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Creative Dispositions: Teaching for Creativity in Engineering Education*

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In this article, we discuss the incorporation of a course entitled "Creative Sound Workshop" into the Acoustic Engineering undergraduate curriculum at the Universidad Austral de Chile. The course was aimed at offering an experience of applied musical creativity to engineering students. We provide a detailed account of the process of curriculum design, with reference to the current literature on creativity and, more specifically, creative thinking in education. We also introduce the notion of "thinking dispositions", in the light of which we discuss students' performance on their final project: the design of a semi-autonomous interactive digital instrument using Pure Data, an open-source visual programming environment. Finally, we reflect on our experience of two years of teaching the workshop, and discuss how the course has been received.

Keywords: creativity; thinking dispositions; engineering education; course design; music creativity

1. Introduction

The '2020 Initiative', drawn up in 2005 by the American National Academy of Engineering, placed creativity as one of five central attributes of modern engineering graduates, and called for changes in engineering education [1]. This analysis has been echoed internationally by numerous studies in the field of engineering education, emphasizing the impetus for change provided by economic trends [2–6] as well as shifting pedagogical paradigms [7, 8]. As the year 2020 draws to a close, creativity has a well-established place at the center of developed and competitive societies, and there is a consensus that engineering training programs should be aiming to produce creative professionals, rather than simply technically-proficient engineers [9]. In response to these demands, the CDIO Initiative, a novel international framework for engineering education, maintains that engineers need to *conceive of*, *design*, *implement*, and *operate* products in increasingly collaborative and transdisciplinary environments [10]. This cultural shift has effectively changed the debate surrounding the place and value of creativity in engineering curricula: creativity today is less a matter of *if* than a question of *how* [11, 12].

But is creativity something we can teach? By all accounts, yes: there is a wealth of evidence that suggests creativity can be enhanced through deliberate instruction, appropriate feedback, and targeted practice [13–15]. This point is crucial because, broadly speaking, creativity is still poorly understood and plagued with enduring myths that undermine its development. The most problematic of these is the persistent idea that people are either inherently creative or uncreative [16]. What does remain unclear, and therefore motivated the research reported here, is the question of which practices produce the most creative thinkers, as curricula capable of nurturing creativity remain very much a "desirable vision" rather than an "empirical outcome" [14, p. 381].

In this article we give an account of the incorporation of a Creative Sound Workshop into the Acoustic Engineering undergraduate curriculum at the Universidad Austral de Chile (UACh). The workshop provided a hands-on and project-based experience of applied musical creativity to engineering students. We discuss how course design was informed by current literature on creative thinking, and how it attempts to promote the development of creative dispositions among young engineers.

2. Creative Attitude and the Thinking Dispositions Model

> "Creativity is a habit. The problem is that schools sometimes treat it as a bad habit" [17, p. 394].

2.1 The Attitudinal View of Creativity

Creativity has always been considered an important feature of human thought, yet it was not until the early 20th century that substantial studies of creative thinking appeared, driven by the emerging field of psychology [18]. Since then, creativity has been studied from a variety of perspectives, alternately emphasizing individual, social, environmental, and economic factors. While many tenets of research into creativity – such as domain-specificity [19] – remain the subject of intense debate, there is generally some convergence around a number of fac-

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tors, behaviors, and conditions that are understood to be relevant – albeit not entirely indispensable – for the development and expression of creativity. Individual attitude is one such factor, and it has long been considered a central attribute in the study of creativity. We tend to think about creativity from the standpoint of the individual, and indeed much of the language we use to discuss it reflects a subject-centered perspective [20]. Seen through such a lens, creativity can be construed as a personal "disposition" towards originality [21], often correlated with personal traits such as openness to experience, tolerance of ambiguity, willingness to take risks, courage, and non-conformity [22–24]. In this article, we look at creativity from such a dispositional perspective, considering it a function of students' thinking habits and skills, and describe how this conceptual perspective has informed our approach to course design.

