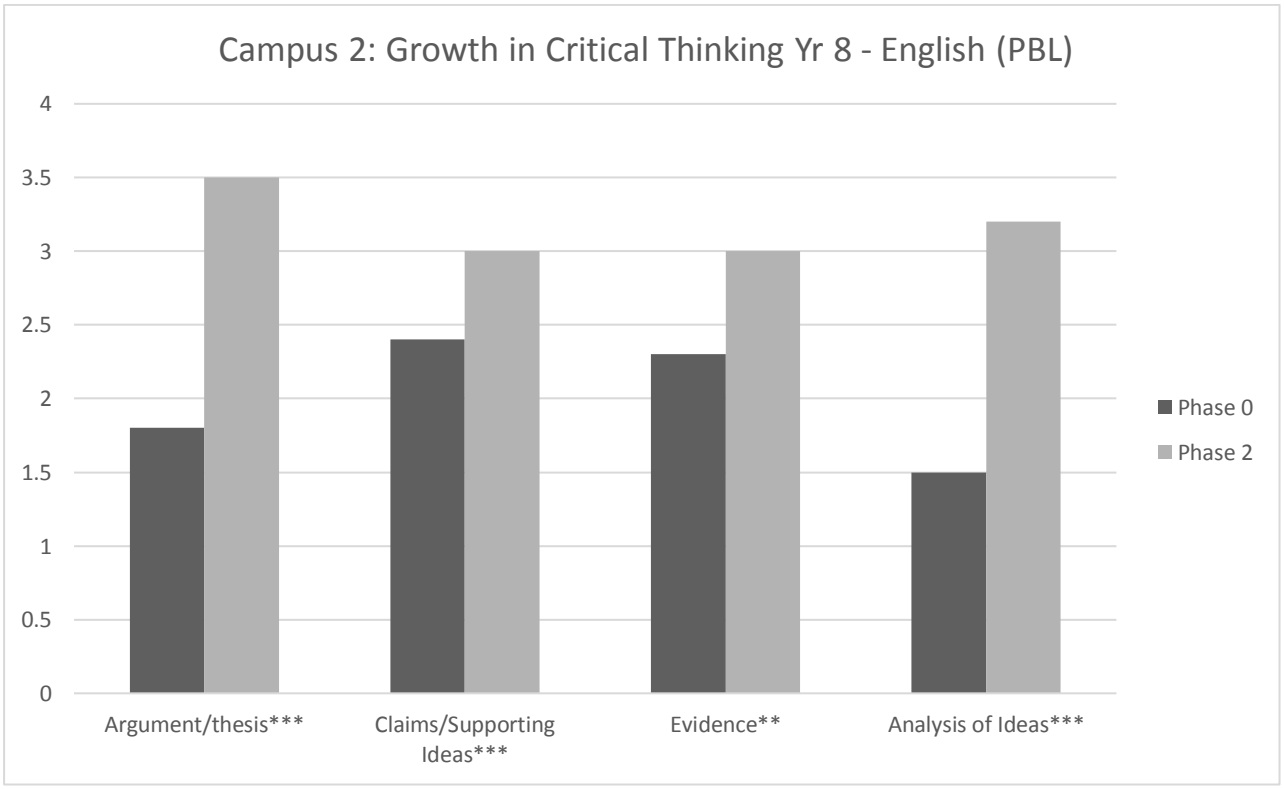
Table 2 Campus 2 - PBL Group Growth in Critical Thinking

Critical Thinking Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Argument/ Thesis	1.77	0.75	3.55	1.06	-8.15 (21) ***
Claims/ Supporting Ideas	2.36	0.73	3.05	1.09	-3.58 (21) ***
Evidence	2.27	0.63	2.95	1.13	-3.38 (21) **
Analysis of Ideas	1.55	0.60	3.23	0.92	-8.83 (21) ***

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 2 Campus 2 - PBL Group Growth in Critical Thinking



The graph and the table reveals highly significant improvements in all four dimensions measured in critical thinking in Campus 2 in the PBL group.

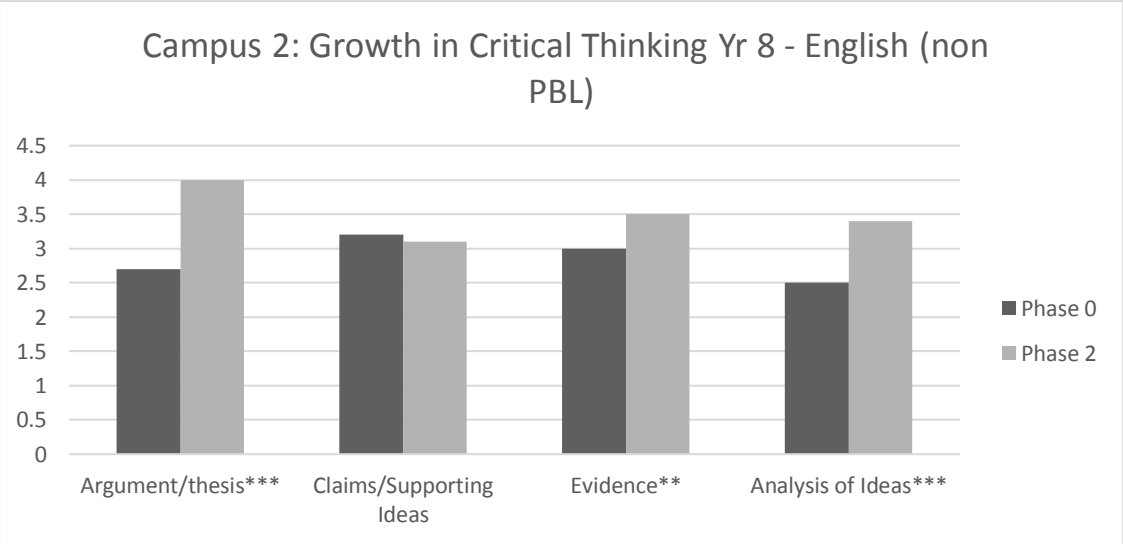
Table 3 Campus 2 - Non PBL Group Growth in Critical Thinking

Critical Thinking Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Argument/ Thesis	2.74	1.54	3.60	1.04	-4.08 (46) ***
Claims/ Supporting Ideas	3.17	0.99	3.15	1.10	0.13 (46)
Evidence	2.96	0.98	3.47	1.08	-2.88 (46) **
Analysis of Ideas	2.47	1.20	3.36	0.97	-6.38 (46) ***

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 3 Campus 2 - Non PBL Group Growth in Critical Thinking



The graph and the table reveals significant improvements in critical thinking in Campus 2 in the Non PBL group in three of the four dimensions measured.

For the below comparison; testing if a group of students scores higher at phase 2 than phase 0. The scores at phase 0 are one sample, and scores at phase 2 are the other sample. Since we did not use matched data, we treated these two samples as two independent samples. Independent sample t-test was used on these two samples.

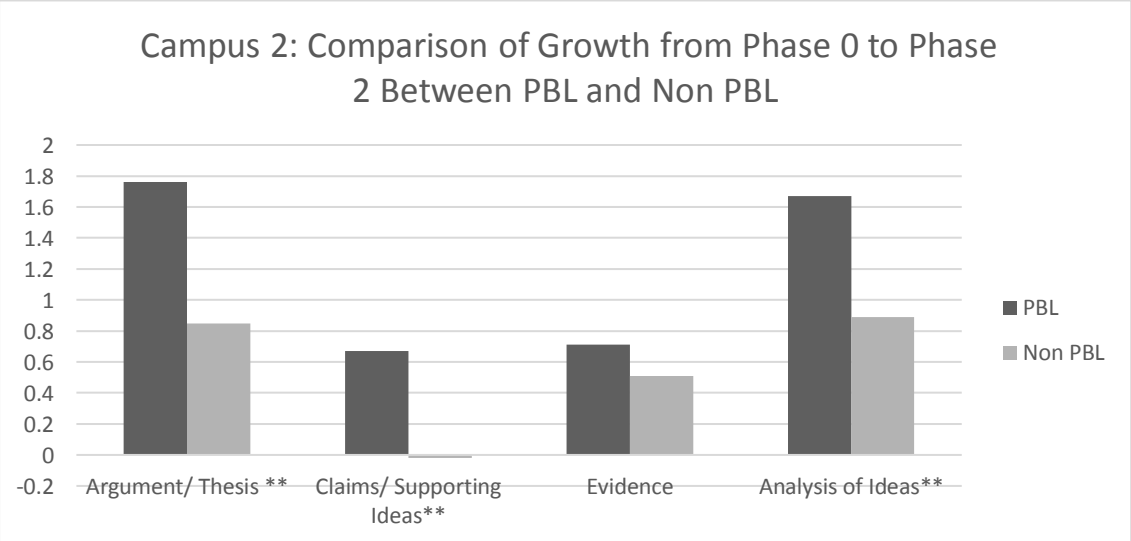
Table 4 Campus 2 - Comparison of Growth from phase 0 to phase 2 in Critical Thinking Between PBL group and Non PBL group

Critical Thinking Dimension	PBL		Non PBL		Independent sample t test
	Mean	SD	Mean	SD	t value (DF)
Argument/ Thesis	1.76	1.04	0.85	1.43	2.95 (51.73) **
Claims/ Supporting Ideas	0.67	0.91	-0.02	1.09	2.70 (45.69) **
Evidence	0.71	0.96	0.51	1.21	0.23 (48.28)
Analysis of Ideas	1.67	0.96	0.89	0.96	3.17 (40.40) **

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 4 Campus 2 - Comparison of Growth from phase 0 to phase 2 in Critical Thinking Between PBL group and Non PBL group



Major finding was that the growth in critical thinking was greater in the PBL group when it was compared with the non PBL group over time at Campus 2.

