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Happy Little Trees

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ABSTRACT

CONTEXT

What do landscape paintings with significant amounts of phthalo blue have in common with engineering education? Quite a bit it seems. Despite being a core tenant of the modern engineer, individuals' creativity may still be held back by both education design (Cropley, 2014), and student expectations. The continued move towards "T" shaped graduates create questions about effective ways to develop deliberate creativity in engineering education.

PURPOSE OR GOAL

The goal of this practice was to provide an educational intervention that deliberately embedded creativity, allowing students the opportunity for creative synthesis of key concepts presented in workshops, with a low barrier to participation. The collaborative approach also served to deliver opportunity for low stake teamwork, and to identify gaps in cohort knowledge. Ultimately it allowed an exploration of simple means of directing students towards informal learning and creative endeavours as compared to traditional delivery.

APPROACH OR METHODOLOGY/METHODS

An approach was trailed bringing together landscape paintings with course curriculum in advanced level electronics courses. This was achieved by reserving time at the end of workshops for a 10-minute live group painting using Zoom drawing tools in the format of a Bob Ross landscape painting. He is known particularly for using a "Wet on Wet" technique to develop paintings within 30 minutes, and this aligned with the format of the session, as well as the tools available to students. The only requirement was to project the core concept that was discussed in the workshop into the painting. Participants were completely free to develop their own style of drawing, whilst following a basic scaffold to guide the sessions.

ACTUAL OR ANTICIPATED OUTCOMES

The creativity of this intervention activity was used to establish higher level synthesis through constructivism (Ackermann, 2001). It also provided opportunity for collaborative learning and teamwork, and established student skills in use of analogy and creative expression to consolidate key concepts and reaffirm that creativity is a core component of engineering education.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Based on the current evaluation, the key strengths of this creative approach have been immediate key concept reinforcement, informal development of collaborative skills and teamwork, and a student appreciation for creative learning activities beyond traditional methods. All these strengths support the move toward the "T" shaped graduate under the 2035 Deans' plan.

KEYWORDS

Creativity, STEAM, Constructivism

Introduction

What do landscape paintings with significant amounts of phthalo blue have in common with engineering education? Quite a bit it seems. Despite being a core tenant of the modern engineer, individuals' creativity may still be held back by both education design (Cropley, 2014), and student expectations.

Promoting creativity, without inadvertently destroying it (Törnkvist, 1998), and promoting innovation in engineering education have long been desirable in professional engineering education. In "Preparing Engineers for 2035" (Lee, 2022) creativity is specifically mentioned as a desirable attribute for "T" shaped graduates; however its purpose is left to interpretation. It states that "engineering must be promoted as both a solutions-orientated and creative field – with creativity not only based around such quantities as inventiveness and design, but also, the skills associated with enterprise and innovation". That is, it seems that creativity and innovation is a driver for enterprise innovation, presumably for new and novel products, and services.

However, when considering the national Stage 1 competency standards for Professional Engineers (Engineers Australia, 2019) it is important to note that approximately 80% of the degree "should" be in a mathematical and scientific area, 10% in professional engineering practice, and 10% in either of those domains or elective studies (Crosthwaite, 2021). There is no explicit requirement concerning creation of ideas, products, services, challenging current norms, nor re-imagining the future world.

This divide between the open-ended desirable skills of "T" shaped engineering graduates, and the rigorous competency standards that they are ultimately assessed against, provides significant opportunity for educators to explore creativity and innovation in the curriculum, classroom and beyond. This embedded creativity and innovation can be both cognate and specialisation related, that is, the use of creativity to solve problems in not only their fields, but in other topic areas as well (Smith & Smith, 2020).

The need for deliberate creativity

There are many broad definitions of creativity, some sociological, some technical.

Creativity is commonly defined as the ability to produce work that is novel, that is original, unique, useful, and generative (Sternberg and Lubart, 1996). As humans, we are elementally creative beings. From an early age we create, and start to practice expressions of art, and the develop the creative self. Our creativity is linked to inventiveness; by looking at the status-quo and challenging assumptions and imaging a different future. According to Guilford (1950), creative people can be characterized by the ability to produce a large quantity of ideas (i.e., ideational fluency), to produce novel output of unique and original ideas, or to think flexibly. That is, the ability to produce different types of ideas.

If we accept the premise that creativity in engineers is a desirable attribute, we need to also accept the premise that creativity needs to be included in engineering education in deliberate ways. But often that 'deliberate creativity' is at odds with the existing education programs.

Overspecializations in engineering education are perhaps causing a problem – Cropley (2015) observed that students in engineering education were subject to a significant level of "relatively superficial" technical material, presented in a "very superficial" manner.