2.2 Thinking Dispositions

The notion of "disposition" has been important for the understanding of our intellectual life offered by a number of prominent scholars, starting with Dewey and his notion of good habits of mind, [25] and developed in authors like Passmore [26], Baron [27], Siegel [28], and Ennis [29]. As defined by Perkins, Jay and Tishman, "thinking dispositions" are "tendencies towards patterns of intellectual activity that condition and guide cognitive behavior" [30, p. 6]. In this sense, good thinking consists of constellations of beneficial and well-developed intellectual habits that afford critical and/or creative thought [31]. Being a good thinker, in other words, literally means having the right set of dispositions for a given situation or task [31, p. 2]. Elaborating on earlier dispositional views of thinking, Perkins et al. assert that any notion of disposition that is too reliant on abilities alone ultimately fails to give a proper account of our actions and habits [30]. This helps to explain what is sometimes referred to as inert knowledge – the idea that knowing something does not neatly translate into a healthy commitment to that knowledge or skill [32]. While abilities – or "know how" – are considered a necessary part of creative behavior, they are also understood as insufficient, in and of themselves, to produce originality and innovation [17, 33].

Aware of the overreliance of traditional engineering education on skills, in designing the Creative Sound Workshop a main methodological goal was to steer away from ability-centered instruction and direct transmission paradigms [31]. We set out to accomplish this not at the expense of opportunities to practice skills, but by adopting Perkins et al.'s triadic theory of dispositions, which places comparable emphasis on inclinations, sensitivities, and abilities [30]. Inclination, according to their framework, refers to a student's "felt tendency towards toward behavior X", such as a propensity engage in divergent thinking. Sensitivity, in turn, is defined as an "alertness to X occasions", such as moments where speculative ideation is appropriate and advantageous to carrying out a project. Finally, ability is defined as the actual capacity to "follow through with X behavior", that is, having the knowledge and skills to execute a task [30, p. 4]. Our adoption of this holistic model was meant to ensure that students not only learn the tools they need in order to be creative, but are also reasonably inclined to use them in their professional lives – i.e., that they make a habit of being innovative and original.

2.3 The Creative Thinker

In this study, we consider a creative individual to be related to the "ideal thinker" described by Perkins et al. [30]. This notion is supported by Halpern, who has drawn attention to the ways in which critical and creative thinking overlap, calling the second a subset of the first [14, p. 382]. This cemented Perkins et al.'s "Dispositional Theory of Thinking" [30] and Tishman et al.'s "The Thinking Classroom" [34] as important conceptual and methodological references for course design and assessment in the Creative Sound Workshop. Between them, the two texts set out a series of thinking dispositions that they claim are paramount for "good thinking". Since our focus in designing the course was on developing students' creative habits and skills, we identified four of these dispositions as particularly relevant to creative development, and devised teaching strategies to support them. The dispositions were:

1. *A disposition to be broad and adventurous*: a tendency to explore, to think "outside the box", to be comfortable with multiple solutions or ambiguity, to guard against narrowminded thinking.
2. *A disposition towards sustained intellectual curiosity*: a tendency to wonder, to speculate, to be observant and analytical; the ability to formulate novel questions.
3. *A disposition to be planful and strategic*: a tendency towards working in a structured way, formulating and executing plans: alertness to the necessity of convergent thinking.
4. *A disposition to be metacognitive*: the tendency to keep track of one's own thinking processes, the ability to control one's own thinking [30, pp. 6–8].

While dispositions 1 and 2 are known to touch on creativity more directly, we considered that dispositions 3 and 4 are key in promoting a reflexive – and ultimately reproducible – approach to one's professional practice. If not an exhaustive list of the dispositions implicated in creative behavior, these general attitudes are in line with research that links creativity to attributes such as "openness", "tolerance of ambiguity", "curiosity", and "self-awareness" [35, 36]. In section 3.3 of this article, we provide a table describing in greater detail how course activities, creative dispositions, and various principles of teaching and learning were combined in the Creative Sound Workshop (Table 1).

