EVALUATION OF DIGITAL MUSICIANSHIP IN HIGHER EDUCATION THROUGH PLAYING AND CREATING DIGITAL SCORES

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ABSTRACT

This paper presents an evaluation of digital musicianship with digital scores. Primary data was gathered during the *DigiScore* 'Roadshow' of North American universities' music departments in 2023 and an extended research workshop in Avellino, Italy, 2023. The activities consist of interactive lectures and practice-based workshops that involve students by asking them to reflect on the nature of their digital musicianship through digital scores. In defining digital musicianship we adopt Hugill's definition of musicianship as "a person's ability to perceive, understand and create sonic experiences" [1], and expand upon this with Brown's *Sound Musicianship* [2]. Through the lectures and workshops, we gathered data using online interactive polls and questionnaires in person. This data gathering was divided into: a) skills; b) contexts, cultures & literacy; c) musical identity & creative practice; and d) perception & awareness of (digital) music. In the paper, we present an analysis of this data and correlate it with observations from these sessions. In our discussion, we point to the interconnectedness of the sub-categories and also draw a connection between digital musicianship and creativity.

1. INTRODUCTION

The Digital Score (*DigiScore*) is an ERC-funded research project that investigates the transformation of the music score through computational technologies. [1] Digital scores utilising computational technology and digital media are emerging worldwide as the next evolutionary stage in the concept of the music score (discussed in Vear's *The Digital Score* [3]). Emerging findings are suggesting that digital scores can generate new music experiences, innovative compositional approaches, novel performance opportunities, and broader accessibility for a vast number of musicians and music cultures around the world. The *DigiScore* project defines a digital score as "a communications interface of musical ideas between musicians utilising the creative potential of digital technology" [3]. While not a separate paradigm to the traditional paper-based platform of traditional/conventional scores, they can be considered the next evolutionary step in the development of the music score by advancing the creative potential of the medium that carries communicative properties of the musical idea. A critical feature of digital scores is the application of elements of rich media, animated shapes, interactive and haptic controllers and even the embodied movement of robots to convey the specific language of the music idea. Thus, digital scores can go beyond fixed notation, and they can embrace the affectual and phenomenological properties of the media. The primary aim of *DigiScore* project is to understand how digital scores shift creativity and musicianship.

1.1 Background of "Roadshow" Research

A major work package in the *DigiScore* project is the "Roadshow." The aim of this is to evaluate higher education music students' wants and needs from digital musicianship education across the globe through engagement with digital scores. The method is to visit a diverse range of music departments across the world and work with the student bodies through interactive lectures and practice-based workshops with digital scores. A typical process would be to spend 3 hours with 4–6 students working through a selection of digital score types, followed by a 90-minute interactive lecture with the full cohort. At the end of this lecture we may perform the works that were workshopped with the students.

Parallel to the lectures and workshops, *DigiScore* developed extended workshops in digital score-making facilitated by a unique set of "creativity cards." [2] The first such workshop was delivered in Avellino, Italy between 11–14 October 2023. The research focus was on students' creative process while observing changes to their digital musicianship. Primarily, the creativity cards workshop supported students' development of a musical idea towards a realisation of a functioning prototype of a digital score. This offered us the potential to study any transformational changes in creativity that can take place through digital score making through questioning, observations and consultations with their academic professor.

2. METHODS AND FINDINGS

2.1 Aims of Digital Musicianship Research

The North American tour (February 2023) gathered data on digital musicianship from the point of view of "a per-

[1] https://cordis.europa.eu/project/id/101002086

[2] Further information can be found at https://digiscore.github.io/pages/Creativity_cards_about

son's ability to perceive, understand and create sonic experiences" [1]. The principle aims of evaluating digital score musicianship during our presentations and workshops were focused on the following criteria:

- **Skills**: what are the skills needed to articulate and interpret features and effects of digital score musicking?
- **Contexts, Cultures & Literacy**: what contextual, cultural literatures and insights are required to inspire creative thought and support musicking ideas?
- **Musical Identity and Creative Practice**: what are the new modes and possibilities of creative practice?
- **Perception and awareness of (digital) music**: how do musicians actively analyse digital score music, and what interpretations are they generating when making music?

2.2 Methods

In the case of the North American tour, we used three types of methods to evaluate musicianship with digital scores. These were:

1. A Mentimeter poll [3] which allowed students to contribute responses through a 90-minute presentation and online survey.
2. After the lecture, there was an online survey questionnaire where students could answer in more depth the questions asked during the lecture.
3. For students participating in practice-based performance workshops with digital scores, there was a questionnaire aimed at evaluation of their creativity, transformational potential and students' wants and needs from higher education.

2.3 Lecture Presentation Findings

Throughout the 4 weeks of the North American tour, we visited public and private universities with music departments that ranged from large internationally renowned centres for innovating electronic music (such as Columbia and Carnegie-Mellon), or music performance and composition schools (such as Illinois at Urbana-Champaign, Northeastern and New England Conservatory), to small departments with a focus on pop music production and music business (such as New Haven). We spoke with undergraduate, and postgraduate students and PhD researchers, postdocs and faculty members.