This approach of loading courses with technical material, in an attempt to expose students to every conceivable situation they might face as a professional, has meant students are more likely to be learning the 'solutions' to current problems, rather than learning the skills needed to develop the solutions that don't yet exist. As Buhl (1960, p10) details, "A student may now be assured that 10 or 20 years after graduation many of the problem solutions and "facts" presented to him will have changed.".

Despite making their observations almost 60 years apart, Buhl (1960) and Cropley (2015) both highlight the same issue, the overloading of education programs with 'solutions for now' technical content proves problematic for engineering students, graduates and professionals in the long term, as it impedes their ability to develop their professional identity (Sheppard et al, 2008) and undertake one of the most fundamental engineering jobs – problem solving.

This functional requirement for engineers to be problem solvers, often "on-the-spot", is one based in creativity. That is, it is necessary for engineers to problem solve through creative solutions at an instant, where further reflection is sometimes possible. This then leads to convergent thinking, requiring immediate attention to the "creative" solution (Kaufman, 2015).

Beyond this link between engineering function and creativity, there are other reasons for deliberately embedding creativity in the engineering curriculum. Among these is the value of creativity at the level of the individual. Cropley and Cropley (2000) drew attention to the benefits of creativity in education, highlighting that in groups of students with high IQs, students with the additional skills of high-level creativity will outperform the other students consistently at school and university.

This pattern is starting to be identified in the larger population as well – a modest study by Anderson et al (2002) compared the brain function of people that scored in the top 2% of the Creative Achievement Questionnaire (CAQ), called the "Big C" group, with a group of highly intelligent, but not particularly creative, people – called the Smart Comparison Group (SCG). The Big C group made more novel connections in the brain, allowing them to come up with more creative solutions to the problems posed. The brains of the SCG showed more use of localised neural networks, which has benefits of increased efficiency, but could be linked to lower levels of creativity.

So if creative thinking can deliver high performing students (and thus graduates), but also talented problem solvers, then it becomes critical that creativity is not left to be developed by 'accident' in engineering education. We must foster deliberate creativity for the benefit of the individual student, as well as for the benefit to the profession as a whole - To think creatively is essential for education.

Engineers – The Visual Learners

It is well observed that Engineers have a tendency to respond well with visual learning methods (Baukal, 2015 & James-Gordon, 2001, for example), and this can be linked to the very nature of what engineering is.

For instance, important elements of electrical and electronics design are the physical components themselves, along with physical concepts such as wiring configurations, coupling of electromagnetic interference, placement of components, physical shielding design, and so on. These physical components require clear demonstrations as to their utility, implementation, and relationship to each other. By definition of their function, there is a piece of visual learning that needs to occur, both in the physical world, and with conceptual models, to ensure understanding of the higher-level design requirements. This visual learning develops the skills that allow students to transcend to a more general visualization process where they can move from the physical world to conceptual models, and vice-versa.

Traditional teaching practices

For mixed cohorts of on campus and online students, traditional teaching demonstrations are often performed for on-campus students and recorded, or special versions recorded and released through learning management systems. While this approach may help address the need for visual learning, it does not allow for spontaneity, or demonstrations of the chaotic nature of the universe i.e., things break, or behave counterintuitively, that are addressed by "on the spot" problem solving. These methods also prevent opportunities for direct feedback, discussion, workshopping, or flipping the session and allowing the student to perform a live demonstration. Ultimately these methods are actively reducing the opportunity for deliberate creativity, and this is exacerbated even further for students who are studying exclusively online.

A deliberate creativity approach

The goal was to provide an educational intervention allowing deliberate creativity to be embedded in an online workshop. The students could observe live demonstrations, providing opportunities for immediate and spontaneous inquiry, while subsequently having them participate in a deliberate creative activity to spark cognitive real-world connections – the behavioural change that was the aim of the intervention.

Studying to be an engineer requires understanding, creativity, and "formation" in its educational process (Shulman, 2005). It could be considered that creativity, per-se, should not traditionally have rules or form. As an open form of expression, it can have purpose, or it can *not* have purpose. It can have outcomes, or *not* have outcomes. That is, it could be considered that there are intrinsically no rules about what it should be.

As an engineer the traditional "engineers deliver" paradigm is true, and usually there is a desire for an outcome or an output because of this creativity. The goal here was not necessarily to force an output but more create an internal dynamic where creative possibilities could be explored or enabled.