3. Creative Sound Workshop

3.1 Acoustic Engineering at the Universidad Austral

The Bachelor's degree in Acoustic Engineering at UACh is one of only two undergraduate programs in acoustics offered in South America. Research in the associated institute is multifaceted, with active lines of research dealing with noise control, environmental and underwater acoustics, signal processing, mathematical modeling of acoustic phenomena, soundscape studies, spatial audio, sound reinforcement, music production, and new musical interfaces. Self-reported assessment by first and second year students in the degree program shows a diversity of interests across different aspects of the discipline, reflecting the interdisciplinary nature of the curriculum. More relevant to this study, this informal assessment shows that the majority of students consider it important – given their own understanding of what an acoustic engineer ought to be – that courses go beyond teaching the skills more traditionally associated with the discipline and venture into more creative territory. We take this data to be significant, given that this belief is likely to inform how students perceive themselves – i.e., as belonging to a "creative" or a "non-creative" class of social actors [16].

3.2 Course Description

The Creative Sound Workshop was conceived of as a course that could provide second year acoustic engineering students with an experience of applied musical creativity, after they had taken introductory courses in music language and technology. The most immediate goal of the course was to provide students with practical and conceptual tools for the design and implementation of creative audio projects, using state-of-the-art music technology. As described earlier, a second goal of the course was to do provide them with these skills in a manner that promoted students' creative inclinations and sensitivities as well. In designing the course, teaching strategies and projects were selected based on the extent to which they provided opportunities for invention, and created incentives for a creative classroom culture. The course came to consist of a mixture of lectures, critical-listening seminars, creative counselling, and project-based workshops. In total, sixteen students took part in the course.

The first unit of the workshop is centered around the design and implementation of an audio composition drawing on both preexisting field recordings and software instruments. No stylistic constraints were placed on the project, and the pre-recorded materials were available merely as scaffolding. The open-ended nature of the assignment allowed for greater diversity of outcomes, and had a notably positive effect on student motivation – a factor we know to be linked to higher creative outcomes [37]. The unit began with lectures on the expressive role of musical parameters such as space, timbre, and musical form, providing students with repertoire examples and targets for their own creative performance [38]. Participants were also given a reading list covering topics of musical creativity, digital audio, and audio mixing techniques. Once work on the creative projects began, teaching shifted to a combination of hands-on workshops and listening seminars. Both formats allowed for plenty of interaction and opportunities for formative assessment, with workshops structured around immediate assessment and listening seminars having an emphasis on peer feedback.

The second and third units of the course feature Pure Data, an open-source visual programming environment for multimedia applications, most notably music [39]. Pure Data, or simply "Pd", is a powerful programing tool that allows for interactive and real-time processing of audio through an intuitive modular interface [40]. When designing an application in Pd, students need only to connect various boxes, called "objects", which perform high-level programming functions such as signal processing, stochastic operations, or data management. In the second unit, students are introduced to Pd through a series of low-stakes creative challenges. These challenges present the students with ample goal-directed practice and reinforce the open-ended character of the programming environment, with multiple "right answers" allowed [41]. The unit concludes with a test taken inside the programming language itself, where students must demonstrate basic proficiency in Pd's programming objects, functions, and other domain-specific skills. The test is considered a baseline from which students can embark on a larger-scale creative project [42].

In the third unit, students are assigned the main creative project of the course: the task of designing a semi-autonomous digital instrument, open to user interaction. Any such instrument would have to contain: (1) a sound engine, using a combination of additive and subtractive synthesis; (2) a stochastic engine, in charge of controlling the instrument's semi-autonomous behavior; and (3) an interface for user input and playful interaction. These structural constraints were devised to offer a sense of "guided openness", where a narrowing of design paths promotes a sense of "zooming in" on the possibilities afforded by the proposed project format. Work on the instruments is carried out through workshops where students are given specific targets, related to the instrument's components, and are encouraged to explore different kinds of musical and structural strategies. Instruction and instructor feedback in unit three is provided with special emphasis on strategizing, computational thinking, metacognition, and the creative possibilities of instrument behavior and interaction. The project is then presented to their colleagues in a poster session format.

3.3 Table of Learning Principles and Thinking Dispositions

Table 1 describes how academic activities were selected in relation to the dispositions discussed in section 2.3. For each academic activity, we identified a series of principles of teaching and learning connected to openness, curiosity, method, and metacognition [38]. This table was not meant as an exhaustive or conclusive framework, but as part of course design process and as a way to bridge theories of creativity and of teaching and learning to the classroom.