Overall, 92 students engaged with the in-lecture Mentimeter polls, from which 50 completed the online form. The findings from both revealed a few tentative trends in digital musicianship. For example, when asked how students would define themselves on a poll with multiple answers such as composer, improviser, performer, electronic musician, instrument maker, etc., 38 out of 92 students (41%) identified themselves as both composers and performers in addition to other multidisciplinary categories (Fig. 1).

[3] https://www.mentimeter.com

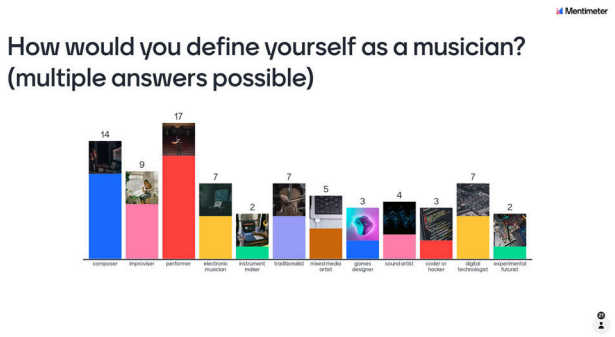

Figure 1. 1st slide from the *DigiScore* roadshow questioning strategy from the Mentimeter poll.

In the online survey, we also found that 66% of students were seeking a variety of digital music skills, including coding, basic audio engineering, recording and mixing (DAW), analogue circuitry, etc. (Fig. 2). These students were already media-curious and used a range of tools and disciplines in their music-making. One student mentioned their skills as: "Classical training on piano and violin, improvisation, coding in Max/MSP, training as a composer, training as a dancer" (Anonymous, 2023).

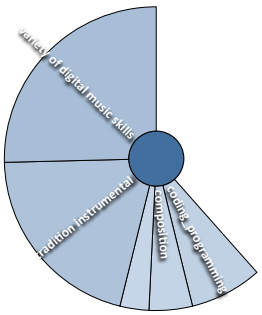

Figure 2. 33 (66%) coding references for *variety of digital music skills* pursued in Digital Skills category of online questionnaire.

Our findings also pointed to a heightened awareness of the need for coding and AI skills in the current and future workplace. Through the Mentimeter poll, we found that 37% were interested in actively pursuing machine learning and AI skills, and developing core proficiency's to prepare for this need, for example:

> I play a couple of instruments at a beginner to intermediate level, comfortable with multiple DAWs and many pluggins, and am proficient at multiple coding languages including python, C++, C#, HTML, and learning a few others. (Anonymous, 2023)

In the online surveys, we found that the skills that musicians were seeking were contributing to how they viewed their digital music identity. 42% mentioned that digital technology was extending or enhancing their music-making. This in turn made their music "more diverse"

contributing to "more efficiency" in their workflow, "allowing a broader sound palette to work with and more access to different sounds" (Anonymous, 2023). As the result of working with digital tools and approaches, some students described their music identity as "creative technologist," "producer/instrumentalist," "improviser and electronic musician," and "composer and producer," which aligns with Mentimeter poll results (Fig. 1).

Overall, students mentioned technology as an important tool in their creative practice of making music. In the *musical identity and creative practice* theme, one student mentioned: "A common thing I practice is the translation of electronic techniques to my instrument" (Anonymous, 2023). Furthermore, there was a general awareness of how digital technology shapes one's musicianship through their creative practice, for example: "I am an explorer of what is out there. The tools change the affordances and therefore my result. I am constantly exploring the variety of tools so I may benefit from them all" (Anonymous, 2023).

When we asked about what might inspire their music in a Mentimeter poll, 64% sighted other media as inspiration. This was a broad litmus test asking them to choose one or more of the following:

- Types of music/musicians
- Books/theories
- Art forms (art, theatre, dance, etc.)
- Media (film, gaming, video, etc.)
- Nature and the environment

Overall, "types of music/musicians" were the dominant choice, but not by much. Generally, only peeking over the top of others by 1 or 2 counts. With the others generally coming out equal. Here, one conclusion is that students are demonstrating aspects of pluralism by taking inspiration from many more sources than merely music studies.

In support of the emerging idea of a pluralistic music identity, we also found that students were engaged in different styles, genres and musical concepts in their music-making. We found that 58% (Fig. 3) draw on different cultural influences and this reflects the digital skills that they are pursuing. While 66% had, or were pursuing, digital music skills, and were from pluralistic backgrounds. For example, one student mentioned the music context that they are working in and the music that they are inspired by: "Electronic music, free improvisation, contemporary classical music, sound art and installation. I'm inspired by traditional Mexican music: son jarocho, son huasteco, norteño, cumbia, reggaeton, sonidero" (Anonymous, 2023). Others mentioned an interest to learn music from other cultures: "I'm mostly interested in working in improvised, electronic, and experimental; however, I have interest in other cultural music from other communities. I love to learn about the musical traditions of other cultures" (Anonymous, 2023).