Summary of Critical Thinking Results

All students within this study have increased their abilities to critically think as indicated throughout the Critical Thinking results; however, Campus 1 results indicate that they have had considerable growth in Critical Thinking.

This can be further substantiated when comparing Campus 2 PBL group's results with Non PBL group results indicating that student growth in critical thinking in all areas except evidence were substantially higher for the PBL group.

Does PBL affect students' growth in critical thinking? These early results indicate a positive impact, students had significant improvements in Critical Thinking.

Results show a change in how students engage in Critical Thinking (CT) from Stage 0 to Stage 2 and these changes are highly significant in that in most instances the difference have a confidence level of 99% or greater.

Written Communication

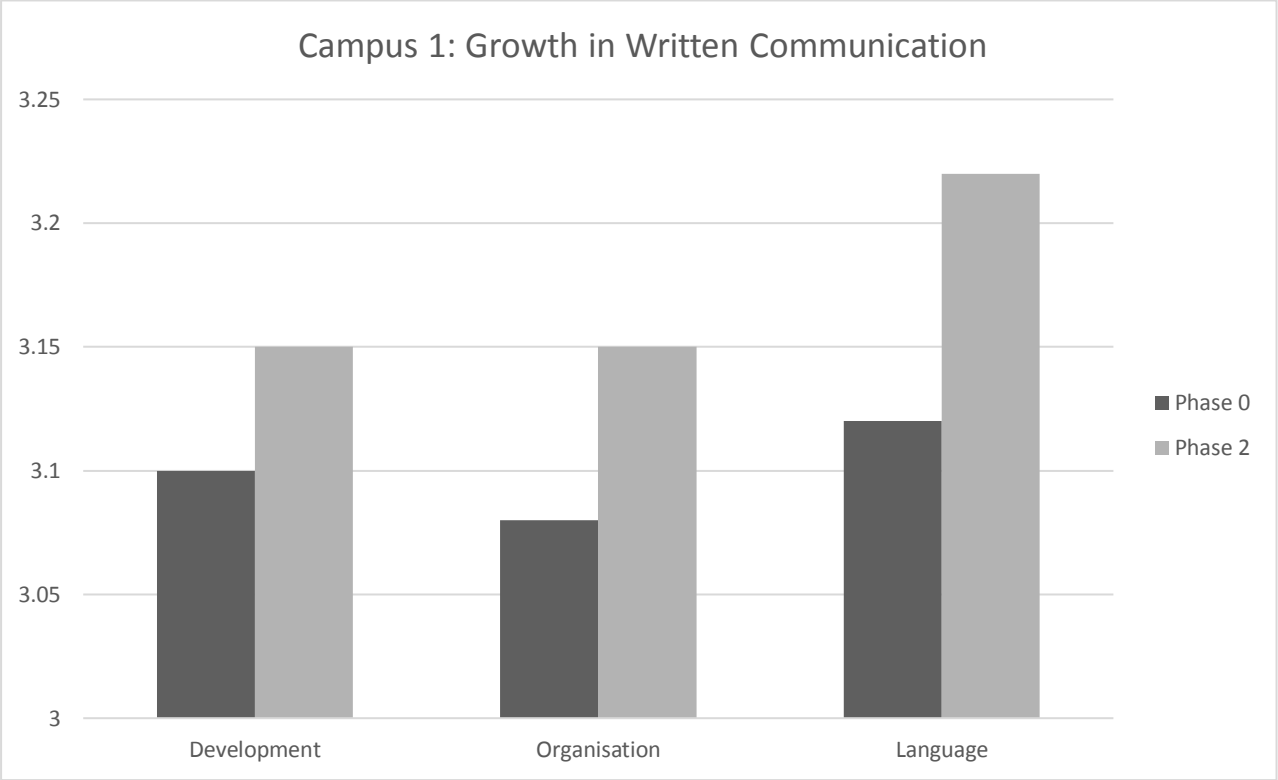
As was used in the tables 1 to 3 above, statistical analysis was of matched student data known as Paired sample t test.

Table 5 Campus 1 - PBL Growth in Written Communication

Written Communication Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Development	3.10	0.94	3.15	1.00	-0.55 (112)
Organisation	3.08	1.02	3.15	0.98	-0.64 (112)
Language	3.12	0.95	3.22	0.95	-1.03 (112)

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*
The figure below is a graphical representation of the table above.

Graph 5 Campus 1 - PBL Growth in Written Communication



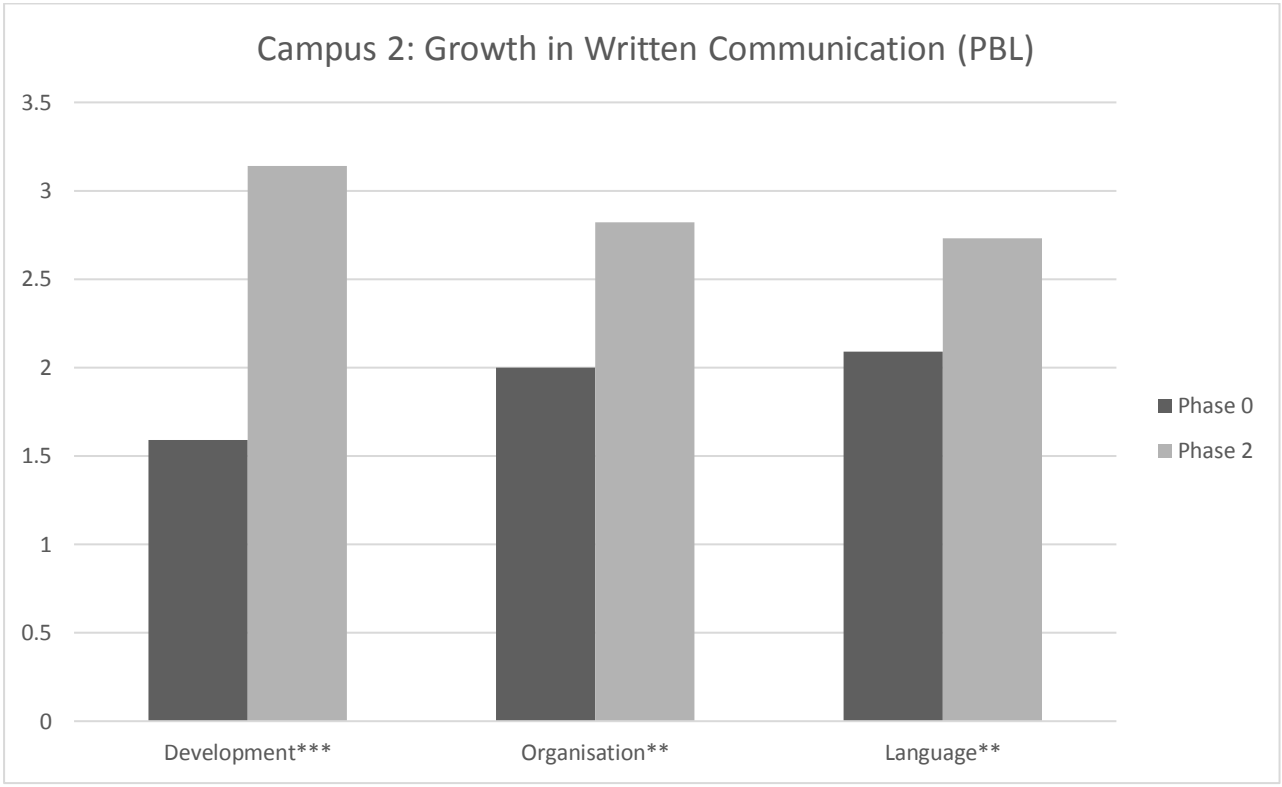
The graph and the table reveals no significant improvements in written communication in Campus 1 in the PBL group in all three dimensions measured.

Table 6 Campus 2 - PBL Growth in Written Communication

Written Communication Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Development	1.59	0.59	3.14	1.13	-6.34 (21) ***
Organisation	2.00	0.62	2.82	1.10	-3.05 (21) **
Language	2.09	0.68	2.73	1.16	-2.98 (21) **

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

Graph 6 Campus 2 - PBL Growth in Written Communication



The graph and the table reveals significant improvements in written communication in Campus 2 in the PBL group in all three dimensions measured.