3.4 Assessment

Opportunities for formative assessment were present in nearly every class of the Creative Sound Workshop. In addition to their role in supporting student learning [43], such instances of feedback are key in creating a classroom culture of constructive and dynamic criticism, breaking down the defensive attitudes, misconceptions, and "blocks" that challenge creative growth [16, 24, 44]. Among the modalities of formative assessment employed in the course, balanced instructor feedback was the most prominent one. These instances would frequently touch on the topic of creativity, with invention and originality as common parameters of assessment. This form of "creative counselling" has been linked to gains in measures of creativity [45, 46] and, while not so common in engineering education, is one of the most predominant teaching strategies in the arts [44]. This approach has been modeled by the authors after highly creative fields such as music composition, creative writing, and painting, where one-to-one criticism is virtually synonymous with instruction.

Peer assessment also played an important part in the Creative Sound Workshop. The first unit of the course culminates in a series of listening sessions, during which students are asked to provide their colleagues with balanced feedback in an online forum. Students were asked to highlight successful features of each other's work, while also providing feedback on what could be improved, according to the project's assessment rubrics. These listening sessions tended to be highly engaging, and helped students to gain confidence and awareness of the quality of their work [44]. Students took on the role of commenting on their peers' work seriously and respectfully, and the task allowed them to exercise a more rigorous and critical engagement with their own projects.

Assessment of creativity during the course was designed around the creative product and did not involve psychometric evaluation of the students themselves. Our assessment was designed to follow the core principles of Consensual Assessment Technique (CAT) as originally proposed by Amabile, which dictate that (a) any assessment needs to be carried out by experts in the domain; (b) that such assessment needs to be independent; (c) that it should consider parameters beyond creativity, such as technique and aesthetics; and (d) that this evaluation should not be made against a fixed standard of creativity, but against other works in the same context [47]. Projects then were evaluated based on technical, conceptual, aesthetic, and reflexive criteria, which were presented to students at the onset of each project. For the final project, which we discuss in the following section, the assessment rubric was composed of five equally weighted criteria:

1. Structural effectiveness.
2. Creative use of musical timbre and mastery over sound synthesis techniques.
3. Conceptual clarity and originality.
4. Interface layout and user interactivity.
5. Reflection and documentation.

Criteria 1 and 2 are predominantly related to skills and techniques acquired during the workshop, while 3 was assessed in light of overall level of conceptual variety and invention. Criterion 4 considers both technical and creative aspects of students' work, and criterion 5 was used as a measure of self-reflection or metacognition.

3.5 Final Project: Creating a Semi-autonomous Interactive Instrument

For their final project, students were asked to conceive and develop a semi-autonomous interactive instrument, using the Pure Data programing environment. Pd is an open software with a global

Table 1. Relationship between academic activities, principles of teaching and learning, and thinking dispositions