Sternberg (2007) presented 12 strategies that can help to guide the development of creativity. Many of the elements may be present in traditional teaching practices, however, deliberate design must be used to drive the practice and development of these skills in engineering education. As such, Sternberg's strategies were modified for the purposes of providing a structure to the intervention – the deliberate creativity activity. The modified strategies were as listed below:

1. Redefine problems, and continue to if required
2. Question assumptions
3. Sell and communicate creative ideas
4. Ideation
5. Encourage sensible risk taking
6. Allow a sense of ambiguity
7. Develop creative self-efficacy
8. Become driven about problems

The "Happy Little Trees" Activity

The overarching goal of what became the "Happy Little Trees" activity was to provide an educational intervention (learning activity) to direct students towards participating in convergent creativity (the behavioural change dictated by the intervention), using the modified strategies to guide the activity.

The development of the activity required the consideration of several key areas, including attendance, participation, collaboration, creative approach, and technology.

As the activity was not specified in the course requirements, and attendance and participation were entirely optional, selling the benefits of the approach as a worthwhile activity to tired students attending a late-night online class session was critical. Initial considerations were that this intervention required a low risk, low stake, and familiar approach, and these would assist in convincing the students of the benefits of participation.

The next consideration was whether the intervention should be an individual or team-based approach. A team based collaborative approach was chosen, with the hope that it would provide the fullest capture of participants (from lurker through to expert painter) and provide a more collegiate approach to the activity.

When considering the possible expressions of creative approaches for the intervention that could be made there were several options to be considered.

- Text based – prose, poetry, code, etc.;
- Sound based – dialogue, discussion, readings, songs, etc.; and
- Image based – scripts, cartoon, movie, painting, etc.

Text based contributions are very common and easy to capture however real-time collaboration would require a platform that allowed this to occur such as an online text editor (Google Docs, Online Office tools). Sound based tools were determined to have been difficult to work with in a real-time manner.

Another consideration was to have students use a different approach to what was already being utilised in the course, as the chosen method for the intervention had to promote the behavioral change outcome, as well as provide reinforced mastery using creative constructs. Text and sound were already being used, so the Image based methods appeared to be the natural solution and were in keeping with the proposed notion that engineers are visual learners.

It was decided that reserving time at the end of workshops for a 10-minute live group painting activity using Zoom drawing tools would be used for the initial run.

As to provide a grounding in the real world, it was decided to adopt the format of a Bob Ross landscape painting. Bob Ross was an American painter and host of “The Joy of Painting” instructional TV series. He is known particularly for using a “Wet on Wet” technique to develop paintings within 30 minutes which was philosophically in line with the short timeframe of the activity.

The annotation/drawing tools available in the “Classic” mode of Zoom, whilst being relatively simplistic, allow colours with transparency, as shown in Figure 1. This would allow for some emulation of the “Wet on Wet” technique for blending colours directly on the canvas permitting unexpected complexity to the drawings. Live annotations made by participants feature a name tag, identifying which participants are actively drawing which object.

Students would be projecting the core concept that was discussed in the workshop into their paintings. Participants were completely free to develop their own style of drawing, whilst following a basic scaffold, utilising the modified strategies to guide the sessions through to timely completion.

And thus the “Happy Little Trees” activity was born!

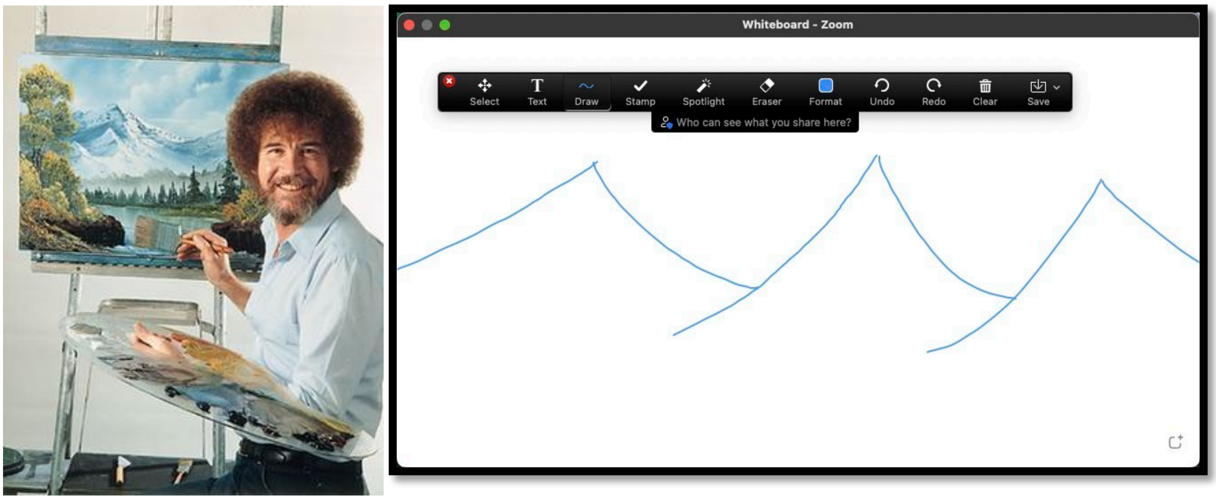

Figure 1 (Left) Publicity photo of Bob Ross with his style of painting in the background (source https://en.wikipedia.org/wiki/Bob_Ross). (Right) The annotation/drawing tools available in the “Classic” mode of Zoom