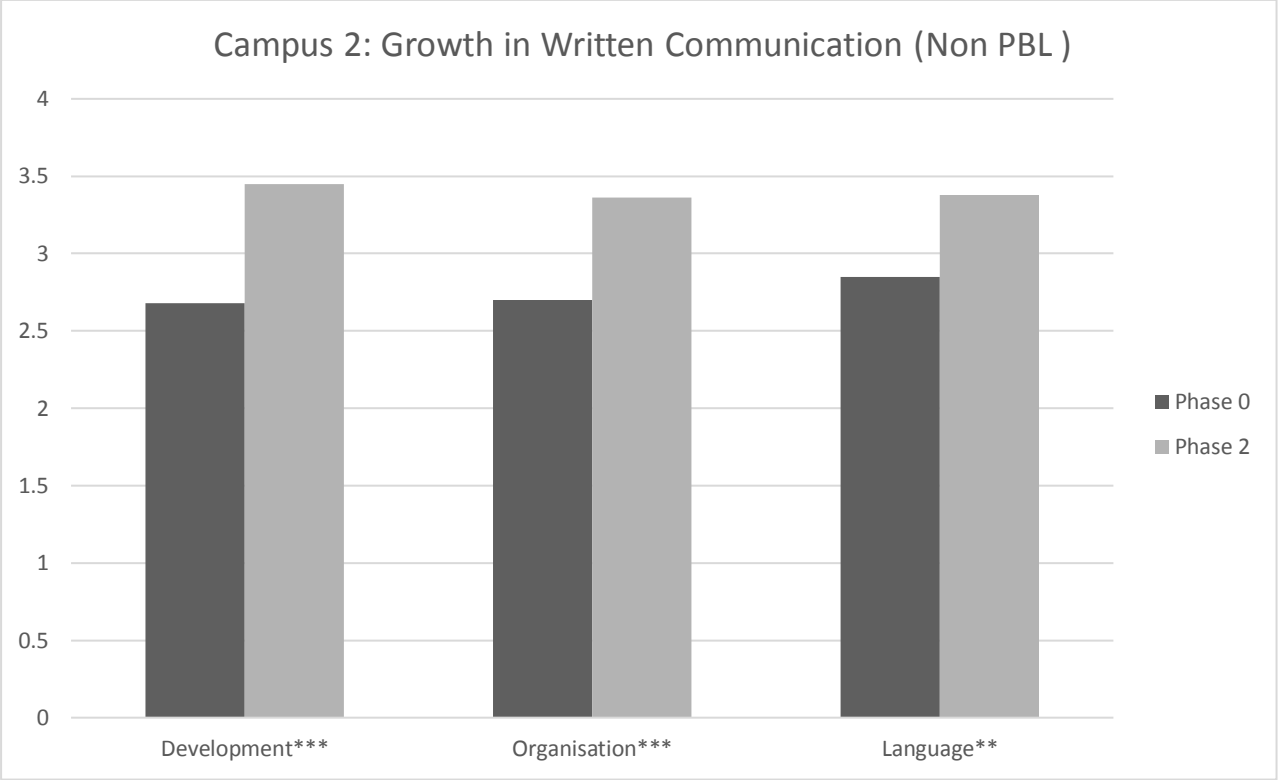
Table 7 Campus 2 - Non PBL Growth in Written Communication

Written Communication Dimension	Phase 0		Phase 2		Paired sample t test
	Mean	SD	Mean	SD	t value (DF)
Development	2.68	1.45	3.45	1.04	-3.75 (46) ***
Organisation	2.70	1.21	3.36	0.97	-3.46 (46) ***
Language	2.85	1.25	3.38	1.03	-2.67 (46) **

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 7 Campus 2 - Non PBL Growth in Written Communication



The graph and the table reveals significant improvements in written communication in Campus 2 in the Non PBL group in all three dimensions measured.

Testing if a group of students scores higher at phase 2 than phase 0. The scores at phase 0 are one sample, and scores at phase 2 are the other sample. Since we did not use matched data, we treated these two samples as two independent samples. Independent sample t-test was used on these two samples.

Table 8 Campus 2- Comparison of Growth in Written Communication Between PBL group and Non PBL group

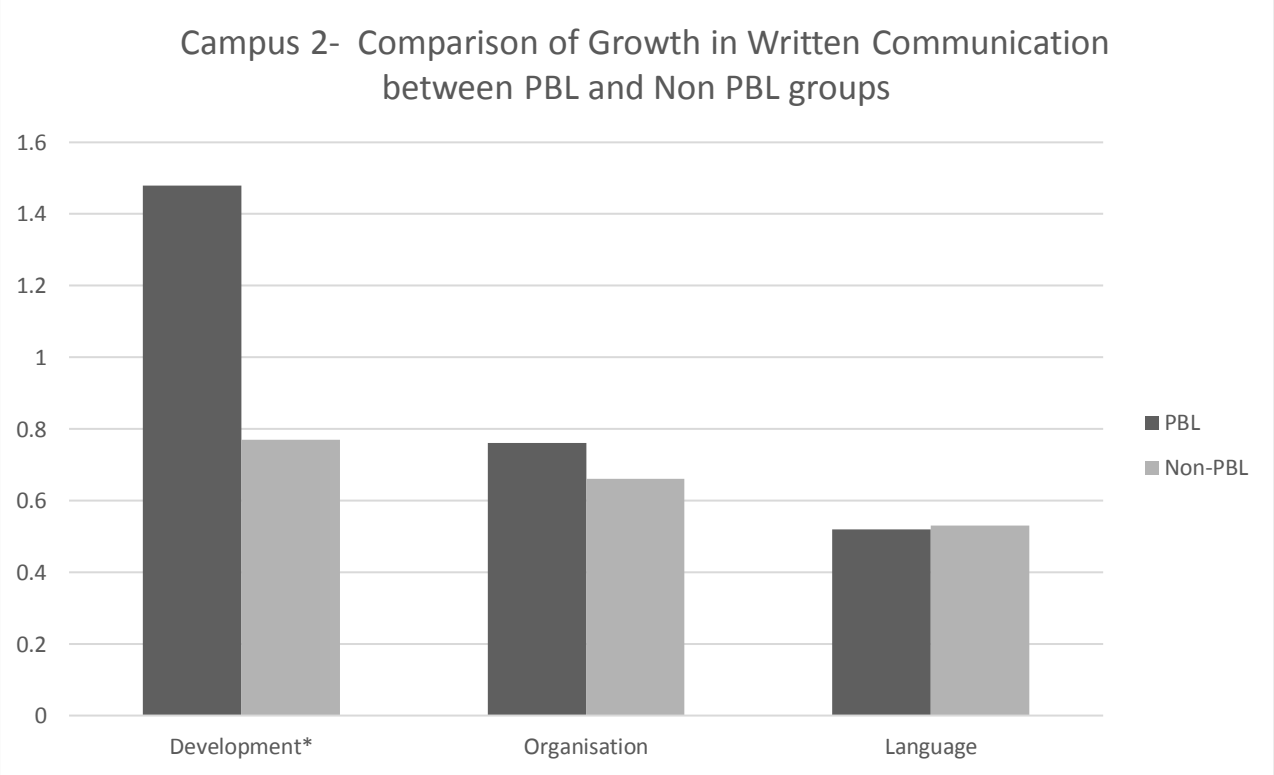
Written Communication Dimension	PBL Group		Non PBL		Independent sample t test
	Mean	SD	Mean	SD	t value (DF)
Development	1.48	1.12	0.77	1.40	2.22 (47.52) *
Organisation	0.76	1.26	0.66	1.31	0.31 (39.81)
Language	0.52	0.87	0.53	1.37	-0.03 (57.65)

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

Note: The mean values are the mean of improvements.

The figure below is a graphical representation of the table above.

Graph 8 Campus 2- Comparison of Growth in Written Communication Between PBL group and Non PBL group



Major finding was that the growth in written communication was significant only in one dimension in the PBL group when it was compared with the non PBL group over time at Campus 2.

Summary of Written Communication Results

Written Communication in Campus 1 students did not indicate significant growth in written communication and yet, there was significant growth in both groups (PBL group and Non PBL group) at Campus 2.

When a comparison was made between Campus 2 PBL group and the Non PBL group there was very little difference between their rate of growth in written communication.