In online questionnaires, when it came to the *perception and awareness of (digital) music* theme, we found that students often described what they value most in their music-making from the point of view of connection and communication. One student wrote: "I like how I can showcase my music to other people, as it gives me inspiration for what I can create and accomplish," and "for me, getting the right mood across to the listeners is a big part, making sure I'm able to make an impact within the song" (Anonymous, 2023). Similarly in the Mentimeter poll, when we asked the same question, a lot of students answered with themes such as "emotion," "community," "connection with others," "connecting with emotion," "sharing with others," "my creative voice," and "honesty."

The "Roadshow" lecture findings point to multidisciplinary identity in music making, inspiration by other media and not just music and other musicians, the pursuit of AI and machine learning skills, and pluralistic music identity. We are also finding that our four themes of *digital music skills*, *context, cultures and literacy, musical identity and creativity, perception and awareness of (digital) music* are mutually interdependent. For example, digital music skills that one is pursuing are often linked to the context in which one may be creating their music as well as the musical identity and creative processes that they are engaging with. Furthermore, it is through the perception and awareness of their digital skills and how they are perceived in a context with other musicians and audiences that musicians learn about their musical practices and their (digital) music identity.

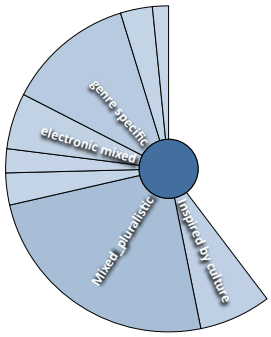

Figure 3. 31 (58%) coding references for *mixed pluralistic cultural influences* in Contexts, Cultures & Literacy category of online questionnaire.

3. DISCUSSION OF LECTURE FINDINGS

The concept of the mutual interdependence among *skills*, *context and cultures, musical identity and creativity, knowledge and awareness* suggests that these elements are not isolated but rather function dynamically aligning with dynamic system's theory (DST) [4]. In this framework, creativity plays a pivotal role in the ongoing process of learning and expressing one's musical ideas. It draws inspiration from an individual's context and background, contributes significantly to the formation of musical identity, and aids in the self-evaluation of digital skills and learning processes.

Our perspective on creativity differs from viewing it as a product solely emanating from creative individuals. Instead, we consider it a phenomenon that emerges through the interactive dynamics among multiple agents and their

connection with the broader socio-cultural environment in which they operate [4]. This viewpoint allows us to better comprehend the dynamic processes inherent in the diverse activities and approaches that current higher education (HE) students undertake as part of their digital musicianship. These activities often unfold in collaborative, self-directed learning environments, extending beyond the structured formal education setting. One student noted: "I value collaboration a lot within my music-making. My most important aspects are the instrumentals & vocals" (Anonymous, 2023), and "my main focus is hardcore crossover due to my band, but I enjoy playing jazz, funk and other types of rock in my freetime" (Anonymous, 2023). These expressions of musical preferences and engagement highlight the dynamic interactivity at play, creating feedback loops through embodied and socially situated practice [4].

In essence, the interconnectedness of skills, context, cultures, musical identity, and creativity is not just a theoretical construct; it manifests in the real-world activities of contemporary HE students involved in digital musicianship. The dynamics unfold within collaborative, self-directed learning environments, emphasising the rich, interactive nature of the processes involved.

To draw the point of the interconnectedness of these categories as facilitated by creativity as a process, we would like to discuss further the dynamic system's approach. In our responses, we found that 26% of students came from specific cultural music environments or identified their creativity to be embedded within them. For example, someone who considers their cultural background and literacy within rnb, jazz and pop might be interested in acquiring skills that are aligned with some traditional music skills such as performing, composing recording and mixing in DAW but also learning about processed and autogenerated sound that could extend their jazz practice to "create a more modern sound that would not have been heard before" (Anonymous, 2023).

58% of all respondents draw on different cultural influences and this reflects the types of digital skills that they are pursuing and the music that they are making. For example, one student mentioned a mix of electronic, improvised, sound art with traditional Mexican, cumbia, reggaeton, and sonidero influences on their music-making while identifying with electronic and improvised music. The fact that students are both embedded and seek different cultural influences speaks to the socio-dynamic aspect of creativity that they are involved with. But equally 42% did not clearly indicate that they were drawing on different cultural influences. This property seems quite balanced, and given the broad flavour of the universities that we visited, probably expected. Interestingly, nonetheless, to note that, around 50% of these students that we polled are drawing on influences that are extra-musical and beyond the typical focus of the academic music curriculum (or at least the ones us authors are aware of).

66% of all respondents had or were pursuing a variety of digital musical skills and were also from a pluralistic background. Here we can consider dynamic processes of co-determination that occur between musicians when they interact in music settings which are mixed between different categories of skills, culture and identity, music identity and creativity, and knowledge and perception. Interestingly, 18% of the participants valued knowledge and awareness of their musicianship within the context or genre within which they were creating. This demonstrates another element of learning and development that is supported through a dynamic system theory approach, whereby critical evaluation is part of what musicians do to see how new or original a certain approach or use of a digital skill could be in their practice. Andrew Hugill cites this as "a curiosity, questioning and critical engagement about what they (digital musicians) do" [1].