U	Academic Activity	Principles of teaching and learning	Thinking disposition involved
1	Lectures on core creative and compositional principles/ parameters.	(1) Providing examples or models of target performance. (2) Creativity and divergent thinking presented in a positive light. (3) Direct transmission.	*(a) Disposition to be broad and adventurous.* *(b) Disposition towards sustained intellectual curiosity.*
1	Independent creative work	(1) Scaffolding (recordings). (2) Project-based learning. (3) Intrinsic motivation (ownership and creative control over product). (4) Hands-on learning. (5) Real-time feedback. (6) Rewards for creativity.	*(a) Disposition to be broad and adventurous.* *(b) Disposition towards sustained intellectual curiosity.* *(c) Disposition to plan and be strategic.*
1	One-to-one feedback and working sections.	(1) Targeted feedback. (2) Real-time feedback. (3) Presenting multiple strategies. (4) Incubation of ideas.	*(a) Disposition to be broad and adventurous.* *(d) Disposition to be metacognitive.*
1	Presentation of work-in-progress to peers.	(1) Balanced feedback. (2) Peer evaluation. (3) Creating a culture of positive critical engagement.	*(d) Disposition to be metacognitive.*
1	Critical listening and providing peer feedback.	(1) Role-play (shift in perspective). (2) Promoting an analytical attitude. (3) Creating a culture of positive critical engagement. (4) Critical listening.	*(d) Disposition to be metacognitive.*
2	Lectures on programming.	(1) Providing examples or models of target performance. (2) Direct transmission.	*(c) Disposition to plan and be strategic.*
2	Programming challenges.	(1) Goal-directed practice. (2) Real-time feedback. (3) Computational thinking. (4) Multiple answers allowed. (5) Rewards for creativity in low-stakes situations.	*(a) Disposition to be broad and adventurous.* *(b) Disposition towards sustained intellectual curiosity.*
3	Project design.	(1) Focus on strategizing rather than execution. (2) Divergent thinking exercises. (3) Intrinsic motivation (ownership and creative control over product). (4) Multiple answers allowed.	*(a) Disposition to be broad and adventurous.* *(b) Disposition towards sustained intellectual curiosity.* *(c) Disposition to plan and be strategic.*
3	Supervised programming sections of semi-autonomous interactive instrument.	(1) Goal-directed practice. (2) Project-based learning. (3) Intrinsic motivation (ownership and creative control over product). (4) Hands-on learning. (5) Real-time feedback. (6) Rewards for creativity.	*(a) Disposition to be broad and adventurous.* *(c) Disposition to be planful and strategic.* *(d) Disposition to be metacognitive.*
3	Creative and technical reflection and documentation.	(1) Self-assessment; (2) Rewards for strategizing; (3) Communicating one's own thinking and creative process.	*(c) Disposition to be planful and strategic.* *(d) Disposition to be metacognitive.*

community of users and developers. It is also commonly used in higher education. Students were encouraged to take advantage of the "tabula rasa" aspect of Pd and be inventive in their choices of sound design, autonomous instrumental behavior, and user interaction. Lastly, students were asked to submit documentation of their work, which functioned both as a user's manual and developer's guide. Despite having limited programming experience, students were enthusiastic about the project and performed well.

Ten projects were submitted by students, two of which will be discussed here in greater detail. While the submissions were markedly different one from another, structurally most of the instruments tended to fall into one of three categories: (1) a keyboard, with the laptop keys triggering musical events; (2) a sequencer, where user-defined events would be played either sequentially or according to a stochastic design; or (3) a loop machine, where textures and patterns are activated and stacked against each other. Although there was a degree of conceptual hybridization, whereby students combined elements from more than one approach, from a user perspective the dominant mode of engagement tended to be clear-cut. The remaining works (i.e., those that did not fall into either of the three aforementioned categories) could be described as an "autonomous melodic improviser" and a "binaural-beat generator". Both were highly original, given the project description, but did not allow for enough user interaction to be considered fully fledged "instruments". Using the standard assessment criteria of divergent thinking, we consider that the student projects expressed a high level of fluency (number of ideas generated); moderate flexibility (structural and conceptual variety); and moderate originality [48].

3.6 Examples of Student Works

In this section, we will discuss two projects which exemplify particularly well the creative solutions and the limitations found we have identified across students' work. Both projects are fairly unique in that they successfully integrated the conceptual dimension of the instruments to aspects of their interface, functionality, and sound production.

The first project falls under the category of a keyboard (Fig. 1). Upon initialization, the instrument began operating autonomously, self-selecting one of four possible chord progressions and creating a soft musical background. A degree of indeterminacy was built into the system, both within the chord progressions themselves, and in the how progressions were selected. The instrument possessed a thematic element, associating each chord progression with a season of the year. The theme was further reinforced by a visual element in the user interface: a tree that changed colors according to the setting in which the instrument was operating. User input came in through the laptop keyboard, and the selected season also defined the musical scale available to the user. Melodic and harmonic timbres were created using a mixture of additive and subtractive synthesis, with a simple timbre associated with the harmonic background and a harsher, more inharmonic timbre associated with the melody. The interface compared the keyboard sounds to those of a "robotic bird".