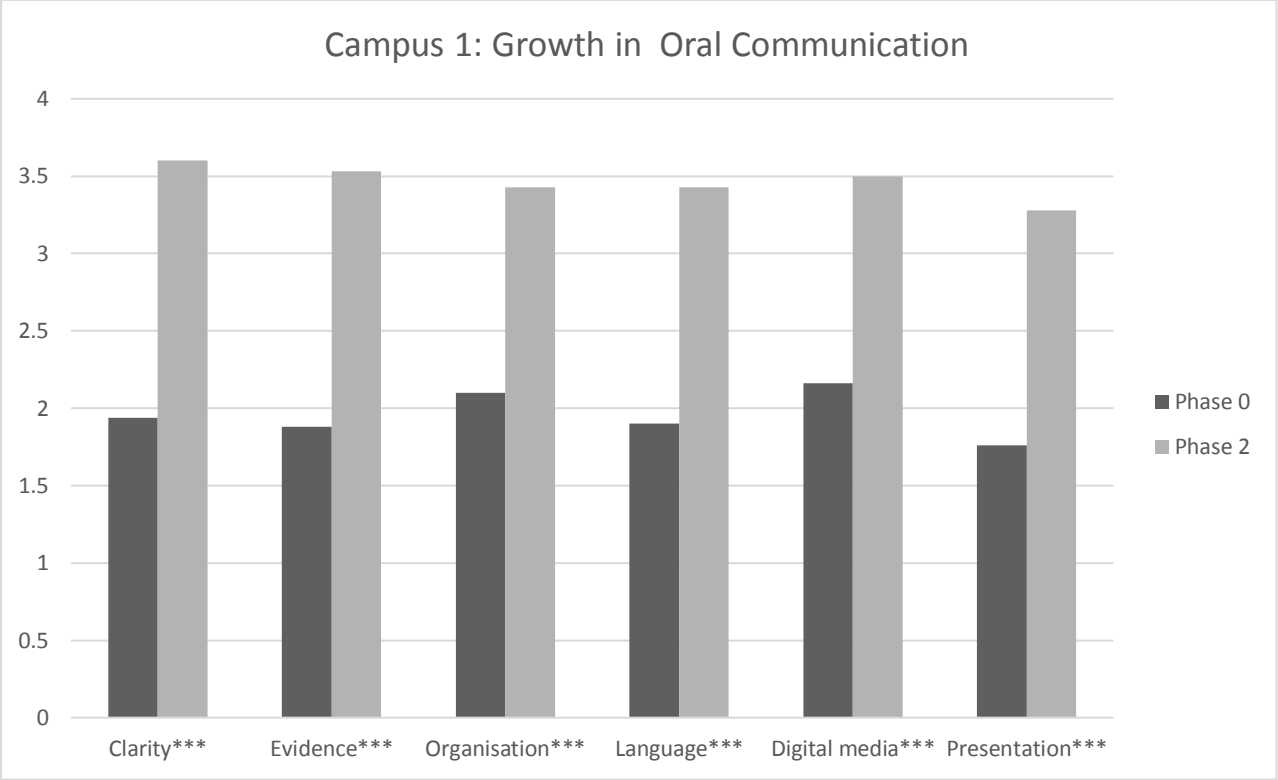
Oral Communication

Table 9 Campus 1 - PBL Growth in Oral Communication

Oral Communication Dimension	Phase 0		Phase 2		Independent sample t test
	Mean	SD	Mean	SD	t value (DF)
Clarity	1.94	0.85	3.60	0.87	-9.04 (82.70) ***
Evidence	1.88	0.81	3.53	1.03	-8.22 (72.65) ***
Organisation	2.10	0.82	3.43	1.06	-6.47 (72.56) ***
Language	1.90	0.80	3.43	0.90	-8.36 (78.58) ***
Digital media	2.16	0.83	3.50	1.20	-5.99 (66.90) ***
Presentation	1.76	0.83	3.28	0.96	-7.89 (77.61) ***

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*
The figure below is a graphical representation of the table above.

Graph 9 Campus 1 - PBL Growth in Oral Communication



The graph and the table reveals highly significant improvements in all six dimensions measured in oral communication in Campus 1 in the PBL group.

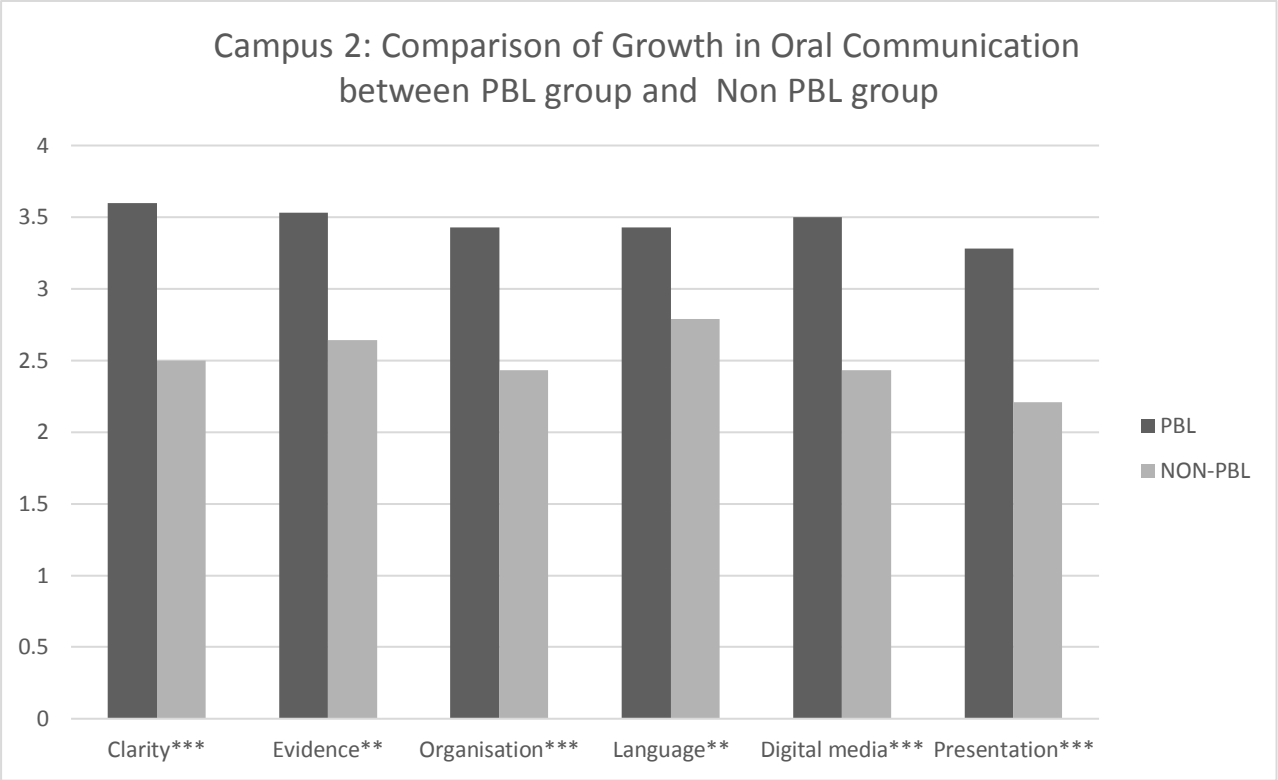
Table 10 Campus 2- Comparison of Growth in Oral Communication between PBL group and Non PBL group

Oral Communication Dimension	PBL		Non PBL		Independent sample t test
	Mean	SD	Mean	SD	t value (DF)
Clarity	3.60	0.87	2.50	0.93	3.60 (20.06) ***
Evidence	3.53	1.04	2.64	0.51	2.96 (25.23) **
Organisation	3.43	1.06	2.43	0.58	4.60 (46.32) ***
Language	3.43	0.90	2.79	0.58	3.03 (35.88) **
Digital media	3.50	1.20	2.43	0.51	4.58 (49.65) ***
Presentation	3.28	0.96	2.21	0.58	4.89 (38.27) ***

SD = standard deviation; DF = degree of freedom
**p<.05, **p<.01, ***p<.001, 1-tailed*

The figure below is a graphical representation of the table above.

Graph 10 Campus 2- Comparison of Growth in Oral Communication between PBL group and Non PBL group



The graph and the table reveals highly significant improvements in all six dimensions measured in oral communication when comparing Campus 2 PBL group vs Non PBL group.

Summary of Oral Communication

There was very strong growth in all oral communication dimensions for Campus 1, the most significant rate of growth was from Phase 0 to Phase 1, with some growth from Phase 1 to Phase 2.

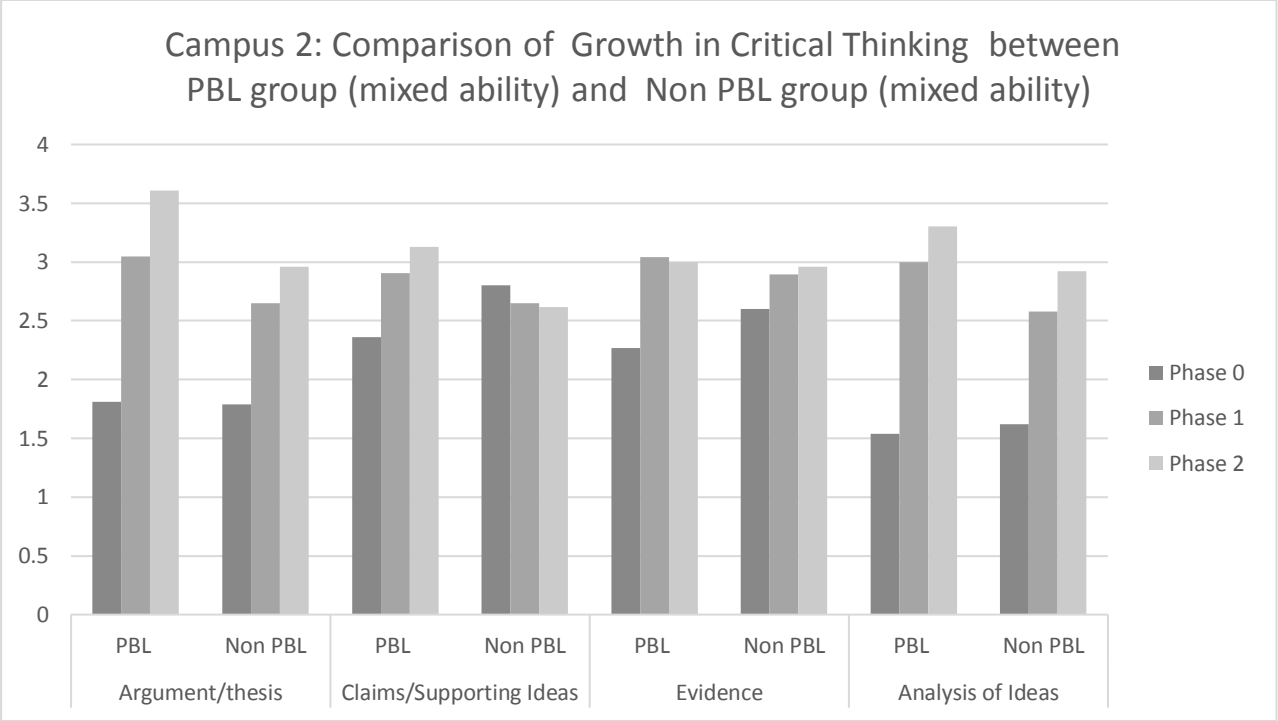
The students at Campus 2 had stronger growth in the PBL group than in the Non PBL group in Oral Communication.