4. PRACTICAL WORKSHOPS

To discuss further creativity specifically with digital scores it is interesting to view the responses from the surveys from both the practice-based performance workshops and the creativity cards workshops. Both sets of workshops gathered a smaller amount of participants' answers, 6 surveys collected from the North American tour and 7 from the creativity cards workshop in Avellino, Italy.

4.1 Performance Workshops

In the practice-based performance workshops, we presented students with a range of digital scores which included digitised, animated, interactive, system digital scores, and intelligent. This was essential to show students the full continuum of possibilities of what a digital score could be as discussed in *The Digital Score* [3]. The aim of the workshop was to support the students' ability to interpret and engage with the range of the digital scores in order to deliver a short digital score performance for their peers at the end of the session.

In the post-workshop questionnaire, we asked students about aspects of creativity with digital scores, their transformational potential and their wants and needs from formal education to engage further with digital score performance. In our surveys, most students remarked on the heightened engagement experienced with the media of the digital score, compared to the traditional score: "My engagement with the scores was more visceral than it may have been were I looking at a score on a piece of paper," while another emphasised, the "animated nature of many of the scores draws my attention to exactly where it needs to be in the score at any given time" (Anonymous, 2023).

Students also appreciated the openness of the digital score, exemplified by pieces such as Gudmundur Steinn Gunnarsson's Quartet [5], where musicians can choose instruments or pitches to interpret with a rhythmic notation on a scrolling timeline. One student expressed: "Pieces like the Gunnarsson's quartet or John Cage's *Variation* provided firm enough ground rules that offered a vast amount of freedom, while not feeling overwhelmed," and another stated, "digital scores seemed to present a source beyond just a composer's outline for a piece" (Anonymous, 2023). With [5], they appreciated the simplification of complex

rhythmic notation, enabling them to engage with an animated timeline instead of counting or observing different time signature changes. "My greatest joy in this piece is that I didn't have to count, I could just play, which is rare in rhythmically-complex scores," and "it is more accessible than seeing different time signature changes on a page" (Anonymous, 2023). The animated aspect of the graphical interface in these scores had a liberating effect on students' engagement and presence while performing. In addition, students remarked on the ease with which one's attention can be drawn towards making abstract relations between sound and what is seen on screen: "I am never at a loss as to where our attention is being directed in the score, and as a result, it is very easy to draw abstract relations between sound and what is on screen" (Anonymous, 2023).

The interactive playful nature of some digital scores such as *Nautilus* [6] and *Plurality Spring* [7] led to spontaneous interpretation for some students that they found would not be possible with paper scores. Both of these digital scores represent interactive game engine digital scores where one's attention is drawn to emerging aspects of the score stimulated by the sounds of the musicians' instruments. Musicians found the interactive and gamified nature of the notation provided numerous possibilities for rhythmic interpretation [8]. The game-like behaviour of some of the digital scores offered positive feedback to participants and encouraged an impulse to 'win' or play a score like a video game, changing the understanding of performing the 'right' actions as one would in a performance: "I felt like I could 'win' by performing the right action, and this impulse took over. At this point, I was no longer performing – I was playing how someone might play a game" (Anonymous, 2023). The gamified approach expanded rhythmic possibilities, as one student confirmed: "the rhythmic possibilities of doing a 'game' piece seem endless" (Anonymous, 2023), sparking creativity in the interpretation of the digital scores.

The animated and gamified nature of digital scores was very engaging for some students, taking away any anxiety associated with sight reading a traditional piece of music: "The digital score version not only stripped the reading of any anxiety, it turned what might be a very tediously-prepared piece into a fun game" (Anonymous, 2023). Moreover, this gamified aspect of digital scores helps us to understand their appeal, as gamification can be understood as a "general process in which games and playful experiences are understood as essential components of society and culture" [8]. Students felt immersed in the moment of music making, particularly when interpreting scores that have been transformed from paper notation like John Cage's *Variation I* to an animated digital format using Decibel ScorePlayer app [9]. Workshop participants recognised and appreciated that the composers were exploring new ways of engaging with performers through their digital scores.

There were also challenges experienced by the students. One significant issue that was managed by the *DigiScore* team, was the amount of contextual explanation that was necessary before the student musicians were able to interpret the score successfully. By that we mean, that they did not have the necessary conceptual training of interpreting animated marks, colours, symbols into a notation that they could realise. And that each new digital score type required a new type of conceptualisation. However, once this had been carefully explained and contextualised they felt a little more sure about how to interpret the music. This was also due to the way the team explained these concepts from the perspective of musicking, and relating abstract media-concepts into usable information for use inside music-making.

Through this, and perhaps because of the careful explanations, the students recognised the advantages of working with digital scores in higher education. They expressed a desire for more accessibility to digital scores, including a repository, easy packaging of digital scores and learning tools for diverse music genres. Overall, they felt that digital scores could foster certain students' motivation and creativity in music education.