The second project falls into the loop machine category. The interface suggested a straightforward series of simple musical elements that the user could activate or deactivate – with the active elements being continuously stacked to produce elaborate musical textures. Individual elements were themselves were fairly complex: each of the 16 available layers is a simple autonomous composition on its own. The result is an instrument capable of producing intricate polyphonic pieces. The result is a simple interface, where playing means cueing layers in and out, producing combinations that range from silence to a thick 16-voice polyphonic texture. In this latter, individual layers combine – some more successfully than others – into a dynamic fabric. As with the earlier example, the

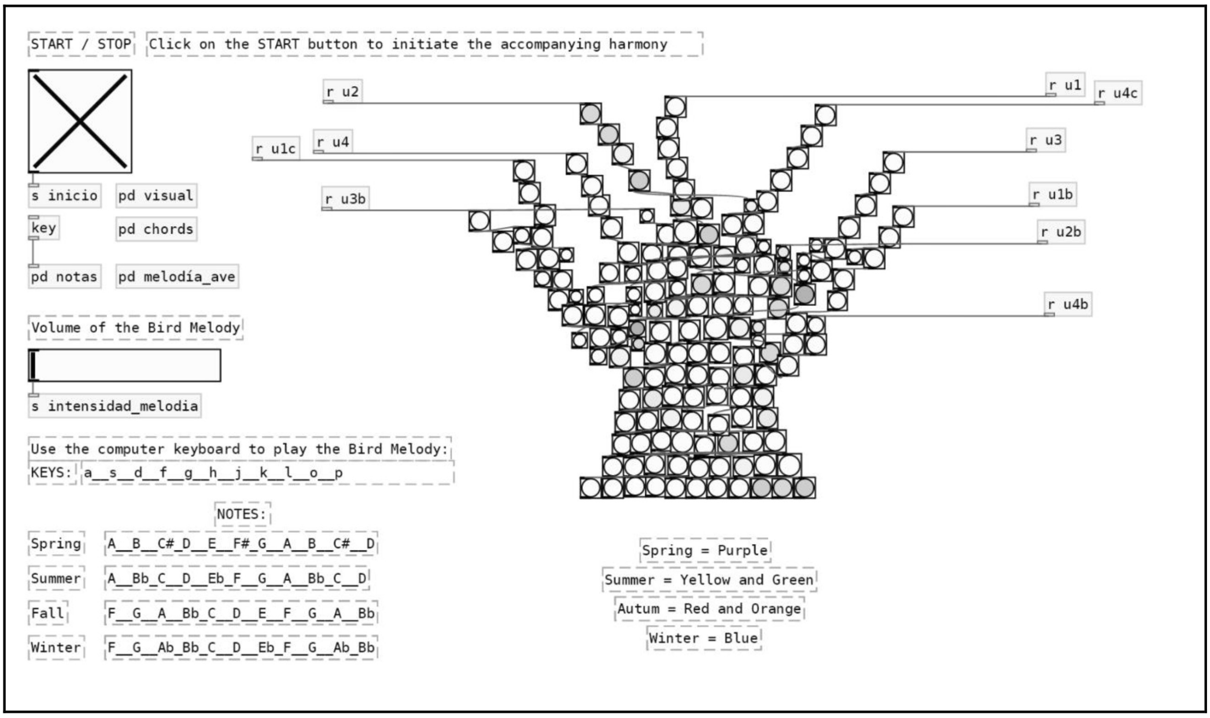

Fig. 1. Example of student work in Pure Data. The interface shows various controls and directions on how to operate the instrument. Instructions have been translated from Spanish.

