

# APPLYING 21ST CENTURY CONSTRUCTIVIST LEARNING THEORY TO STAGE 4 DESIGN PROJECTS

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## Abstract

This research applies a conceptual framework to the development of a classroom resource: design process folios. The conceptual framework is comprised of three overlapping lenses that account for the syllabus from the New South Wales Board of Studies (BOS), social constructivism theory and 21st Century learning needs. The use of this framework in design for learning provided a structured approach for the improvement of teaching and learning, aligning both the mandated curriculum as well as theories of learning. The aim for developing this resource was to provide opportunities for meaningful and engaging experiences for learners. In this paper, we report on the application of this conceptual framework to the analysis of a school-developed folio. The folios were comprised of engaging learning materials and tasks that make use of ICTs to support learning of design processes by Stage 4 Technology students in an Australian Independent School. The experience of the lead author was that the folio was an effective and engaging way to deliver design projects. The school-developed folios have an inherent quality: they can be continually refined and improved to reflect changes in society, technology and the curriculum. Analysis of the folios suggested that these resources can be seen as systems that evolve and this has applications to other curriculum areas that engage project based learning approaches.

## Introduction

The design of learning resources must take into account multiple areas of knowledge. This paper presents a framework that allows a learning resource to be analysed in terms of the intersection of curriculum requirements, social constructivist theory, and 21st Century learning needs. The aim of doing so was to identify the points of intersection between these perspectives, successful components of the design of the folios, and potential areas appropriate for redesign. The first part of this paper will articulate the conceptual framework and establish each of the three lenses. Firstly describing key features of the Stage 4 Technology Syllabus, secondly presenting a literature review of constructivism and thirdly, discussing 21st Century learning needs while maintaining appropriate employment of ICT. The framework will then be applied in the analysis of a learning resource, developed by the lead author. This learning resource is a design process folio, for Stage 4 Technology, a key requirement of the NSW Technology Syllabus. The analysis reported in this paper discusses three key sections of the design process folio in order to demonstrate the way in which the core aim of improving opportunities for learning was met through the intersection of the three elements identified in the framework.

## The Conceptual Framework

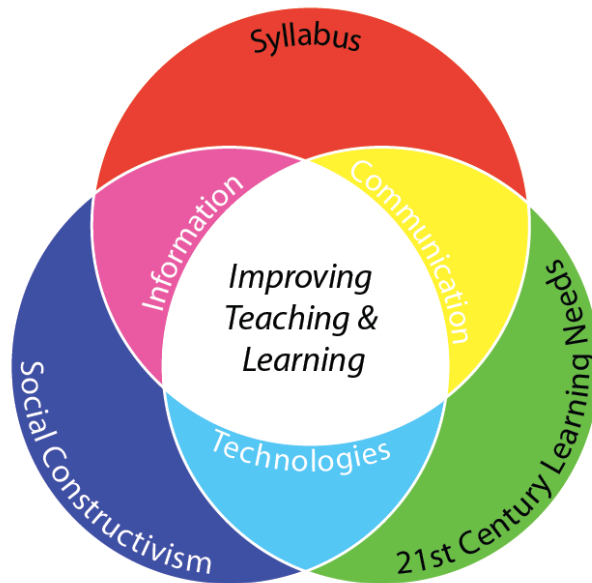


Figure 1. The Conceptual Framework

The conceptual framework is based on ideas outlined in Carvalho & Goodyear’s (forthcoming) framework for the analysis of networked learning environments. Carvalho and Goodyear suggest the use of an architecturally inspired approach in the analysis of complex learning environments. Their approach focuses on identifying key design elements, examining connections between them and exploring how what is designed may influence and affect learners’ activities in a given learning setting. These components may include physical, digital and human elements, which may encompass tools and artefacts, texts and proposed tasks or suggestions of things to do, roles and divisions of labour and so on. As a way of abstracting these ideas in the analysis of design for learning, Carvalho and Goodyear suggest the use of four analytical dimensions: i) set design, ii) epistemic design, iii) social design and iv) co-creation and co-configuration activities. Set design relates to the physical or digital elements that are brought together to compose a learning environment. It relates to the tools and artefacts that may be available to learners and the affordances of a space. Epistemic design is about the proposed tasks, and the examination of what and how tasks are suggested to learners. Social design relates to the expected assemblage of learners, including for example proposed arrangements of groups, expected roles or a proposed script that learners are expected to follow. The fourth dimension, acknowledges that these designed elements are likely to be re-shaped and re-configured by learners.

In this paper we report the use of three lenses – syllabus, social constructivism and the 21st Century learning needs (Figure 1) – in the development of a learning resource: design process folios. We start with the examination of how epistemic elements may be brought together to inform the design of this learning resource, identifying aspects related to the ways tasks could be suggested and the core knowledge to be learned. We then connect these ideas to specific technological tools and resources available to learners (that is, with elements of set design) and discuss the roles of teachers and learners and the specific arrangements of learners (proposed collaborations and interactions) based on a design studio scenario (social design).