4.2 Composition Workshop With Creativity Cards

For the first half of 2023, the *DigiScore* principal investigator designed and developed a creativity card resource for use in digital score practice-based workshops. These cards aim to scaffold the design, development and creation of digital scores. They present insights from different perspectives about the possibilities, opportunities, challenges and questions around creating a digital score. They have been designed to operate like a conversation between workshop participants, their creative ideas, and the experience from those who have researched and specialised in making digital scores.

[10] points out that decks of cards are a long-established tool to aid design, fostering an environment to encourage creativity through play and problem-solving. In music, *Obliques Strategies cards*, pioneered by Brian Eno and Peter Schmidt, have been used in suggesting different paths through a repository of tools for artists and musicians to overcome creative blocks [10]. Eno clarifies that the cards' role is to provide a broader perspective when it comes to finding creative solutions: "The cards evolved from me being in a number of working situations when the panic of the situation [...] tended to make me quickly forget that there were other ways of working and that there were tangential ways of attacking problems that were [...] more interesting than the direct head-on approach" [11]. Over the past decades, a variety of cards have been produced aimed at stimulating creativity in fields such as marketing, management as well as design, especially user experience (UX) and digital design. Like in the cards for design, the *DigiScore* creativity cards are also not prescriptive but act as a support for inspiration, organization and communication of ideas of the digital score [12]. Thus, it is no surprise that they could be used in an intermediate endeavour like making a digital score, and like in UX design, they could be aimed at creating an experience inside the music-making process for the musicians.

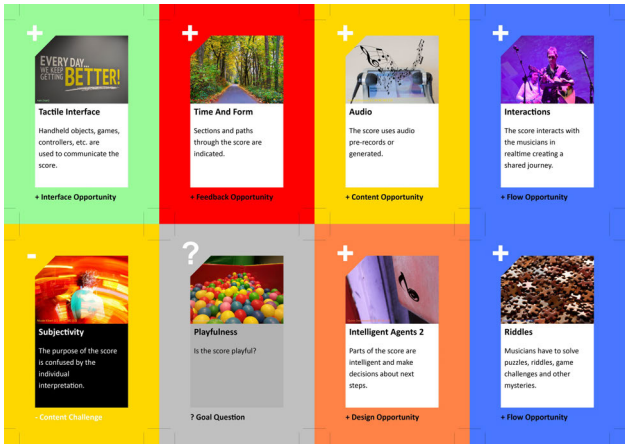

Figure 4. Print sheet from the *DigiScore* creativity cards collection, showing 8 different types of cards.

The direct inspiration for the *DigiScore* creativity card*s* was Wetzel et al's *Mixed Reality Game* (MRG) cards [13]. On the history of ideation cards, they state:

> The physical properties of ideation cards make them resemble card games, and they can be classified as design games [14] [15]. Ideation cards possess game-like rules ranging from the way they structure card draws, turn-taking, playing and discarding cards to randomly revealing them. They enable collaborative design in a playful atmosphere. Cards are used as orienting devices, conversation starters, and pace-makers [16]

[17] describes ideation as "a matter of generating, developing and communicating ideas, where 'idea' is understood as a basic element of thought that can be either visual, concrete or abstract." As physical artefacts, the cards allow groups to think through the process of composition, a type of exploration in which the participants "play around with materials without knowing what will come of it" [18].

Like Wetzel et al's MRG cards, the *DigiScore* creativity cards are designed for two purposes:

- First, to open out creative thinking by presenting possibilities and systems for idea generation within the context of digital score creativity.
- Secondly, to present known problems, challenges, and opportunities as springboards for design selection or refinement.

Currently, the *DigiScore* pack comprises 152 cards split into 3 different sections: *opportunities, challenges* and *questions*. Each of these sections is split into 7 different modes of thinking that align with the 7 modalities of a digital score [3]: *interface, design, content, language, goal, feedback, flow* (Fig. 4).

The first creativity cards workshop was presented at Cimarosa Conservatory in Avellino, Italy, October 11–14, 2023. In the 3-day workshop, we worked with two groups of three and four students respectfully. They were mostly first-year music composition students with an addition of a couple of older year students. Throughout this process, the research team also observed students' creative engagement in the workshops and delivered surveys tracking how creativity cards contributed to students' digital musicianship.

4.2.1 Observing Creativity, 1. Communications Skills

In observing students' activities in the workshop, we employed two existing theoretical frameworks to identify communication and creative engagement with the cards. The first one focused on their communication through a framework known as COGS (Communication Opportunity Group Scheme) [19]. This supports observations of an individual's progression/development in communication skills through the activity. These skills are:

- Personal qualities
- Social qualities
- Decision-making
- Communication (verbal and written)
- Performance (showing, demonstrating, presenting)
- Interaction with technology

To observe these skills in action we trialled a course grain approach of logging specific students growth over three steps: passive, engaged, and leading. The aim was to capture any indication that either the cards or the engagement with digital scores could be enhancing these extra-musical skills through the workshop process. This task was undertaken by the research assistant of the project using a simple matrix sheet of skill vs development for each target student.