Table 11 Campus 2 Comparison of Growth in Critical Thinking between PBL group (mixed ability) and Non PBL group (mixed ability) (mean values)

Phase	Argument/Thesis		Claims/Supporting Ideas		Evidence		Analysis of Ideas	
	PBL	Non PBL	PBL	Non PBL	PBL	Non PBL	PBL	Non PBL
Phase 0	1.8182	1.7917	2.3636	2.7917	2.2727	2.6250	1.5455	1.6250
Phase 1	3.0476	2.6471	2.9048	2.6471	3.0435	2.8947	3.0000	2.5789
Phase 2	3.6087	2.9615	3.1304	2.6154	3.0000	2.9615	3.3043	2.9231

Graph 11 Campus 2 Comparison of Growth in Critical Thinking between PBL group (mixed ability) and Non PBL group (mixed ability) (mean values)

The figure below is a graphical representation of the table above.



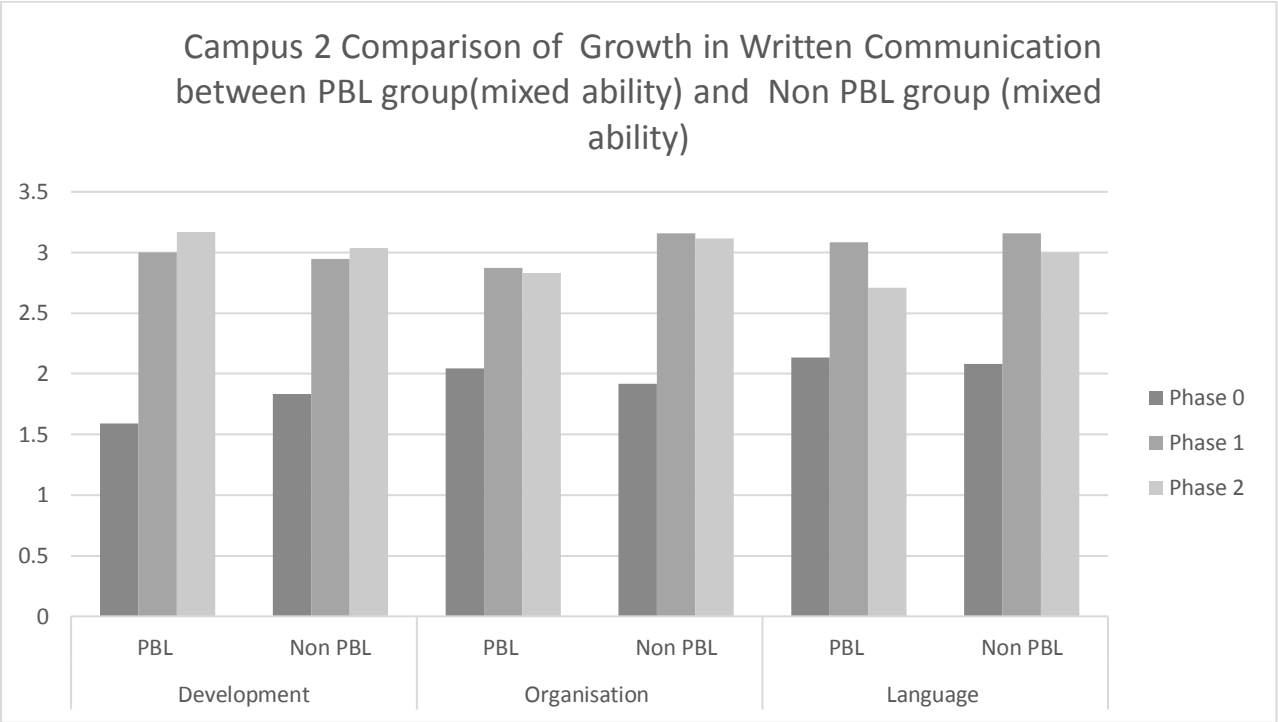
The above findings confirm that PBL had an effect of student's abilities to think critically.

Table 12 Campus 2 Comparison of Growth in Written Communication between PBL group (mixed ability) and Non PBL group (mixed ability) (mean values)

Phase	Development		Organisation		Language	
	PBL Group	Non PBL	PBL Group	Non PBL	PBL Group	Non PBL
Phase 0	1.5909	1.8333	2.0455	1.9167	2.1364	2.0833
Phase 1	3.0000	2.9474	2.8750	3.1579	3.0833	3.1579
Phase 2	3.1667	3.0385	2.8333	3.1154	2.7083	3.0000

The figure below is a graphical representation of the table above.

Graph 12 Campus 2 Comparison of Growth in Written Communication between PBL group (mixed ability) and Non PBL group (mixed ability) (mean values)



The above data indicates mixed findings on the early effects of PBL on written communication.

Academic Outcomes

The below is a measure of the research cohort's academic outcomes. Semester Grades are based on then BOSTES common grade scale (where 5 is the highest grade). The students reported below in 2015 are the same cohort reported on in 2016.

Note Semester 1 2016 is the implementation of PBL.

Campus 1

English- Campus 1

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	5.7	9.6	+68
4	31.8	30.4	-4.4
3	56.5	56	
2	7.7	3.7	
1	0	0	
Total No of Students	138	135	

Some growth in top grades.

Science -Campus 1

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	4.4	14	+218
4	34.8	42	+20.7
3	53.6	41.2	
2	7.2	3	
1	0	0	
Total No of Students	138	136	

Enormous growth in top grades

Human Society in Its Environment – Campus 1

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL%	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	10.9	12.7	+16.5
4	50.7	44	-13.2
3	37.7	42.5	
2	.7	.7	
1	0	0	
Total No of Students	138	134	

Some growth in top grades.

Personal Development and Health Campus-1

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	9.4	9.6	+2.1
4	57.2	45.6	
3	33.3	44.9	
2	0	0	
1	0	0	
Total No of Students	138	136	

Very little effect in any grades.

Campus 2

English- Campus 2

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 1- class Min of 10 weeks PBL %	% increase or decrease
5	14.3	13.3	-6.9
4	27.1	33.3	+22.9
3	41.4	30.7	
2	12.9	17.3	
1	4.3	4	
Total No of Students	70	75	

Mixed effect

Science – Campus 2

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 1 class -Min of 10 weeks PBL %	% increase or decrease
5	8.6	6.7	-22.1
4	37.1	26.7	
3	44.3	36	
2	5.7	16	
1	4.3	14.7	
Total No of Students	70	75	

Negative effect on top grades.

Human Society in Its Environment – Campus 2

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	21.4	16	-25.3
4	44.3	29.3	
3	18.6	36	
2	11.4	14.7	
1	4.3	4	
Total No of Students	70	75	

Negative effect on top grade.

Personal Development and Health -Campus 2

BOSTES Grades	% of students gaining each BOSTES Grade		
	Semester 1 2015 No PBL %	Semester 1 2016 Min of 10 weeks PBL %	% increase or decrease
5	18.6	25.3	+36
4	61.4	57.3	
3	20	17.3	
2	0	0	
1	0	0	
Total No of Students	70	75	

Positive effect on top grade

Summary of Academic Outcomes

Campus 1

A comparison of the academic BOSTES grades were analysed for the % increase or decrease from Phase 0 to Phase 2.

The top 2 bands (i.e. bands 4 and 5) were compared.

There was considerable % increase in Band 5 for English, Science and HSIE.

There was slight growth for Personal Development and Health.

Campus 2

A comparison of the academic BOSTES grades were analysed for the % increase or decrease from Phase 0 to Phase 2.

The top 2 bands (i.e. bands 4 and 5) were compared.

There was considerable % decrease in Band 5 for English, Science and HSIE.

There was strong growth for Personal Development and Health.

Discussion

Critical Thinking

Results from this study would indicate that PBL improves critical thinking refer to tables 1-4. The pedagogy of PBL requires students to present ideas, produce evidence to support their ideas and then to analyse their end products. It can be seen that working through these processes as a part of everyday learning would support the development of these skills (Bradley-Levine & Mosier, 2014; Panasan & Nuangchalerm, 2010).