## 1. Board of Studies Stage 4 Technology Syllabus

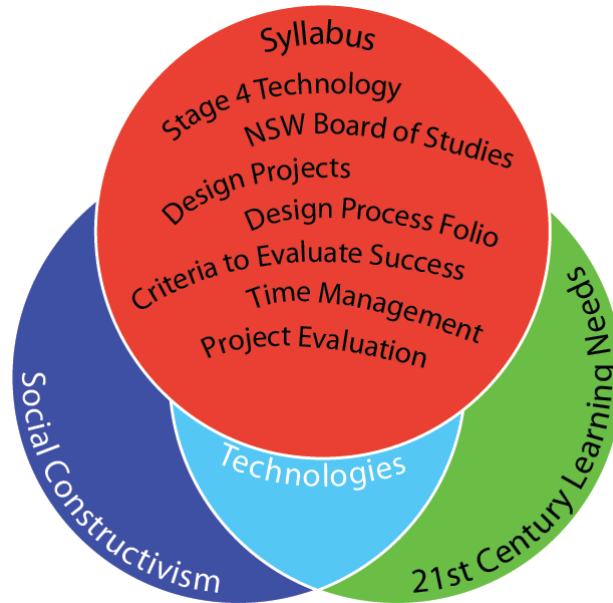


Figure 2. Syllabus Lens in Focus

The syllabus lens focuses on the program for learning that schools and teachers are expected to deliver. In this case, the Stage 4 Technology Mandatory Syllabus, published by the Board Of Studies (BOS, 2003) as part of the K-10 curriculum framework. This syllabus is delivered to students during Years 7 and 8. The focus is on solving authentic problems using a design process that calls upon attributes such as research, ideation, creativity, experimentation, evaluation and planning. Learners are expected to use technology within design projects in appropriate ways to create quality solutions. It is the development of self-efficacy (Zimmerman, 2000) with regards to technology, rather than the use of the technology itself, that is the aim of the approach. Students are expected to be able to confidently explore and learn new technologies that meet their needs. The rationale behind the Stage 4 Technology Syllabus is that students “develop a capacity to solve problems and generate new ideas through the use of new conceptual approaches” (BOS, 2003, p.8). This addresses the 21st Century skills associated with learners being able to shape and alter their environment, improve their quality of life and keep up with the increasingly rapid rate of technological change.

The Stage 4 Technology Syllabus comprises six broad learning objectives that expand to twelve outcomes. Each outcome includes ‘students learn about’ and ‘students learn to’ statements that cover the declarative and procedural knowledge students need to demonstrate. During Years 7 and 8, students learn a selection of six different technologies chosen from fifteen that include food, textile polymer and timber. The technologies should be learned as part of authentic design projects and within each project students produce a quality solution and document the design process in a folio. ICT is one of the 15 options, however it is also part of the essential cross curriculum content present in all syllabuses in the NSW K-10 curriculum.

The inclusion of the syllabus lens in the conceptual framework ensures that any improvements made to resources like the design process folio maintains a top down approach that includes the requirements of the BOS.

## 2. Social Constructivism

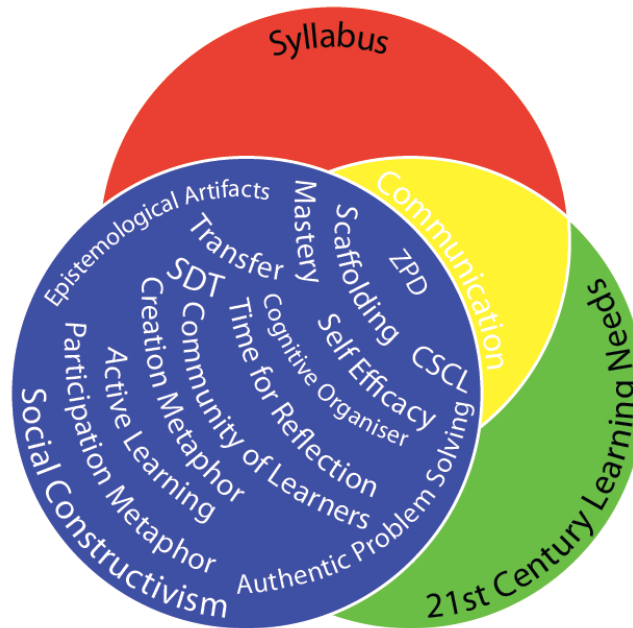


Figure 3. Social Constructivism Lens in Focus

Central to constructivism is the view that we learn most naturally through active learning (Dewey, 2009). Dewey’s notion of active learning suggests that for learning to be effective, it needs to be an engaging and meaningful experience for the learner. Pedagogical activities that foster active learning focus on offering:

- Scope for self direction
- Provision that allows for exploration and expansion of content
- Learning activities that are engaging and interactive
- Time for reflection so learners can construct meaningful knowledge that builds on their prior knowledge

Maria Montessori (1946) provided a rationale for why this type of learning was suitable by highlighting that “education is a natural process spontaneously carried out by the human individual, and is acquired not by listening to words but by experiences upon the environment” (p.4). Her view rejects the assumption that one can teach effectively by merely telling someone what you know and emphasises the importance of the learning experience. From this foundation Lev Vygotsky promoted a new branch of constructivism called social constructivism emphasising the significance of human interaction in learning. Vygotsky’s theory of zone of proximal development (ZPD) describes the way learning is socially mediated between people through mimicry, influence and interpretation (1978). We learn by watching others, and we can learn more deeply by collaborating with others.

Social constructivism has influenced many areas of the design for learning. The focus on the “knowledge economy” (Sawyer, 2006, p.2) as well as ICT have resulted in changes in what and how we design for learning. Much professional work is focused on the deliberate advancement of knowledge rather than the production of material things (Bereiter, 2002). Consequently, the development of creative thinking skills is now considered an essential learning outcome. 21st Century skills emphasise the need for learning to be holistic, integrated, connected, skillful, relevant, adaptable, student centered, project based and authentic (McLeod, Bathon & Richardson, 2011). In order to appropriately incorporate such a change in educational design, assumptions about knowledge and learning themselves need to be considered.

There are at least three metaphors that have been used to describe learning. Sfard (1998) discusses two of these: acquisition and participation. Traditionally, learning has been described as an acquisition of knowledge (Reynolds, Sinatra & Jetton, 1996). These early views of learning considered knowledge to be transferrable, and teaching was simply telling another person what one knows. Sfard proposes that

a more appropriate metaphor for acquiring new knowledge is the learning participation metaphor. Participation embraces the fact that learning takes place through experiences, situated in an environment and involves interaction with the people within it. This metaphor provides a more complete analogy for the epistemology on knowledge and how it develops. It allows learning to be regarded as an individually unique process whereby learners construct their own understanding of the world around them. It places greater importance on the situatedness (Greeno, 1989) of the learning, not just the content of what has to be learned.