Over the course of the workshop it became evident that this method was not going to work as originally planned due to the dynamic nature of interactions in the group. As such, these categories were followed only loosely; thus, our evaluation of their activities was not judged individually but from the point of view of a group activity. Also, students were interacting mostly in Italian, and our full ability to judge their overall performance in these categories was limited. However, one core member of our group did speak fluent Italian and was able to report on the verbal communication aspect of this study. The advantage of the COGS framework is that growth in communication skills beyond text and spoken word can still be observed through the students' engagement with the task.

Throughout the workshop, we noticed some students' progress in their communication skills and understanding of the task at hand. There were observable elevations in all categories of COGS across these students. Overall, we found students were responsive to questions posed by the *DigiScore* team, were highly motivated and engaged in the activities of decision-making and creation with creativity cards.

Of the evidence that we gathered, it is difficult to state what caused this seemingly elevated state of engagement. We do not know if this was because of the activity, the cards or engaging with digital scores, or whether this was their natural behaviours and personal attributes emerging through the workshop as they became confident or comfortable with the *Digiscore* team and the workshop. Con-

sultations with the students' professor provided some evidence that both were true, but we have no quantitative evidence to support this beyond his testimony.

In the future, this essential aspect of the research will need to be enhanced to include bookend tests of the students' baseline attributes in communications. The COGS scheme does supply such a test, and this has been proven effective across numerous trials. It was not implemented in this workshop because we wished to test the relevancy of such an approach. So, from this perspective, we feel that COGS is a crucial method with which to study the impact of digital score engagement on the communication skills of music students, and will be employed in future workshops.

4.2.2 Observing Creativity, 2. Possibility Thinking

The second theoretical framework examined students' creative engagement with the cards through Possibility Thinking (PT) [20]. PT is mostly used in pedagogical environments in the context of children's learning through the following categories:

- Posing questions
- Play
- Immersion and making connections
- Being Imaginative
- Innovation
- Risk-taking
- Self-determination

We assessed students' engagement through questions, and observing their immersion and connection to the task of making a digital score, being imaginative in realising a prototype digital score idea, taking risks with the idea of making a digital score as no one in our workshop had done this before, and a degree of innovation with realising complex technical music ideas with simple means. Overall, we find PT was useful in observing creativity through the creativity cards workshop.

Another important aspect of PT is *play*, and it was observed in students as they enacted musical activities, playing through and with creativity cards and trying their digital score ideas with musical instruments. We also observed a relational approach to making music with the help of creativity cards, whereby students interacted with each other through collaboration, communication, self-organisation and playing with ideas. This speaks to the embodied approach to learning whereby students were adapting through dynamic interactivity in relation to each other's activity [21].

In the post-performance discussion, students said that creativity cards presented them with "many choices, opportunities and possibilities for making a digital score" (said in Italian and translated by the course teacher). Students also appreciated that the focus of creativity cards stayed on their embodied experience within the digital scores that they were making, being immersed in musical situations rather than technical or programming ones (observed in the post-performance discussion). It was interesting to note that one of the students mentioned a "destabilising effect" (said in English during the post-performance discussion) of creativity cards as it introduced a new approach to composition that she had not encountered before. However, she also admitted that "destabilisation" was productive for the digital score idea as it introduced a new way of thinking and resolving problems. The destabilising effect can also be viewed from the point of view of DST, whereby a new action may introduce entropy into an organism or, in our case, a musical situation that would need to be resolved contributing to learning a new skill or a creative approach [4].

Structuring the workshop in this way and allowing new ideas to emerge within a group dynamic has many challenges. While the activities were structured using the creativity card format and programme [4] and managed by the experienced team, it led to many heated discussions amongst the student groups, one in particular being overly vocal about it. This was more noticeable during the initial brain-storming activities were minds were allowed to run wild in the 'candy-store' of possibility. It is a useful activity, but on the other hand, it needed careful management so as not to detract from the main focus of the workshop which is building a rapid prototype version of their idea. During this phase, the teamwork became more apparent, but with a lot of guidance and management from the experienced team.

With the final presentation on day 3, we observed that while the original ideas for digital scores in both groups were very ambitious, incorporating sensors, AI and complex sound synthesis, both groups were able to reduce the technological demands of their digital scores through creativity cards. The fourth round of cards asked them to reconsider the ideas brainstormed so far pushing towards a finer focus for the performance. In addition, the embodied and practical way of working with the digital scores enabled students to test through their playing what could work to realise a complex idea with the tools and means available to them in the moment of making. In the end, students reflected positively on their digital score prototype ideas. They appreciated that creativity cards enabled them to generate many ideas giving opportunities to make a digital score faster, promoting fast thinking and doing. This type of process prioritised music-making and not just programming, starting from the practical aspect of making a digital score with limited means possible. In this way, technology became a tool for students like a piece of paper in the traditional composition approach.