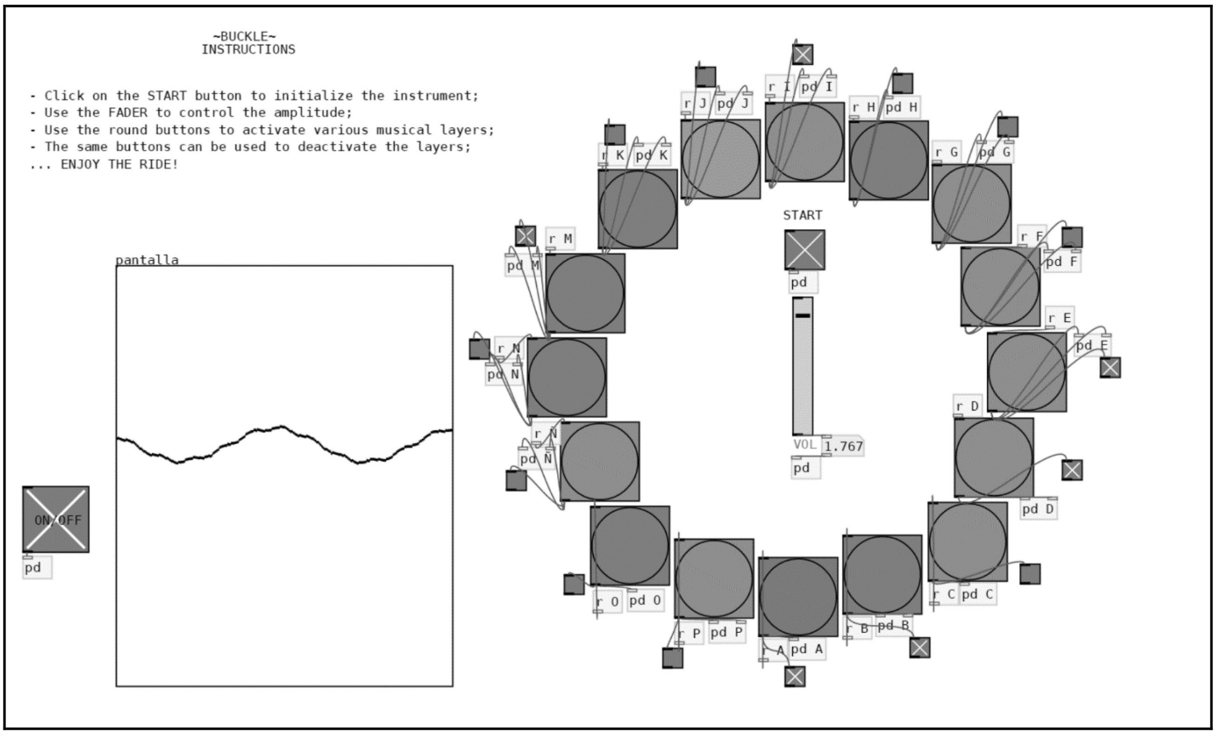

Fig. 2. Example of student work in Pure Data. The visual interface is dominated by a series of buttons arranged in a circle. The instrument also contains a visual display of sound (oscilloscope), a fader, and two activation buttons. The instructions have been translated from Spanish.

user is not in control of timbre – this parameter is largely predefined. The interface is well conceived and intuitive: since relatively few visual elements are present, a user needs only start pushing the big buttons to learn how to play. Finally, the inclusion of visual feedback – in the form of real-time display of audio output – helps inexperienced listeners appreciate how new musical elements present themselves.

4. Discussion

The Creative Sound Workshop was seen by students as a creative outlet within the curriculum. While at the outset this guaranteed a level of enthusiasm and a positive learning culture, it nevertheless posed challenges when it came to crossing the barrier between doing something that is *generally creative* (e.g., working on a music project) and *innovating* (e.g., using or transforming sounds in inventive ways). Likewise, the open-ended nature of both projects also helped fuel student motivation, at times at the expense of a more structured pursuit of originality. Evidence of this trend was found in both projects. In the composition assignment, students often leaned towards their preferred musical idioms instead of constructing more speculative works. In the design challenge, meanwhile, the instruments that were created gravitated towards (1) readily available modes of interaction, such as the computer keyboard, and (2) stylistically familiar musical devices, such as the sequencer. This highlighted a need to actively guide students to think creatively, as well as a need to place innovation as a formal parameter of assessment [49].