Paavola & Hakkarainen (2005) suggest that a third metaphor is required for learning, knowledge creation. In order to make the sharing of knowledge tangible the creation metaphor involves creating epistemological artifacts that become products of knowledge and these can then be used to mediate discussion amongst peers (Sterelny, 2005). For example, producing a research paper, new formula, prototype or model provides something real for others to investigate. Artifacts can contribute to a cycle of innovation whereby each successive contribution can be examined, evaluated and improved upon (Scardamalia & Bereiter, 2006). Paavola & Hakkarainen (2005) point out that professional communities around the world are working together on epistemological artifacts to advance what is collectively known. Examples like the Mars landing by NASA and the development of the Large Hadron Collider by CERN demonstrate recent efforts by the scientific community to work together to create new knowledge. The knowledge creation metaphor emphasises the importance of working collaboratively and sharing knowledge amongst peers. Working as a community towards common goals is a more powerful way to reach greater heights, than for example, working individually, secretly and/or competitively to be better than all others. The success of this learning model is evident around the world with researchers from all fields sharing their discoveries through a wide range of “epistemic things” (Rheinberger, 1997) such as topical peer reviewed journals.

Ann Brown observed how successful the collaborative approach used by professionals was and suggested forming a community of learners (COL) in the classroom (1994). COL aims to get students to play roles of a research community where the goal is knowledge sharing and creation. Practices such as interchange, reciprocity and community create a classroom environment made up of people, tools and artifacts that push learners to the top end of their ability not the bottom.

This lens offers a particular way of understanding how learning may take place and, when combined with the syllabus, enables the creation of learning tasks that not only address the curriculum but that also engage students. Constructivist-learning theory has had a profound influence on education and some of these theories specifically address elements of the classroom such as the students, teacher, task and resources (see Figure 4).

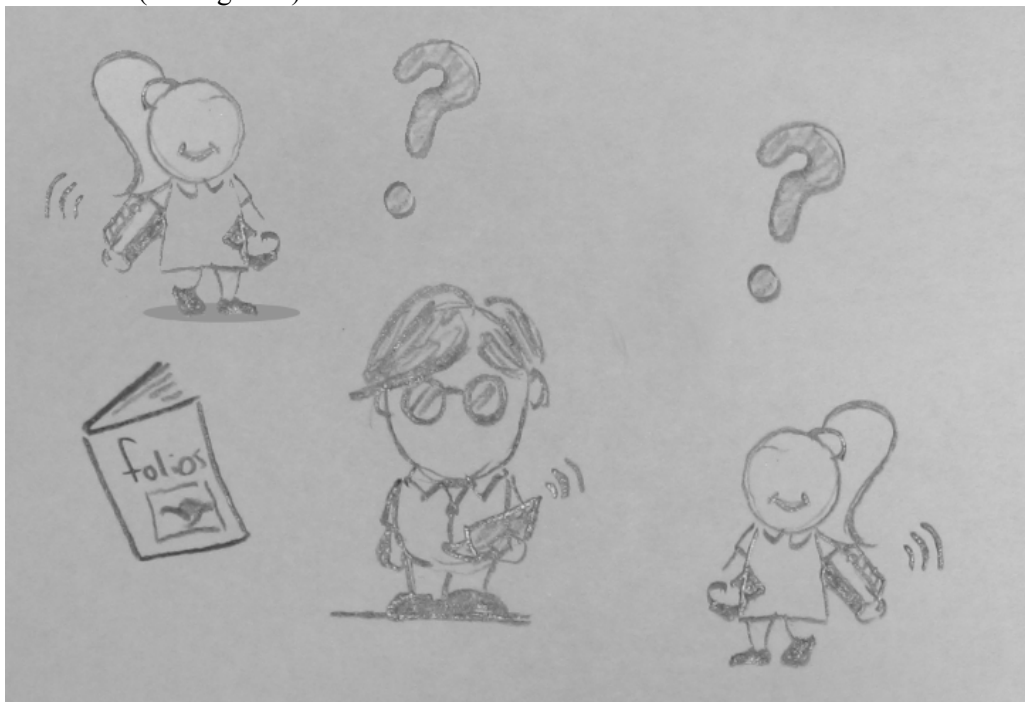


Figure 4. Elements of the Classroom

### *The Student*

Building on social constructivism each student can be regarded as an individual, who comes to a task with different experiences and prior knowledge, different cultural backgrounds and different learning trajectories. Prior knowledge is the starting point for every learner and the goal is to allow new knowledge to be integrated with prior knowledge in meaningful ways (Linn, 2006). It is important that teachers take time to ascertain prior knowledge to ensure that what they learn is both challenging, and relevant to their interests. Students integrate knowledge along different learning trajectories and so a variety of different pedagogical strategies should be in place in order to accommodate different learning styles (Linn, 2006).

Within a classroom context it is important that students are encouraged to take responsibility for their own learning and share what they know with their peers (Glaserfeld, 1989). Collaboration amongst students benefits students with both higher and lower levels of understanding (Vygotsky, 1978). Students with lower levels of understanding tend to learn from peers in ways that are often less formal while higher-level students gain a deeper understanding of their own knowledge as they explain what they know (Glaserfeld, 1989). Moreover, supporting interaction amongst students allows them to seek common understanding and they are more likely to identify and grapple with conflicting meaning, thus allowing for more robust mental models (Chi, 2005; diSessa, 2006) that have greater applicability in real world tasks.