Written Communication

Written Communication in Campus 1 students (all PBL) did not indicate significant growth in written communication (refer to table 5) and yet, there was significant growth in both groups (PBL group and Non PBL group) at Campus 2 (refer to table 8).

This may have been due to Campus 1 students starting from a higher baseline in Phase 0 (refer table 5), than students at Campus 2(refer to table 6). Thus, growth in written communication at Campus 1 was not as rapid as it was for Campus 2. Indicating that PBL can have a positive effect on written communication.

Literature suggests (Schmidt, Vermeulen, & Van Der Molen, 2006) that in the early implementation phase of PBL there is a greater emphasis on oral communication and collaborative skills development than on written communication.

This could explain the subdued growth in written communication within this study group especially with Campus 1 students. The substantial growth in oral communication from this study group supports this view.

This was also supported by Rawson, Quinlan, Cooper, Fewtrell, and Matlow (2005). Although our course provides many opportunities for verbal elaboration of students' understanding of course content, students do not formally practice expressing their understanding of pathophysiological concepts in writing. Unless the tutor is particularly rigorous, oral explanations during tutorial sessions tend to be rather untidy in the interest of simply generating discussion. Furthermore, the paucity of lectures limits the exposure of students to teachers who can model the use of accurate

medical terminology and concepts. That they needed more practice and perhaps more explicit instruction and modelling to attain proficiency.

In summary

Does PBL affect students' growth in written communication? It is unclear especially for students of Campus 1 where the results show very little change in mean scores. However, it is worth noting the mean scores for written communication on Campus 1 at Phase 0 were higher than the mean scores for critical thinking and oral communication at Phase 0 suggesting students on Campus 1 were already performing at a fairly high level (in respect to the written communication rubric) and so the impact of PBL in the improvement of writing is not as evident when compared to the more dramatic increases in performance in critical thinking and oral communication. This may speak to the strength of the previous approaches to teaching on Campus 1.

At Campus 2 where the mean scores at Phase 0 were lower there has been significant increase in writing performance but it's difficult to attribute this solely to PBL given there is only 1 element of writing (development) where there are significant differences between the PBL and non-PBL groups.

Oral Communication

There was very strong growth in all oral communication dimensions for Campus 1(refer to table 9). The students at Campus 2 had stronger growth in Oral communication in the PBL group than in the Non PBL group (refer to table 10).

In summary does PBL affect students' ability to communicate orally? There was significant improvement in oral communication.

In fact, this is where PBL currently appears to have had the most impact when considering the magnitude and significance of change for oral communication from Phase 0 to Phase 2.

The highly significant differences between the PBL and non PBL group strongly suggest the PBL has been a significant contributor to students increased performance.

Academic Outcomes

Literature has suggested that content knowledge may suffer in PBL pedagogy (Dods, 1997; Van den Bossche et al., 2000) suggest that PBL may result in a decrease in content knowledge (Drake & Long, 2009). Within this study that was not the case at both campuses. There was significant growth is academic outcomes for Campus 1 and a less clear picture in Campus 2. Campus 1 results suggest that content knowledge may not be compromised when using PBL pedagogy.

Campus 1

A comparison of the academic BOSTES grades were analysed for the % increase or decrease from Phase 0 to Phase 2.

The top 2 bands (i.e. bands 4 and 5) were compared.

There was considerable % increase in Band 5 for English, Science and HSIE.

There was slight growth for Personal Development and Health.

Campus 2

A comparison of the academic BOSTES grades were analysed for the % increase or decrease from Phase 0 to Phase 2.

The top 2 bands (i.e. bands 4 and 5) were compared.

There was considerable % decrease in Band 5 for English, Science and HSIE.

There was strong growth for Personal Development and Health.

Answering the question "*Can academic growth be sustained as PBL is implemented"* – using the BOSTES grades should be addressed with some tentativeness, in as much as we are only reporting on the impact of 10 weeks and the ***real potential*** value of PBL will be the iterative cycles where students will have more opportunities to practice applying the skills of critical thinking, oral communication and writing more effectively to the different disciplinary contexts. Early signs at Campus 1 are encouraging with some subjects showing some remarkable gains (Science and English) and others very little change (HSIE) with one case (PDH) showing some regression.
BOSTES grades for Campus 2 show a more complex picture with only PDH showing any positive change. At this point it appears PBL is not having a positive effect for the 75 students in relation to their BOSTES grades apart from PDH.

Possible limitations of the study

New implementation of PBL pedagogy across both campuses for this research project, was a positive challenge for staff. Timing of units and making sure that we maintained fidelity in the PBL pedagogy was a continuous process. Meeting times for staff to collaborate and agree on the direction and priorities of learning outcomes for each project, was a new skill for many staff. Opportunities for collaborative meetings for PBL staff should be a priority to maintain the validity of the PBL process. Capturing data to measure student growth, can be an issue in a school setting where students are leaving and entering the school. This made matching of student work samples over sampling periods redundant if the student had exited the school or entered it at a later phase post baseline. Aligning student classroom tasks (task content and timing) so that the research question could be addressed through the work samples, can cause constraints. Collaboration was initially going to be measured through student surveys; however, after initial survey data was gained, it was decided that surveys for this collaborative skill was not a reflective measurement tool.

Implications:

As schools look for new ways to support students to acquire skills that have been identified as required in future employment summarised below by (World Economic Forum, 2016)

Most In-Demand Skills of 2015	Most In-Demand Skills of 2020
1. Complex Problem Solving	1. Complex Problem solving (same)
2. Coordination with Others	2. Critical Thinking (+2 spots)
3. People Management	3. Creativity (+ 7 spots)
4. Critical Thinking	4. People Management (-1 spot)
5. Negotiation	5. Coordination with Others (-3 spots)
6. Quality Control	6. Emotional Intelligence (new)
7. Service Orientation	7. Judgement and Decision Making (+1 spot)
8. Judgement and Decision Making	8. Service Orientation
9. Active Listening	9. Negotiation (-4 spots)
10. Creativity	10. Cognitive Flexibility (new)

Schools require new pedagogies that challenge and create opportunities for students to gain and practice, critical thinking and communication whilst still gaining and maintaining knowledge. A pedagogy that allows students to engage in authentic learning, which also builds transformative skills for the future needs of our economies is vital. This research has contributed to the wider educational community by providing quantitative data concerning the effects of the PBL pedagogy, abilities to support the acquisition of critical thinking and written and oral communication. This data should give practitioners the confidence to explore PBL further as a way to enhance transformative skill (21st Century skill) development.

Recommendations and directions for future research:

Based on our finding as a school Campus 1 is continuing to support staff to gain skills in PBL and is also training new staff in PBL pedagogy so that subsequent year groups will be learning through PBL. As a consequence of our experiences, skills in collaboration in students and staff need further development. Future research will be directed at implementing a cohesive process of student and staff training and coaching in collaborative skill development through a PBL framework. Both qualitative and quantitative data will be collected especially looking at the use of case studies as well as quantitative data. In future research, we would like to follow this cohort through to Year 12 to study the gains in transformative skill development comparing them with the control group from Campus 2.

Conclusion

It has become in our new educational setting, amongst the information explosion, impossible to meet all of the demands students will need to know and how much they will need to know, in future careers that do not yet exist. The ability to engage diverse groups of learners adequately within a traditional teacher setting and build transformative skills, is difficult. To limit students to continuous teacher directed and controlled knowledge building is not developing skills in our students required to meet the needs of economies of the future. PBL in this study and others has shown that it can support transformative skills and disposition development.

Drake and Long (2009); Howard (2002) state that, "in PBL, students are able to simultaneously develop problem-solving strategies, disciplinary knowledge bases, collaborative skills, and dispositions. By organizing the curriculum around the completion of an authentic problem or project, PBL requires students to use the knowledge and skills they have acquired in meaningful contexts."

Our experiences during this research project also affirm the above findings, PBL allows students to have authentic projects which give students time, opportunities and routines that enable them to build critical thinking skills and oral communication skills which will impact on them as life -long learners.

Research to Practice Impact

Participation in the AISNSW funding support for SBRPs has increased our school's engagement in and with research. Without the Association of Independent Schools of NSW support, we would have been many years away from launching an intervention such as PBL to support our students to acquire the transformative skills much needed in learners. This process has allowed our school to understand how to make whole school change that can impact student learning. Engaging in research has allowed our community to gain evidence that informs our educational practices.

The awareness of research as a driver for informing and guiding change is evident in our community. Staff are now volunteering themselves and their students to be part of the process.

Staff attitudes towards research have always been positive; however, this process has allowed us to understand how we can easily be part of the research process.