Happy Little Trees: Take 1

The first attempts of the “Happy Little Trees” activity, bringing together landscape paintings with course curriculum, were in advanced level electronics courses.

The behavioural change of the intervention required participation in the “Happy Little Trees” activity. The concept of collaborative drawing was introduced early to the class, and it was reiterated that it was indeed a learning activity that would benefit the students individually, and as a group. As the activity would be typically conducted at the end of a workshop session, there was a need to create enablement and reduce session attrition before the conclusion of the drawing. This was done through creating a sense of purpose and belonging with the cohort.

Again, whilst not wishing to curb creativity, the notion of recurring themes was introduced so that it created a sense of familiarity to the overall open-ended activity and allow for recurring themes, object permanence and convergent creativity. Not only was the Bob Ross landscape theme used as a reoccurring theme, but to support authentic engagement the academic in charge of the sessions added their own personal elements, including elements of:

- a person SCUBA diving with pink equipment - the academic has pink SCUBA equipment
- a Scottish flag - they have Scottish heritage
- the Loch Ness Monster - again the Scottish heritage

- A small “tinny” boat with an outboard motor - with an electric motor, linking the concepts of electronics
- A submarine with elevated periscope -drawing on the absurd nature of this image reinforcing that a lack of real-world coherence was allowed in the task

Examples of the outputs of these initial attempts can be seem below in Figures A1 through A5, along with a short narrative about the figure.

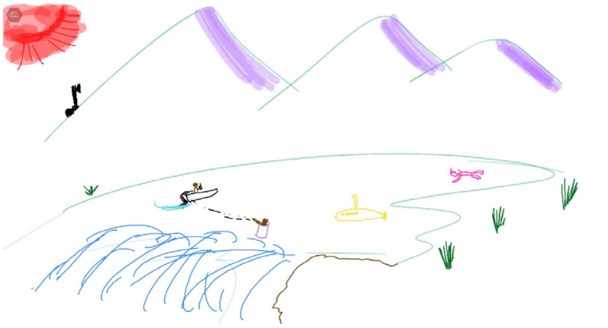

Figure A1. An early Bob Ross Style collaborative painting as students gain confidence in both the collaborative drawing system, and their art style.

Figure A2. A Bob Ross Style collaborative painting regarding “Phase Locked Loops” re-imagined to be “Fishing Locked Lines”, a play on words.

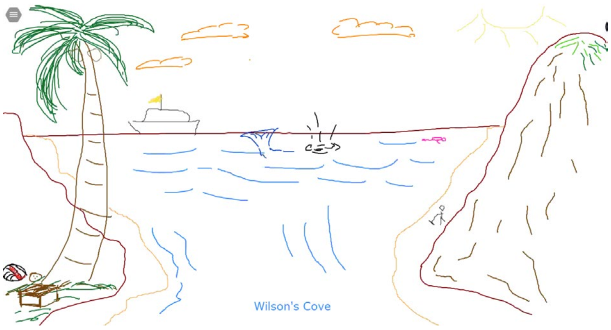

Figure A3. Painting depicting “signal <u>isolation</u>” (despite the lecturer still SCUBA diving in pink equipment and easy access to a cruise ship)

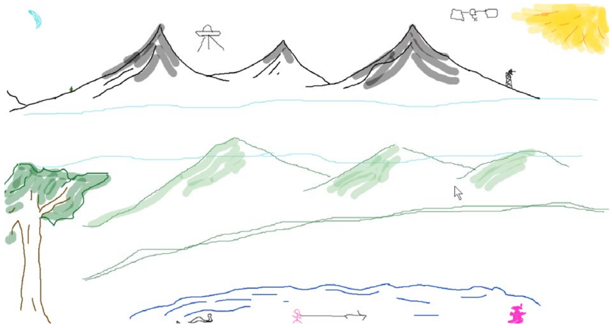

Figure A4. A more traditional painting about satellite communication. As elements of SETI and NASA Voyager were mentioned, appropriate contributions can be seen as well as the course lecturer in pink SCUBA gear, ski-boat, and Loch Ness. Strangely missing is the submarine periscope - possibly hinting that the student typically contributing that element was not in attendance.