### *The Teacher*

Perceptions of the role of the teacher have shifted, previously seen to be the ‘sage on the stage’, instead as Sawyer suggests they are the “guide on the side” (2006 p.4), facilitating learning for students. Instead of being regarded as the “font of all wisdom” (Ryland, 2011), they are an active member of the classroom whose focus is to ensure that all the students are learning. Such a shift of role brings ZPD (Vygotsky, 1978) into effect, as students may contribute to the classroom understanding of a concept and have opportunities to learn from each other, not just the teacher (Holt & Willard-Holt 2000).

For teachers, facilitation involves the challenge of creating multiple learning opportunities in a classroom so that the students can learn in the ways most appropriate for them. Maintaining control of a multi-dimensional classroom environment where students are working collaboratively on different tasks can be challenging. Noise is often an issue, and a teacher may struggle to be cognitively aware of everything that is happening. The development of tasks and resources that address such issues in this type of environment is therefore necessary.

### *Learning Tasks*

Social constructivists posit that learning and knowledge are invented human constructs that do not exist in a vacuum (Kukla, 2000). It is important that school activities resonate with and have relevance to experiences in other environments. Learning tasks should therefore aim to have some level of authenticity and meaning for students. There should be opportunities for students to transfer what they have learned in the school context to a context they experience beyond the classroom (Perkins, 1992; Brandsford, Brown & Cocking, 1999). Teachers can address these goals by designing learning tasks that are student centered, set at an appropriate level for students and target their interest and motivation. Such tasks would be expected to successfully engage students in their activity. However, the area of motivation for learning is not that simple.

Ryan and Deci (2000) examine motivation for learning using a taxonomy that ranges from extrinsic to intrinsic. Examples of extrinsic motivation include working for rewards, or winning a competition while intrinsic motivation involves doing something for the sake of enjoyment or a desire to master it. Mastery is about one’s desire to reach the best of his or her ability and the learner’s sense of satisfaction comes from the work itself. Mastery is associated with deeper engagement with the task and greater perseverance regardless of any setback (Ames, 1992). Building on these ideas, it seems important that task design targets both intrinsic and extrinsic motivators, for instance by offering opportunities for students to create something that is of use to them. However, Ryan and Deci’s continuum of motivation shows that the strongest forms are derived from innate psychological needs

of competence, relatedness and autonomy. If a task addresses these innate needs and targets intrinsic motivators then it will more likely result in greater student outcomes.

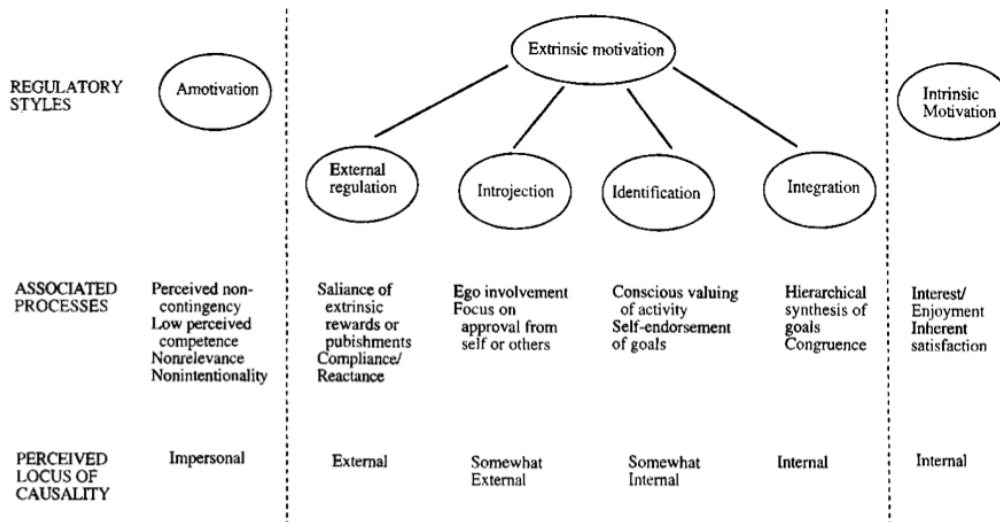


Figure 5. Taxonomy of Human Motivation (Ryan & Deci, 2000, p.61)

Self-efficacy is also important when considering motivation. To achieve high motivation students need to believe they can master a given task. Zimmerman (2000) explains that teachers can support students' development of self-efficacy by making sure students have early success in a task. Early success experiences are likely to help students in developing the confidence and experience needed to push forward and overcome obstacles they might encounter later. Tasks that provide structure and basic skills that clearly relate to later activities help develop self-efficacy. Reeve (2006) suggests that teachers create an autonomous supportive classroom in order to support the innate needs of students and to stimulate higher levels of student motivation. If students are engaged, proactive and participating in what is happening in the classroom, then learning is occurring. However, as pointed out by Reeve, Deci and Ryan (2004), getting these conditions right can be difficult. and to explain these issues the authors propose a framework where structure and control are interchangeable (see Figure 6).

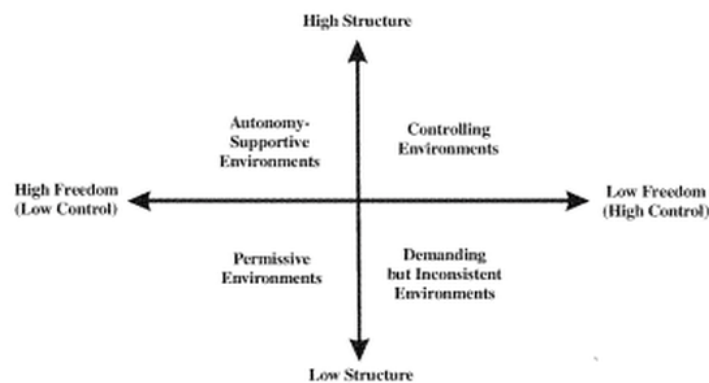


Figure 6. Autonomous Supportive Classroom Framework (Reeve, Ryan & Deci, 2004, p.51)

Reeve, Deci and Ryan (2004) suggest that autonomy supported classrooms are more likely to have high structure and low control (see Figure 6, top left quadrant), arguing that this combination allows students to clearly understand what they are doing and yet gives them the freedom to choose the way they do it. In terms of design for learning, this may be enacted in an environment that offers opportunities for self directed learning where students participate in decision making processes, and where they are provided with clear and meaningful rationales about why they are doing a task and how it relates to their world and so on (Brown & Campione, 1994).