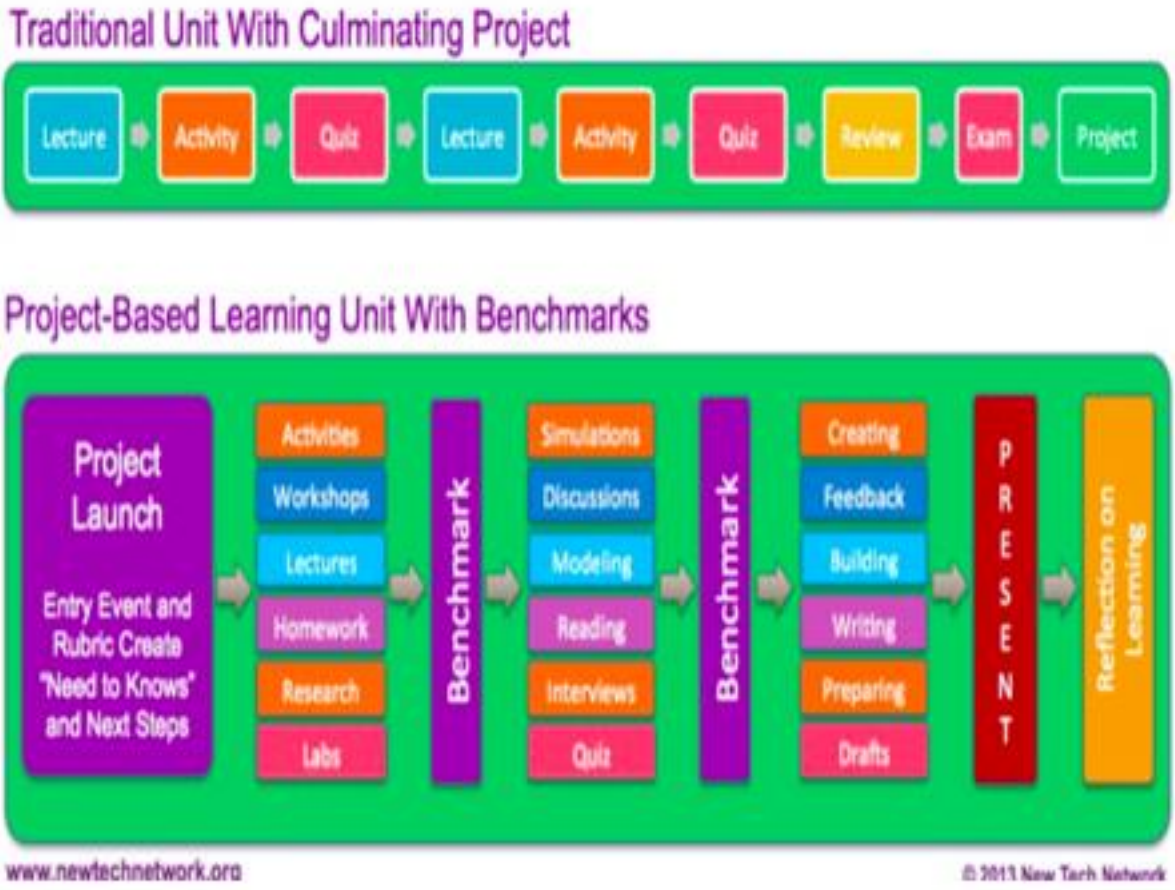
Attitudes and perceptions are changing as we realise that it is not only traditional academic institutions that can develop and run research. We recognize the importance of the traditional academic institutions supporting our research as their specialized skills in research are difficult to develop in a school setting. The union between our University partner and the school has proven to be a positive and successful experience which has initiated the success of this report. We have always been aware of the importance of research; however, the SBRP others research findings and our own school based research findings are now more part of our current practices. Our school has appointed a leader of research and we intend to continue research on PBL and its effects on transformative skill development. This highlights the desire of our school to continue building our research capacity.

Knowledge transfer of our research findings are still in the preliminary phase; however, we have discussed producing a student and parent version of the research and staff will be informed through staff meetings and professional development afternoons. As well will be submitting it through to NTN and to our school partner Parramatta Marist High School to support their practices. Other knowledge translation portals would include those that are commissioned by the AIS Research Council. In addition, we would aim to publish in the following academic arenas; Adolescent Success Journal and website, Australian Journal of Middle Schooling, Australian Curriculum Studies Association Primary and Middle Years Educator, Australian Association for Research in Education, Australian Council for Educational Research.

School based research has improved our education practice, in a diverse and practical way that has supported positive and real change for our student body and staff.

Appendices

Appendix 1-New Tech Network Model for **PBL**



Appendix 2- New Gold Standard -Buck Institute for Education Model for PBL

Buck Institute

Appendix 3 – Ethics Clearance Permission Note.

Monday 8th February 2016

Dear Parents and Students,

St Philip's Christian College is always looking to sustain, improve and refine our excellent Teaching and Learning practices.

We live in an era where skills development in the areas of critical thinking, collaboration and communication (3C's) are extremely important acquisitions for the modern day learner and employee. To strengthen the growth and development of these skills in our students we are partnering with the Australian National University.

St Philip's Christian College and the Australian National University (Researcher Glen O'Grady) are requesting your permission to gather evidence of student learning in the key learning areas of Science, Physical Development and Health, English, and Human Society and its Environment for research purposes. Students would submit their normal evidence of learning to their classroom teachers and would be assessed in customary manner. However, student work would also be reviewed and analysed for research on student's development in the 3C's. Gathering of student work would entail checkpoints and identification points inclusive of:

- essays,
- topic tests and quizzes,
- presentations,
- student survey,
- reflection journals
- student interviews

The analysis of the data on the development in the 3Cs will be used in research reports that will be published and available for the school and wider community. All student work would be anonymous for this research.

This research will allow us to support a culture of continuous growth and improvement in our teaching practices so that our students improve their ability to critically think, collaborate and communicate.

The ethical aspects of the research, have been approved by the ANU Human Research Ethics Committee.

You may choose to withdraw your child's participation in the research project by notifying one of the researchers below.

Please sign the permission slip and return to ..... at the Middle School Admin Office or email your permission back to ..... by the 29th February 2016.

.../2

- 2 -

Research Reference Number -2015/763

Adapted- NTN (for an Australian Context)- Knowledge and Thinking Rubric for ELA Textual Analysis, (Middle School) Grade 8

The ability to reason, problem-solve, develop sound arguments or decisions, and create new ideas by using appropriate sources and applying the knowledge and skills of a discipline.

	Emerging	Working Towards	Working at Stage	High	Exceeding
ARGUMENT/THESIS *What is the evidence that the student can communicate an argument/thesis?*	• Argument/thesis is **unclear, missing,** or **off topic**	• Argument/thesis reflects a **general understanding** of the text	• Argument/thesis is **clear** and **demonstrates understanding** of the text	• Argument/thesis is clear and demonstrates **understanding** and a level of **engaged reading** of the text	• Argument/thesis is clear and demonstrates **engaged reading and thinking**
CLAIMS/SUPPORTING IDEAS *What is the evidence that the student can determine claims/supporting ideas?*	• Includes **unclear** or **irrelevant** claims/supporting ideas	• Includes claims/supporting ideas **related** to the argument/thesis	• Includes claims/ideas that **support** the argument/thesis	• Includes claims/ideas that **support** the argument/thesis • Includes **some specific** claims/ideas that support the argument/thesis	• Includes **specific** claims/ideas that **support** the argument/thesis
COUNTERCLAIMS (OPTIONAL)* *What is the evidence that the student can address counterclaims?*	• Counterclaims are **absent, one side dominates**	• **Alludes to** counterclaims, counterclaims may be **unclear**	• **Acknowledges clear** counterclaims	• Acknowledges **clear** counterclaims and is **beginning to develop** and respond to stated counterclaims	**Develops** and **responds** to **clearly stated** counterclaims
EVIDENCE *What is the evidence that the student can support the argument/thesis?*	• Evidence **does not** connect to argument/thesis or **is absent** • Evidence is used in an **awkward or confusing way**	• Refers to **limited** textual evidence relevant to argument/thesis • Evidence is **unevenly integrated** into the writing	• Refers to textual evidence **relevant** to argument/thesis • Evidence is **smoothly** integrated into the writing with **some lapses**	• Refers to **strong** textual evidence **relevant** to the argument/thesis • Evidence is **smoothly** integrated into the writing with **slight lapses**	• Refers to **strong and thorough** textual evidence relevant to argument/thesis • Evidence is **smoothly** integrated into the writing with **minor lapses**
ANALYSIS OF IDEAS *What is the evidence that the student can analyze and interpret ideas in the text?*	• Demonstrates **minimal** or **misunderstanding** of text(s) • **Does not refer to** a particular event/line/etc.	• Demonstrates a **basic** understanding of text(s) • **Summarizes** a particular event/line/etc.	• Demonstrates an **understanding** of text(s), including both **explicit** and **inferred** meanings • **Analyzes** a particular event/ line/etc. and its effect on plot	• **Demonstrates an understanding of text(s), including both explicit and inferred meanings** • **Analyses with some detail a particular event/line/etc. and its effect on plot**	• Demonstrates **comprehensive** understanding of text(s), including both explicit and inferred meanings • **Analyzes in detail** a particular event/line/etc. and its effect on plot

	Emerging	Working Towards	Working at Stage	High	Exceeding
ANALYSIS OF AUTHOR'S CRAFT* *What is the evidence that the student can analyze author's choices and purpose?*	• Makes **no reference** to the author's point of view or purpose in a text • Makes **no reference** to author's choices	• **Briefly notes** the author's point of view or purpose in a text • **Briefly refers** to author's choices	• **Determines** the author's point of view or purpose in a text • **Describes** how author's choices **contribute to meaning or style**	• **Determines** the author's point of view or purpose in a text and somewhat **reveals** how it impacts on overall meaning • **Describes** how author's choices **contribute to meaning or style and at times** recognizes that a particular effect **has been created.**	• **Determines** the author's point of view or purpose in a text and its impact on overall meaning • Describes how author's choices **contribute to meaning or style** and **create a particular effect**

*The inclusion and addressing of counterclaims (e.g. explanatory writing) or analysis of author's craft will not be required or appropriate for all kinds of writing
Adapted -Changes acknowledged -The student outcomes have been aligned to the Australian Curriculum and the "High " outcome has been added with adjustments.