4.2.3 Digital Musicianship Surveys and Creativity Cards

To look further into what students experienced through the 3-day workshop, we can turn to the digital musicianship surveys that were captured each day of the workshop.

The digital musicianship surveys focused on the four areas of digital musicianship as mentioned in 2.1. However now, these categories were measured progressively throughout the 3-day workshop. The aim was to notice any changes in *digital music skills*, *contexts and cultures*, *digital identity and creativity* and *knowledge and perception* over time. This was structured as:

[4] introduced at https://digiscore.github.io/pages/cards_how_to_use

- An initial questionnaire on students' musical background was taken enquiring on their skills, how they normally present and communicate their music, how they describe their musical identity and their process of making music, and what they value most in their music making.
- At the end of day 2, the second survey focused on whether there was an extension to the musical skills that students previously had, new approaches to composition or did the students use the skills already at their disposal. The second question in the survey asked whether making a digital score changed the way they normally communicate music, while the third question focused on how making a digital score changes the way musicians perceived themselves and whether it extended their musical process or introduced something completely new; while the fourth question focused on what musicians perceived as interesting and useful about working with creativity cards to make music.
- The third survey enquired whether, through the overall process of making digital scores, students had acquired new music skills and what new aspects of music-making students would like to keep for their future work. The questionnaire also asked whether the final presentation reflected well the digital score idea that the students were working on with the creativity cards and, given the experience of this workshop, will it influence how students present their future projects.

In the category of *digital musicianship skills*, we had a very diverse group of students, some using more established digital music skills such as digital audio workstation (DAW) programming, and others just starting to compose instrumental music. For example, 3 out of 7 students (43%) mentioned DAW skills and working with sound analysis tools. Students with digital music skills mentioned building on their previous skills and in some instances acquiring new skills such as making a digital score or playing music with instrumentalists as previously they only made electronic music.

Students who did not have previous digital music skills also learned about new types of software that could be used in digital score making in addition to being introduced to a completely new way of composing. Some of the answers related to the digital skills used and learned in the workshop: "I used skills learned over the years and learned new ways of writing and playing music," and "they were an extension of what I knew, a new way of composing" (Anonymous, 2023). Others remarked on the novelty of the workshop as: "New, I would never have thought of such an approach," and "I relied little on what I knew as it was all new information" (Anonymous, 2023). Another student remarked that the new skill as facilitated by creativity cards was: "Knowledge of what a "digital score" is and working in the shortest time possible for maximum yield" (Anonymous, 2023). Here, we saw progress in the digital music skills that students acquired through the workshops. All students seemed to have acquired new skills, either through working with other students who already had digital music skills or being introduced to what a digital score is and how to make one in the shortest amount of time possible.

In *contexts and culture*, most students mentioned their background in contemporary/classical music. 3 out of 7 students (43%) already were fluent in electronic and digital music and the context in which they presented their music reflects this. It was interesting to observe through the survey answers on days 2 and 3 that most students felt the workshop changed their perspective on the way music can be made as one student mentioned:

> Creating a score different from the one usually used opened my mind to new ways of expressing and perceiving music by listening and welcoming what other musicians do. (Anonymous, 2023)

And how it may inspire their future music making: "Surely, it's a way of making music that will certainly influence my future projects," and what they learned through the creativity cards workshop:

> A greater curiosity in drawing from the technological world a series of tools that can expand the language. The understanding of a musical context that can no longer be divided into watertight compartments: composer, performer, audience. (Anonymous, 2023)

Most students understood the freedom implicit in making and performing digital scores, the change in aesthetic perspective as there is no one composer/performer but all are equally involved, and the openness of possibilities to explore further in the digital tools and ways of making music.

In *digital identity and creativity*, most respondents already mentioned that their musical identity and process were generally very open to new influences, contexts or circumstances of making music. This we do not find surprising as most of the students were in the first year of studying composition. However, even at this stage, they found creativity cards' way of working transformative to their music making. Some mentioned that creativity cards extended their vision when it came to collaboration with others. While others said: "It introduces the ability to not abandon ideas, be more practical and use more instinct" (Anonymous, 2023). One student found it an additional tool to their composition work: "[I] think it is a parallel path to traditional composition work, certainly very interesting" (Anonymous, 2023). Some found it very transformative to their music identity and future creativity: "I am no longer a defined identity (director, composer or performer) but I am a musician who mixes with other musicians by processing their inputs" (Anonymous, 2023). Some other transformative experiences of music making were stated as: "The experience changes the way of interacting with the score and, therefore, with the music, extending musical discourse to new vocabulary" (Anonymous, 2023), and "it is extending my way of making music and this can only make me a complete musician" (Anonymous, 2023).

In *knowledge and awareness*, reflecting on the usefulness of creativity cards for their digital score idea during the workshop: "The most interesting thing was starting from the core of the idea and then expanding it," and that in future work, the same participant said: "I will be more careful to integrate different aspects of music, not just electronic" (Anonymous, 2023). Students mentioned how the creativity cards workshop was useful in making digital score prototypes: "To reach a working goal in the shortest time possible" and "the most interesting thing was the collaboration" (Anonymous, 2023).