The teacher's main role, in this case, is to establish rules, expectations and offer access to some level of basic instruction. Beyond that, teachers need to focus on helping students find relatedness with their

prior knowledge, be supportive of challenges and troubles, be attuned to specific needs and most importantly discipline needs to be gentle (Reeve, 2006).

### Resources

The thoughtful design of resources for learning is essential to the success of any learning environment. Appropriate support for learners is a key feature of educational design. For teachers who are faced with the need to create a classroom that fosters the constructivist learning theories, learning portfolios offer a design solution that can deliver appropriate scaffolding to an unstructured classroom. Scaffolding describes a framework that is made available to the students to help them work through problems without stating the solution itself (Sawyer, 2006). Using prompts, hints and examples to help learners try to work things out themselves provides an opportunity for understanding and the achievement of deeper learning outcomes. As learners progress, scaffolds should be removed, and learners can then develop self-efficacy and autonomy.

Interaction is another element to consider in educational design. This includes learners' interaction with technology, as well as with peers. Computer Supported Collaborative Learning (CSCL) focuses on pedagogical approaches that use computers for interactive learning whereby student interactions contribute to the development of new knowledge (Stahl, 2006). Computers are well suited for creative work and the creation of epistemic artifacts. In industries such as architecture, interior design, engineering and countless more, creative people use specialised software to produce solutions to problems. It is important that students see the role computers play in the facilitation of creative work. Ensuring students have access to computers creates an opportunity to use ICT in an appropriate way. As this section has suggested, documents like learning portfolios provide scaffolding, while the computer is an available tool for interactive knowledge building, higher order thinking and the creation of epistemic artifacts.

### 3. 21<sup>st</sup> Century Learning Needs

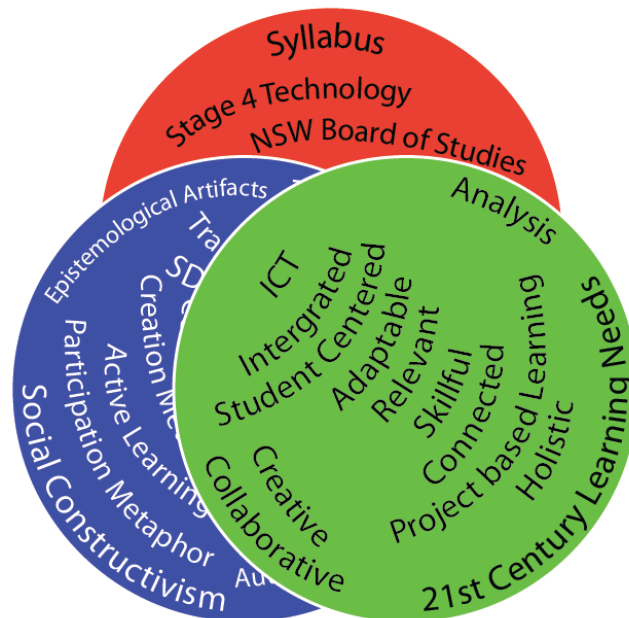


Figure 7. 21st Century Learning Needs Lens in Focus

The importance of providing students with an education relevant for the society in which they participate is paramount. Students need to be skillful and adaptable, they need to be able to work creatively with ICT and communicate effectively. They also need to be autonomous while possessing the ability to work on collaborative projects. 21st Century skills need to accommodate a professional and societal environment in which access to knowledge is instant, and one-to-many styles of communication are common. In this environment, education has a responsibility to enable students to



develop the necessary skills to become active participants in our society.

Educational research, psychology and the learning sciences communities have endorsed a view that constructivism and the principles that accompany it provide a well-suited platform for learning in the 21st Century (Brown & Campione, 1994; Sawyer, 2006; Stahl, 2006; McLeod et al., 2011). 21st Century learning combined with constructivism is student centered and geared toward deeply understanding content in order to work creatively with it. Wagner (2008) suggests that the most important skills to develop are:

- Critical Thinking and Problem Solving
- Collaboration across Networks and Leading by Influence
- Agility and Adaptability
- Initiative and Entrepreneurialism
- Effective Oral and Written Communication
- Accessing and Analysing Information
- Curiosity and Imagination

It has been suggested that learning that is holistic, meaningful, that engages students academically, emotionally, morally and physically will best enable the development of these skills. Effective curriculum implementation will cater for multiple intelligences (Gardner, 1983) by stimulating and developing all of them. With a focus on the whole person, a student will typically identify personal strengths and be able to develop confidence and efficacy that can be expanded across to other domains.

A process of inquiry can help to encourage students to take control of their own work and make decisions about the specific nature and direction of their work (Edelson, 2001). Reeve, Ryan & Deci's (2004) high structure low control approach suggests that it is important to create an environment where one may develop a sense of ownership and curiosity and that may, in turn, contribute to students' capacity to be life long learners. Developing a culture of inquiry by using project based learning methods where students take on different roles such as designer or scientific researcher gives students an identity with which to make decisions and can pursue paths of interest (Brown & Campione, 1994).