Adapted NTN (for an Australian Context) –Oral Communication Rubric (Middle School)Grade 8 2016

The ability to communicate knowledge and thinking through effective oral presentations.

	Previous Stage	Working Towards	Working At Stage	High	Exceeding
Clarity *What is the evidence that the student can present a clear perspective and line of reasoning?*	• Presents an unclear perspective • Line of reasoning is absent, unclear, or difficult to follow.	• Presents a general perspective • Line of reasoning can be followed.	• Presents a clear perspective • Line of reasoning is clear and easy to follow.	• Presents a clear and **original** perspective. • Line of reasoning is clear and easy to follow.	• Presents a clear and original perspective • Line of reasoning is clear and convincing. • Addresses alternative or opposing perspectives when appropriate
Evidence *What is the evidence that the student can present a perspective with supportive evidence?*	• Draws on facts, experience, or research in a minimal way • Demonstrates limited understanding of the topic	• Draws on facts, experience, and/or research inconsistently • Demonstrates an incomplete or uneven understanding of the topic	• Draws on facts, experiences and research to support a perspective • Demonstrates an understanding of the topic	• Draws on facts, experiences and research to support a perspective – some synthesis. • Demonstrates an understanding of the topic	• Facts, experience and research are synthesized to support a perspective • Demonstrate an in-depth understanding of the topic
Organisation *What is the evidence that the student can organize a presentation in a way that supports audience understanding?*	• A lack of organization makes it difficult to follow the presenter's ideas and line of reasoning.	• Inconsistencies in organization and limited use of transitions detract from audience understanding of line of reasoning.	• Organization is generally appropriate to the purpose, audience, and task. • Transitions are used and sometimes guide audience understanding.	• Organization is appropriate to the purpose, audience, and task. • Transitions are used and guide audience understanding.	• Organization is appropriate to the purpose and audience and reveals the line of reasoning. • Effectively hooks and sustains audience engagement.
Language Use *What is the evidence that the student can use language appropriately and fluidly to support audience understanding?*	• Uses language and style that is unsuited to the purpose, audience, and task. • Stumbles over words, interfering with audience understanding.	• Uses language and style that is at times unsuited to the purpose, audience, and task • Speaking has significant lapses of incorrect language use that detracts from audience understanding.	• Mostly uses appropriate language and style that is suited to the purpose, audience, and task. • Speaking is fluid with minor lapses of incorrect language use that detracts from audience understanding.	• Uses varied language that is suited to the purpose, audience, and task. • Speaking is fluid with minor lapses of incorrect language use that detracts from audience understanding.	• Uses varied language that is suited to the purpose, audience, and task. • Speaking is consistently fluid and easy to follow.
Use of Visual Displays *What is the evidence that the student can use visual displays to engage and support audience understanding?*	• Digital media or visual displays are confusing, extraneous, or distracting.	• Digital media or visual displays are primarily informative and relevant but some elements are confusing, extraneous, or distracting	• Digital media or visual displays are informative and relevant	• Digital media or visual displays are informative and relevant, and support audience engagement.	• Digital media or visual displays are appealing, informative, and support audience engagement an understanding
Presentation Skills *What is the evidence that the student can control and use appropriate body*	• Makes minimal use of presentation skills: lacks control of body posture; does not make eye contact; voice is unclear	• Demonstrates a command of eye contact and clear and audible voice • Presenter's energy is sometimes appropriate for	• Demonstrates a command of some aspects of presentation skills, including control of body posture, language fluency,	• Demonstrates a command of **many** aspects of presentation skills, including control of body posture, language fluency, eye	• Demonstrates a command of presentation skills, including control of body posture and gestures, eye contact, clear and audible

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language and speaking skills to support audience engagement?	and/or inaudible; and pace of presentation is too slow or too rushed • Presenter's energy is unsuitable for the audience and purpose of the presentation	the audience and purpose of the presentation	eye contact, clear and audible voice, and appropriate pacing • Presenter's energy is appropriate for the audience and purpose of the presentation, with minor lapses	contact, clear and audible voice, and appropriate pacing • Presenter's energy is appropriate for the audience and purpose of the presentation, with **momentary** lapses	voice, and appropriate pacing • Presenter's energy and affect are appropriate for the audience and support engagement
INTERACTION WITH AUDIENCE *What is the evidence that the student can respond to audience questions effectively?*	• Provides a vague response to questions; demonstrates a minimal command of the facts or understanding of the topic	• Provides an indirect or partial response to questions; demonstrate a partial command of the facts or understanding of the topic	• Usually provides a direct and mostly complete response to questions; demonstrates an adequate command of the facts and understanding of the topic	• Often provides a direct and mostly complete response to questions; demonstrates a more than adequate command of the facts and understanding of the topic	• Provides a direct and complete response to questions; demonstrates an in-depth command of the facts and understanding of the topic

Adapted NTN (for an Australian Context) Written Communication Rubric, Grade 8

The ability to effectively communicate knowledge and thinking through writing by organizing and structuring ideas and using discipline appropriate language and conventions.

	PREVIOUS STAGE	WORKING TOWARDS	PROFICIENT	High	Exceeding
DEVELOPMENT *What is the evidence that the student can develop ideas?*	• **Does not explain** background or context of topic/issue • Controlling idea* is **unclear** or **not evident** throughout the writing • Ideas and evidence are **underdeveloped**	• Provides a **simplistic or partial explanation** of background and context of topic/issue • Controlling idea* is **present** but **unevenly addressed** throughout the writing • Ideas and evidence are **somewhat developed**	• Provides a **partial** explanation of background and context of topic/issue • Controlling idea is **evident** but may not be **present throughout** the text • Ideas and evidence are **mostly developed**	• Provides an explanation of background and context of topic/issue • Controlling idea is **evident** and **has presence throughout** the text • Ideas and evidence are **developed with minor lapses**	• **Addresses** appropriate background and context of topic/issue • Controlling idea* is **presented clearly** throughout the writing • Ideas and evidence are **developed.**
ORGANIZATION *What is the evidence that the student can organize and structure ideas for effective communication?*	• Ideas and evidence are **disorganized** making relationships are **unclear** • **No** transitions are used, or are used **ineffectively** • Conclusion, when appropriate, is **absent** or **restates** the introduction or prompt	• Ideas and evidence are **loosely sequenced or organized; some sense of** relationships • Transitions **connect ideas** with **some** lapses; may be **repetitive** or **formulaic** • Conclusion, when appropriate, **follows from** the controlling idea	• Ideas and evidence are **organized to show relationships**, though organization may be **formulaic** • Transitions **connect** ideas • Conclusion, when appropriate, follows from **and supports** the controlling idea	• Ideas and evidence are **organized to show relationships**, with minor lapses into **formulaic organization** • Transitions are **varied** and connect ideas, **showing relationships** • Conclusion, when appropriate follows arguments and **raises implications**	• Ideas and evidence are **sequenced** to **show relationships** • Transitions are **varied** and connect ideas, **showing clear relationships** • Conclusion, when appropriate, is **logical** and **raises important implications**
LANGUAGE AND CONVENTIONS *What is the evidence that the student can use language skillfully to communicate ideas?*	• Language, style, and tone are **inappropriate** to the purpose, task, and audience. • **Attempts** to follow the norms and conventions of writing in the discipline/genre with **major**, consistent errors	• Language, style, and tone are somewhat **appropriate** to the purpose, task, and audience with **minor** lapses • **Follows** the norms and conventions of writing in the discipline/genre with **minor, consistent** errors Has some **minor errors** in grammar, usage, and mechanics that **partially**	• Language and tone are **mostly appropriate** to the purpose and audience with **minor lapses** • Follows the norms and conventions of writing in the discipline with some errors • Is **generally free** of **distracting** errors in	• Language and tone are **appropriate** to the purpose and audience with minor **lapses** • **Follows** the norms and conventions of writing in the discipline/genre with minor errors** • Exhibits minor lapses of **distracting** errors in grammar, usage, and mechanics	• Language, style, and tone are **appropriate** to the purpose, task, and audience with **minor** lapses • **Follows** the norms and conventions of writing in the discipline/genre with minimal errors** • Is **free** of distracting errors in grammar, usage, and mechanics

	• Has an **accumulation** of errors in grammar, usage, and mechanics that **distract or interfere** with meaning • Textual citation, when appropriate, is **missing or incorrect**	distract or interfere with meaning • Cites textual evidence, when appropriate, **partially or using an incorrect format**	grammar, usage, and mechanics • Cites textual evidence when appropriate with **some minor errors**	• Cites textual evidence when appropriate with **some minor errors**	• Cites textual evidence when appropriate with some minor errors

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