Other statements on how working with digital score creativity cards was transformative and impactful: "The openness to new writing systems that include technological tools not "only" as tools, but as a source of," and "the fact that making music is not just playing an instrument. It helps me to be aware of the fact that everything around us can be a composition" (Anonymous, 2023). Students also reflected on how creativity cards' approach to composition might influence their future compositions: "I will modify them in an innovative way that is different from what I have done until now," and "this project will certainly have an impact on my vision of making and creating music" (Anonymous, 2023). Other transformative statements were: "It's definitely a mind-changing experience that will influence my way of playing, composing and just generally creating," and "there will be greater attention to the roles involved in a performance, to the importance of a score that can be generated live, to an interactivity that develops together with others" (Anonymous, 2023).

4.3 Discussion of Creativity Cards

Through the digital musicianship surveys, we can track clear changes that took place in students' musicianship. They indicate that through an engagement with creativity cards these students had new and transformative experiences in making and performing music. When it came to digital music skills, creativity cards either extended musicians' previous skills or introduced completely new tools and ways of making and performing music. In the post-workshop reflective report, one student mentioned that "we had the opportunity to discover a new way of making music that goes beyond what we are used to" (Anonymous, 2023). We also noticed positive changes in the way musicians viewed themselves and the kinds of activities they would want to engage in the future as a result of working with creativity cards. 4 out of 7 students (57%) mentioned the interchangeability between 'composer'/'performer' in the making and performing digital scores as truly transformational to how they will view music-making in the future. These students also appreciated the accessibility of digital scores that could invite untrained musicians or the audience into making music.

In analysing the evolution in these digital musicianship surveys, we can see that the changes that took place in students' musicianship could be supported by our observations from a three-day workshop on students' creative process. Here, we observed students' engagement, immersion and play with digital creativity cards, where we can conclude that meaningful interaction took place. Furthermore, these interactions took place within group dynamics whereby students posed questions and came up with innovative ideas for their prototyped digital scores through lively and embodied interactions with each other, demonstrating that both 4E creativity [4] and PT [20] took place. Additionally, meaning was made in relationships that students built with the score materials and each other during the workshop, as many mentioned "collaboration" and "communication" with the score and each other that formed part of their reflection on whether they would use this approach in the future.

There were some other conclusions that are worth noting here, although there is less conclusive evidence to support them. First, it is interesting to note that the creativity cards introduced a destabilising effect for composing music. Here, we see no surprise since the idea of using cards, although has been used in music, comes from the field of graphic design, and none of the students have engaged with this way of creativity before. However, the novelty of introducing creativity cards to making music indicated an opportunity for divergent thinking which in itself is an endeavour resulting in higher creative gains [21]. Another point worth noting is that these cards have the potential to bring the benefits outlined by [22], as they allowed the framing of problems from multiple perspectives, leading to externalisation of insight to facilitate dialogue while providing a way to use existing knowledge that may have been dormant. The cards also offer frameworks for visualising problems and solutions and equip teams for learning about people's experiences. And finally, the cards offer a type of creative engagement involving both combinatorial and divergent thinking, pushing students to collaborate with each other and experience their digital scores from an embodied perspective.

5. CONCLUSIONS

In this paper, we presented the findings from two separate, yet interlinked, activities: a "roadshow" of North American university music departments that included interactive lectures and practice-based workshops, and an extended three-day practice-based workshop in Italy. The focus was on engaging student musicians with digital scores in order to gain insights into their perspectives around digital musicianship and their needs and wants from contemporary music education. We surveyed roughly 60 students and engaged 12 in the practice-based workshops. While this is not an exhaustive survey, our findings point to emerging trends in students reflective understanding of musicianship through these four themes: 1) *skills*; 2) *context, culture and literacy*; 3) *music identity*; and 4) *creativity, knowledge and perception.*

We speculate from these findings that these themes are interlinked and dynamic with each other. Furthermore, that this dynamic interrelationship is often a socially situated, interactive and embodied experience for these musicians. In studying the dynamic behaviour of these four themes, it has been shown that many musicians in our study possess a pluralistic music identity that does not reflect one

genre or cultural background, and this extends their digital music practice. From our practice-based workshops in performance and composition of digital scores, we observe and conclude that creativity as a dynamic process is shaping musicians' meaning-making with digital scores which further transforms their digital musicianship.

However, we note that this is not self-evident. The students that we engaged with needed concepts explained to them, workshops managed, and the translation of extra-musical or media theories into a language that is relevant to the domain of music. Furthermore, the process of conducting practice-based experiments with new concepts such as gaming, animated scores, AI and robotics opened up the 'cookie jar' of possibility and potential that led to heightened states of [over] excitement. We might conclude that if, as music educators, we are to adopt emerging insights into the nature of current digital musicianship, and the wants and needs of some of the students in our HE system such as those presented here, we may find it necessary to update our current ways of thinking and adjust how we instruct digital musicianship.

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