## **Implications for Design: Appropriate use of ICT**

In developing the conceptual framework, it appears that one area that meets the requirements of all three lenses concerns the use of ICT. Students of today have been "engulfed by a wave of always on technology" (Whyte, 2012) giving them options that no other generation has had. Beyond basic ICT skills, what students need to learn is how to be safe and act responsibly in the cyber world. In addition, students would ideally be able to use computers as tools for learning and creating, not just consumption. The opportunities for learning are vast, from game based learning tools, to online communities of people sharing ideas and information. This potential for creativity is ICT's core strength, the production of podcasts, movies or professional documents are a few examples of what is now possible. Educational design needs to focus on developing these abilities with an emphasis on creative quality. As outlined in the discussion of the conceptual framework, the design of tasks that incorporate ICT should consider interactivity and appropriate support.

## **Analysis of the Design of a Learning Resource**

This section of the paper will describe the learning resource to be analysed, and then discuss the implications of the analysis for redesign.



Figure 8. Lens Expanded

The Technology department of the independent Australian School in this research uses printed booklets called design process folios. Inherent qualities of the booklets, such as their reliability and accessibility, make them preferred resources for learning activities. They are the property of the students, who are free to actively learn through drawing, writing, and beyond, through various extension tasks on offer. Booklets become an artifact that registers the students’ efforts - a keepsake and evidence of the time and effort a student has put into a project. At every point, the booklets’ design uses seductiveness, vividness and coherence (see Figure 9) to engage the student’s situational interest, giving teachers an opportunity to build their work on students’ personal interests (Schraw & Lehman, 2001).

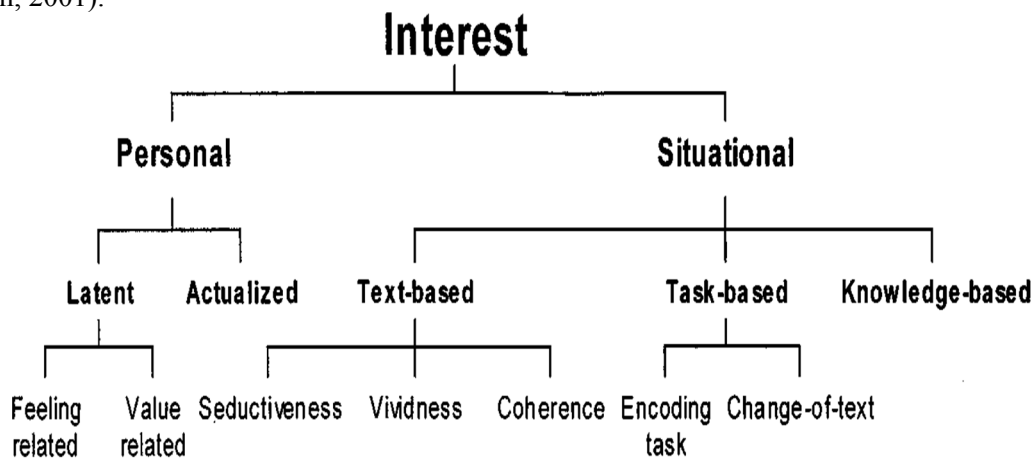


Figure 9. Schraw & Lehman, A taxonomy of personal and situational interest, 2001 p.28).

Printed project booklets support learning that is memorable (Dewey, 2009). Alternatives such as textbooks are dense, not scaffolded in the shape of a project and mainly beneficial as a support document and reference. Teaching staff at the School’s department have considered and tried to move to eBooks, but the lack of tangibility was viewed as an important missing aspect, from both students’ and teachers’ perspectives.

It is important that learning tasks be challenging. To effectively achieve this requires changes at a macro and meso level of educational administration (Goodyear & Carvalho, 2012). The importance of a holistic approach that encompasses analytical thinking, problem solving, understanding, engagement and varied communication skills cannot be addressed by simply changing a lesson plan. It needs to be in the way courses are conceptualised and structured and for this reason, the framework is applied on a meso level.

The design process folio (see Figure 10) is one element of a studio-based approach to Stage 4 Technology, adopted by the School. Sawyer (2012) observed that the studio model used in art and design education overcomes one of the “paradoxes of constructivist teaching” (p. 34). Students learn

basic facts, concepts and skills as part of the curriculum, however they are also required to use this knowledge in creative ways within design projects to address real and relevant problems. The school seeks to deliver BOS outcomes using constructivist approaches that make appropriate use of ICT in order to provide relevant, engaging learning experiences for the 21st Century learner.



Figure 10. Design Process Folios

## 1. Criteria to evaluate success

**CRITERIA FOR SUCCESS**  
 Project Process  
 Long before any great product has been produced you can be sure that a team of designers worked together to come up with a clear objectives for what they hoped to achieve. These objectives are called the Criteria for Success and they provide designers with a vision they can strive for.  
 Developing the Criteria for Success is all about imagining what you hope to achieve and striking a balance between aiming high and keeping it real.  
 What do you think the meaning of Bo Jackson quote is?

**Set your goals high, and don't stop till you get there.**  
**Bo Jackson**  
 (First All Star of both Football & Baseball)

**SMART GOALS**  
 The SMART acronym is useful for setting goals that are possible. Each goal you come up, should meet the five SMART parameters in order to feel like you can actually meet your criteria and declare your project a success!

Specific    Measurable    Attainable    Relevant    Time Bound

**BRAINSTORM CLOUD**  
 Think of all the things you want to achieve your toy. As they come to mind, write them all down in the Brainstorm Cloud.

**- MY CRITERIA FOR SUCCESS -**  
 Review the goals and objectives you have written down in the brainstorm cloud. Make sure they capture your vision and are SMART. In the space below organise and prioritise the main objectives into the categories of Function and Aesthetics.

Function	Aesthetics
1	1
2	2
3	3
4	4
5	5

**CRITERIA FOR SUCCESS FLIP CARD**  
 Use Microsoft Word to create a Criteria For Success Flip Card that can be used throughout the project for ongoing evaluations. The flip card will be an easy to access tool that you can use to evaluate the progress of your project during the development and production stages of your project.  
 Visit Moodle to download the Flip\_Card\_Template.docx and then add your own functional and aesthetic criteria. Once you have added the information, make changes to the colours and font until you are pleased with the visual aesthetic. Once you are happy with the overall look, print the file so that both pages are on a single A4, fold it in half and laminate it to create your Criteria For Success Flip Card.