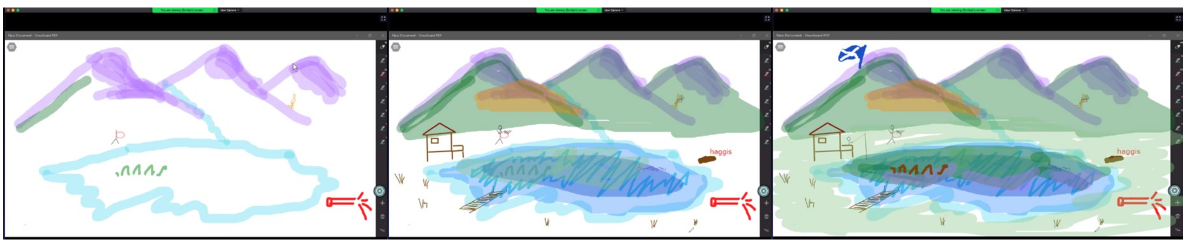

Figure A5. An example of the development of the above painting showing the initial template, and then progressive edits to incorporate the creative elements, and then adding the theme or topic, in this case eWaste and environmental issues. Note the Scottish influences, including haggis, flag, and bagpipes.

Observations

Observations were made by the educational professional running the session, both during and after each session to identify any broad or specific patterns that occurred throughout the activity, particularly around students synthesizing the workshop content, as a specifically designed learning activity designed to deliver course learning outcomes. Using the modified strategies of Sternberg (2007), as noted below, the observations were formed into a thematic analysis of in-session behavior, as well as specific or identified learnings of reinforcements that could be identified.

1. Redefine problems, and continue to if required
2. Question assumptions
3. Sell and communicate creative ideas
4. Ideation
5. Encourage sensible risk taking
6. Allow a sense of ambiguity
7. Develop creative self-efficacy
8. Become driven about problems

The observations made included:

- Particular students preferred to contribute specific elements. This was a recurring theme during the sessions where specific students took it upon themselves to contribute a consistent message, object, or method. This self-organization suggests reinforcement of the notion of establishing team roles, while also identifying a sense of belonging to the group and activity.
    - Strategies demonstrated: 3, 4, 7, 8
- Synthesis across fields of knowledge, where it was common to create anamorphic representations of concepts and of electronic components.
    - Strategies demonstrated: 2, 3, 4, 7
- Creating the complete show – knowing there was a format to the show allowed a sense of belonging to develop and appeared to reduce the anxiety of participation in a group activity.
    - Strategies demonstrated: 1, 3, 4, 5, 7, 8
- Alliteration became a key component - the exploration of technical words and creating similar sounding but more descriptive terms or words. Given that it is assumed that engineers tend to be more visual, this was also explored where themes of concepts were re-worked into a visual description and then changed to fit the themes of the "painting". An example is a painting after a session on Phase Locked Loops. The new painting became "Fishing Locked Lines", including at least 3 concept changes of conceptual alliteration in the title itself.
    - Strategies demonstrated: 1, 2, 3, 4, 5, 6, 7
- Object permanence was explored, where a range of common elements were always contributed, such as UFO (Alien Ships), Aliens, Some form of natural disaster, Person fishing with a rod. Many of these elements were led by the nature of guiding mountains and lakes into many of the "paintings".
    - Strategies demonstrated: 1, 2, 3, 4, 6, 7

Conclusion

Based on the observations and initial evaluation against the modified strategies, there have been success indicators in key areas of the deliberate creativity intervention of "Happy Little Trees" learning activity, beyond the achieved course learning outcomes. These include:

- immediate key concept reinforcement – students were able to develop and utilise several creative ways, beyond drawing, to embed the course concepts into their paintings. These included alliteration, humour, and analogies.
- development of collaborative skills and teamwork – students worked on their paintings in teams, and this resulting in them discussing the electronics concepts as a group, allowing a higher level of understanding and synthesis.

- student appreciation for creative learning activities beyond traditional methods – students were able to participate in a non-traditional learning activity that linked deliberate creativity to key concepts, highlighting the opportunity for creativity in their learning journey.

All the modified strategies were used and could be seen in action at various stages throughout the workshop and “Happy Little Trees” activity, however further evaluation is required to fully map the strategies against the observations and other success indicators.

Overall, this activity can be considered as having been successful in its initial attempts, achieving the goal of behavioural change by application of deliberate creativity to engineering education. Further attempts and refinement are planned.

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