And yet, elements of creativity were not hard to find in students' work. We found that, more often than not, a "safe" feature of a project – e.g., a formulaic musical architecture – would serve as a kind of scaffolding, erected by the students themselves to support more adventurous work in another domain. This was the case of many of the keyboard instruments that were submitted: as a paradigm for interaction, the keyboard lacks the ideational development afforded by Pure Data. However, by and large, the keyboard instruments that were designed could still be considered original in how they presented themselves visually, in how they were contextualized, or by virtue of their sound production capabilities. In the example discussed in section 3.4 (Fig. 1), the keyboard was one element in a supra-instrument that consisted of a constantly evolving harmonic background and an interjecting melodic protagonist. Finally, in both examples discussed in that section, visual elements of the interface rose above their pragmatic purpose to become an important piece of the instrument's aesthetic.

Categorizing student works as either creative or uncreative risks reproducing the notion that creativity is a fixed attribute in students [16]. Creativity is a general term that can describe anything from personal insight all the way to paradigm-shifting innovation ("big-C" creativity) [13, p. 28]. Any assessment of student originality must account for students' individual processes in developing the dispositions that support more advanced forms of creativity. Here, the frequent opportunities for formative assessment afforded by the "creative counselling" format allowed for both an appreciation of where each individual student was in their creative development, and a classroom culture where constructive feedback was normalized. In informal surveys conducted by the instructors at the end of the semester, students responded positively to these formative assessment strategies, particularly in how they incentivized reflexivity and openness.

While the course was enthusiastically received by students, it is important that we recognize the limitations of this study. As educators, we set out to design a course that promoted students' creative dispositions from a triadic perspective that included work on students' inclinations, sensitivities, and abilities. We have pursued this goal by incorporating a series of methodological changes to ensure a classroom culture where creative risk was encouraged and rewarded. Having been independently and expertly evaluated, our assessment of the creative products generated during the workshop followed core principles of Consensual Assessment Technique (CAT) [47]. However, we did not conduct psychometric studies of looking at the creative process or student personality [50]. We also cannot claim that our assessment is an accurate measure of changes in student sensitivity or inclinations, even if we believe it provides insight of their creative abilities in regard to those particular tasks. A more comprehensive study of changes in students' creative dispositions would likely require further instances of assessment, which go beyond the goals of this preliminary work.

Ultimately, any effort to incorporate creativity in an engineering curriculum at course level needs to recognize a significant limitation: the overarching culture of teaching and learning. Even if we look at creativity from an individual and dispositional model, it is crucial that we do not divorce it from social and institutional dynamics. Creativity is socialized over the years through countless interactions, and teachers play a big part in that process – whether intentionally or otherwise [17]. We know that learners act in ways that are suggested by their environments [51, 52]. Creating a localized classroom culture that rewards creativity can therefore go only so far, if other courses do not offer opportunities for its exercise, or even actively discourage it. Commitment to a culture that produces creatively minded engineers must not tokenize innovation within the curriculum: it should aim for transversal implementation of creative methodologies and initiatives. Further work in the Creative Sound Workshop would include potentializing creativity itself as an object of study inside the course, while more clearly defining and incorporating innovation as a goal within the course projects. We also hope to create similar faculty-wide engineering courses outside the acoustic program, at both undergraduate and graduate levels.

5. Conclusion

In this article, we discussed the design and inclusion of a sound-based creativity course in an acoustic engineering curriculum responding to shifting professional and paradigmatic demands in engineering education. We looked at creativity from a dispositional perspective, considering it a function of students' thinking habits and how they are socialized in classroom settings. We identified four thinking dispositions related to creative development and devised a table according to which each course activity had to engage at least one of these dispositions. In designing the course, we incorporated a "creative counselling" methodology common in humanities and arts education, with ample opportunities for feedback and formative assessment. This model was found to have a very positive impact on student motivation and was successful in promoting a positive and critical learning culture. Student projects displayed various levels of creative achievement, and while conceptual variety (or "fluency") was not high, creativity was often manifested in different project features, such as creative use of visual elements, conceptual originality, and resourceful use of the programing environment. After two years, we consider the workshop to have been a positive addition to the acoustic engineering program at the Universidad Austral. We hope in future not only to offer a faculty-wide version of this applied-creativity course, but to incorporate disposition-based and creative counselling methodologies in other disciplines of the curriculum.

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