FUNCTIONAL CRITERIA	OR OBJECTIVES	AESTHETIC CRITERIA	OR OBJECTIVES
1	Description	1	Description
2	Description	2	Description
3	Description	3	Description
4	Description	4	Description
5	Description	5	Description

**Ongoing Evaluations**  
 Ongoing Evaluations assess the progress of your project against the criteria for success. At various stage of the project you need to stop and reflect on whether or not you are meeting the objectives on your flip card. As you are working through your folio, whenever you see an empty purple box like the one below you need to do an ongoing evaluation.

**Practice Ongoing Evaluation**  
 Evaluate one of the toys on the front cover using a PMI.

Ongoing Evaluation Title: Toys on Cover  
 Name the toy you like most and its location.

**Inspirational Quote**  
 Use the internet to find a quote you like on Goal Setting:

Figure 11. Criteria to Evaluate Success

### 1.1. Board of Studies Stage 4 Technology Syllabus

The folio section criteria for success addresses two syllabus outcomes: 4.1.1 Design Processes and 4.6.1 Evaluation. Outcome 4.1.1 states that students learn to “establish criteria for successful achievement of needs and opportunities” (BOS, 2003, p.20). Outcome 4.6.1 requires they develop

“criteria for success as a tool for assessing design development and production” (BOS, 2003, p.25) and in order to achieve this students use a template file to create a flip card that they will use to conduct “ongoing evaluation of design ideas and decisions” (BOS, 2003, p.25).

The criteria for success section of the design process folio occurs at the beginning of the project but as design is holistic, students are asked to create an evaluation system that will be used throughout. Outcome 4.1.1 (needs and opportunities) is met by firstly having students brainstorm the goals they have for the project. Students then reorganise and prioritise these into five functional and aesthetic goals that become their criteria for success. Outcome 4.6.1 (assessment of design development and production) is met by requiring that students reflect on learning. Once students decide on their goals and criteria for success, this evaluation system (the design process folio) becomes a tangible resource that they can use repeatedly to evaluate their progress. A purple evaluation box is used throughout the folio to indicate when they need to reflect on learning using their criteria for success flip card. By associating a colour (e.g. purple) to a task (e.g. reflect using criteria for success), the folio symbolically links the current task to others in the design process. In doing so, students are given opportunities to establish connections between the various components of the design process, seeing how their ideas from reflection during the purple task (goal and criteria), can be re-applied in other tasks of the design process.

### 1.2. *Social Constructivism*

The criteria for success section incorporates a social constructivist learning approach through the development of a flip card. The criteria for success section adopts an active learning approach that culminates in the creation of a quality epistemic artifact that has the capacity to be shared with the teacher and peers so evaluation can be discussed collaboratively. The focus on functional and aesthetic criteria is orientated toward mastery of skills and intrinsic motivators that provide the students with meaningful motivational incentive to commit to the project and achieve their goals.

The creative input, personal ownership of the flip card and its appearance aims to enable a strong person connection between the students and the criteria. It allows deep understanding of their goals for the project and the confidence to conduct ongoing evaluations throughout the project using their card. The section provides high structure and low control, by providing purple boxes throughout the folio so they can conduct ongoing evaluations.

### 1.3. *21st Century Learning Needs*

This section addresses 21st Century skills by requiring students to use computers in a creative manner to create their flip card. As the card becomes a shared tool, students are encouraged to produce a quality document that conforms to the limitations of a card, and is of a standard that others can understand. As the task is student centered and deeply integrated within the project, students are motivated to participate.

## 2. Time management

**7 Technology – Kewell Toys**

**TIME MANAGEMENT**  
Project Management

**Calendar Blocking**  
This project will run for 12-school weeks. This does not include holidays. On the 2013 calendar below, mark the day you started this project and then colour in the weeks that this project runs for in 2013. You will need to "block out" the school holidays using another colour.

(Add your birthday for good measure!)

January, February, March, April, May, June, July, August, September, October, November, December

**1.** Why is it important that you consider how much time you have for a project?  
\_\_\_\_\_

**2.** What are the calendar dates (dd/mm/yy) when this project starts and finishes?  
\_\_\_\_\_

Project Start Date: dd/mm/yy Project Finish Date: dd/mm/yy

**3.** What are the school term and week when this project starts and finishes?  
\_\_\_\_\_

Start Term/Week: \_\_\_\_\_ Finish Term/Week: \_\_\_\_\_

**4.** Are there any holidays or school camps that interrupt this design project? \_\_\_\_\_

**5.** If "YES", in between what weeks do they occur? \_\_\_\_\_

3

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**7 Technology – Kewell Toys**

**TIME MANAGEMENT**  
Project Management

**Activity – Colour Gantt Chart**  
Number the "Project Week" row 1-12 making sure to include the holidays. Match these up with the "Term and Week", for example Term 1, Week 3 is T1, W3. Colour the weeks that you will be doing each stage of the design process.

Design Process																							
Project Week		1	2																				
Term & Week																							
Project Proposal																							
Project Management																							
Research																							
Project Development																							
Construction																							
Evaluation																							
Presentation																							
Due Date																							

**ACTION LIST**  
Make a list of the jobs you need to do in order to get your project underway.

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**ORGANISATION WITH ICT**  
Use your laptop and/or smart phone to add these dates to a calendar app of your choice. You may use iCal, Outlook or something else. Describe the ICT method(s) you use to keep organised.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Ongoing Evaluation Title: Time Management Plan  
How well did you keep to this Time Management Plan?

+ \_\_\_\_\_

- \_\_\_\_\_

o \_\_\_\_\_

4

Figure 12. Time Management

### 2.1. Board of Studies Stage 4 Technology Syllabus

The time management section of the design folio is based on achieving part of syllabus outcome 4.5.1 “applies management processes to successfully complete design projects” (BOS, 2003, p.24). Part of this outcome requires that students develop action/time plans and this section of the folio aims to provide them with the structure of a pragmatic approach.

Students begin by blocking, on a yearly planner, the twelve-week period that the project requires. This allows them to visualize the duration of the project. They then plan the stages of the project using a Gantt chart. This method gives students the ability to determine when the project is complete and to appreciate that planning involves dividing time up evenly. A purple evaluation box is included to allow students to evaluate how accurate their plan was. To extend this section, students are then encouraged to add important dates to their digital planners in order to stay on track.

### 2.2. Social Constructivism

Social constructivists call for authentic real world problem solving (Sawyer, 2006) and involving students in the process of working out an action and time plan for their projects is a valid way of achieving this. In all six projects we provide students with an empty and identical cognitive organiser. For each project, figuring out dates and establishing a twelve-week plan is a meaningful and engaging task for students.

The repetition of the task builds up their efficacy levels and students learn and re-use strategies from their past efforts for how to best approach the task, for example, many refer to diaries and digital calendars and discuss the timing of the project with very little teacher intervention.

The task encourages the development of an important life skill and the potential for near transfer is apparent to the students as they see the potential of this activity being performed in any larger project.

The possibility of far transfer where they creatively use the same approach to a different task is also likely as they appreciate the effectiveness a cognitive organiser has for solving challenging equations.

### 2.3. 21st Century Learning Needs

The task is relevant and develops skills using an adaptable method. ICT is called upon as an appropriate tool whereby we ask students to enter the dates of the project into software program on their computer or smartphone. Programs like Outlook and iCal are common ways people stay organised and it is important that students are given opportunities to use these programs in school activities in order to develop useful ICT skills that are essential in a working environment.

## 3. Evaluation

The figure shows two pages of a student evaluation form. The left page is titled "Evaluation" and contains sections for "TOY EVALUATION" (Functional and Aesthetic), "Final Evaluation", and a peer review section. The right page is titled "CONSIDERATIONS" and includes sections for "Environment", "Ethical", and a reflection on sustainability and class conduct.

Figure 13. Evaluation

### 3.1. Board of Studies Stage 4 Technology Syllabus

The Evaluation section of the folio is the final section and covers the outcomes 4.6.1 Evaluation and 4.6.2 Considerations. The entire section is focused on reflection and a number of different strategies are used to address these two outcomes.

Outcome 4.6.1 states that a student “applies appropriate evaluation techniques throughout each design project” (BOS, 2003, p.25) and is also partially addressed in the criteria for success section of the folio. This evaluation section brings resolution to the design process by calling for a final evaluation of the project using the criteria for success tool. Rather than a purple box, the whole section is purple to indicate reflection. The evaluation focuses on their quality solution, the design process and their own learning. As students are expected to “self-assess and peer-assess design solutions” (BOS, 2003, p.25), the page’s final evaluation requires that a peer judges their quality solution against the criteria for success tool.

Outcome 4.6.2 “identifies and explains ethical, social, environmental and sustainability considerations related to design projects” (BOS, 2003, p.25) is addressed on the second page of the evaluation section. As students need to consider the environmental impact and sustainability of their project, each student has to draw a project life cycle analysis that identifies what happens to the materials at the end of the project’s life with a question mark over anything that becomes general waste. The purpose of this task is to develop responsible and ethical designers who think about the impact of their designs in terms of waste and devise sustainable design solutions.

The latter part of this evaluation questions how they could improve their work practices and become a more environmentally conscious member of the class. The self-improvement dimension of this page is separate to the project work they are doing and raises awareness about greater care towards others and the environment.

### 3.2. *Social Constructivism*

Reflection is one of the key methods suggested by constructivists to develop deep understanding (Dewey, 2009). By reflecting, students have to think metacognitively about their learning, helping to build stronger connections between new knowledge and prior knowledge. Successful knowledge integration is a critical part of learning and reflection creates an opportunity for this to occur in an appropriate way. Knowledge is lost without “robust connections” (Chi, 2005) and it is important that evaluation occurs as it allows for students to have a deeper and more connected understanding of the content. Reflection can give students an opportunity to identify misconceptions and then repair them by critically thinking about ways to improve their work.

### 3.3. *21st Century Learning Needs*

This Evaluation section completes the holistic approach of the design process and through the reflective analysis of their work students are supported in developing an awareness of their own efforts. The section encourages students to learn about life cycle analysis and then use ICT tools like Microsoft Word to a diagram that they can then glue in.

Evaluation is an important section that provides students with the opportunity to engage authentically in the process of reflection. The structure and varied methods students complete allows for the process to work on many levels. It is important that time and space are given to the section and the double page in the folio ensures this.

## **Conclusion**

The Stage 4 Technology Syllabus, by design, is capable of delivering authentic constructivist learning. The conceptual framework has identified the strengths of the design process folio, a core component of which is the effective use of ICT. This has been demonstrated through the analysis of three enhanced sections of the design process folio. ICT has been incorporated appropriately in combination with the design of tasks like the flip card and life cycle analysis allowing students to work creatively on individualised knowledge artifacts that they understand. In addition, by encouraging students to use ICT for the time management section, they gain experience with one of the technology’s greatest strength, the organisation of action and time, using the software application of their choice. The student-centered philosophy is deeply embedded and there is scope for students to make many of their own decisions throughout the high structured low control design process folio.

Improvements to the design of the design process folio identified by this analysis include: the explicit identification of syllabus outcomes and further opportunities to apply social constructivism through the appropriate use of ICT. This method of analysis could be applied to other teaching and learning designs.

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