Onloop - Composition and Sound Research

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Abstract. *Onloop is a creative center responsible for training music producers for the gaming industry and other immersive media, as well as conducting research in the area of Computer and Music Technology. It has an official research group recognized by CNPq since 2018, involving undergraduate, master and doctoral students in its research topics. In this short article, we present its main research initiatives and resulting publications divided into two fronts: (i) Research in Computer and Music Technology and (ii) Research in Education with an Emphasis on Digital Games and Music Production. Ten key publications are presented, summarizing the group's work since 2016.*
Keywords *Immersive Media, Games, Music, Education, Computer and Music Technology.*

1. Introduction

Onloop – Composition and Sound Research is a creative center at PUCPR University, responsible for the production of sounds, music and research in the area of Computer and Music Technology. The research nucleus was created with the initial objective of training undergraduates to produce soundtracks. In the second half of 2015, the undergraduates underwent a training period in order to be able to develop music for digital games. Also in 2015, a partnership with PUCPR Technology in Digital Games graduation course was established, making it an immediate first customer. Since 2015, Onloop has been responsible for producing sounds and music for LAJE at PUCPR (Games and Systems Development Laboratory). In 2016, it started a partnership with PPGIa[1] (Postgraduate Program in Informatics) in research involving sound and music producing. PPGIa was created in 1996 and has CAPES evaluation concept 5 (master's and doctoral courses). At the PPGIa (Sound Research context) several students completed their master's and doctorate degrees in the research line of Computer and Music Technology.

[1]https://www.ppgia.pucpr.br/

2. Research Group skills and infrastructure

2.1. The Research Group

Although research began in 2016, the group was officially established at CNPq in the year 2018 under the name *Computer and Music Technology (Onloop)*. It has been part of the research group directory since then. It is possible to observe the recent registration[2] of the research topics, as well as the students and researchers. The group has 10 research professors, 2 doctoral students, 4 master's students, 8 undergraduate students and a high school student. The research, innovation, and extension group in computer and musical technology has the following objectives:

- *Develop new approaches to handle the large volume of available musical information.*
- *Create new technologies with a pedagogical foundation for music education.*
- *Compose soundtracks and sound effects for different digital media.*
- *Study the relationships between soundtracks created for different media and contexts, such as music for film, games, etc.*

From the more specific perspective of the study of Music Computing, the group emphasizes the following research topics:

- *Music Auto Tagging.*
- *Music Genre Classification.*
- *Music Emotion Classification.*
- *Automatic Music Composition.*
- *Music and Media.*
- *Music Information Retrieval.*
- *Music Recommender Systems.*
- *Technology for Music Education.*

2.2. Computer Music Technology Laboratory

The laboratory was created to accommodate students and researchers. It has 10 Dell PCs with Intel Core i5 processors. For projects involving instrument assembly, Arduino kits (Uno R3 and Mega) are available. Since Onloop has also a sound and musical production team of students, the laboratory also has equipment common to a basic studio: audio interface, studio monitors, headphones, MIDI controller, microphones for basic recordings, bass guitar, electric guitar, an electronic drum, and digital audio workstation (DAW) softwares.

3. Featured Publications

Over the years, the group has focused its efforts and resulting publications primarily on two fronts: (i) *Research Initiatives in Computer Music Technology* and (ii) *Research Initiatives in Education with an Emphasis on Digital Games and Music Production*. This section uses this subdivision to successfully present the most impactful articles produced by the research group. Since this is a short article, the first part (section 3.1) will be summarized in a table, and the second part (section 3.2), which deals more with education and digital games, will be more explanatory.

[2] dgp.cnpq.br/dgp/espelhogrupo/9810094849676184

3.1. Research Initiatives in Computer Music Technology

The initiatives related to Computer Music Technology detailed here have a more technical-scientific nature. They are directly related to the research topics listed in section 2.1. Table 1 details each reference, title and means of publication.

Reference	Title	Means of Publication
[Pereira and Silla(Jr) 2017]	Using simplified chords sequences to classify songs genres	IEEE International Conference on Multimedia and Expo (ICME)
[Martiniano and Silla(Jr) 2017]	Birits: A music information retrieval system using query-by-playing techniques	IEEE 29th International Conference on Tools with Artificial Intelligence (ICTAI)
[Nanni et al. 2018]	Ensemble of deep learning, visual and acoustic features for music genre classification	Journal of New Music Research
[Kostiuk et al. 2019]	Multi-label emotion classification in music videos using ensembles of audio and video features	IEEE 31st International Conference on Tools with Artificial Intelligence (ICTAI)
[Pereira et al. 2019]	Representation learning vs. handcrafted features for music genre classification	International Joint Conference on Neural Network (IJCNN)
[Mengarelli et al. 2020]	OMR metrics and evaluation: a systematic review	Multimedia Tools and Applications
[Catharin et al. 2020]	Multimodal Classification of Emotions in Latin Music	IEEE International Symposium on Multimedia (ISM)

Table 1. Most relevant references (Computer Music Technology)

3.2. Research Initiatives in Education with an Emphasis on Digital Games and Music Production

From an educational perspective, three recent works summarize the group's efforts to contribute to education through the support of technologies.

In 2021, [Moro et al. 2021] developed an innovative research entitled "*Using discord as an extension of the emergency remote teaching classroom during the covid-19 pandemic*" that describes how a group of teachers used Discord to extend the emergency remote teaching classroom during this dificult period of time. It details the teaching

strategies employed with Discord in a game development undergraduate course and presents students' perceptions and feedback on using this tool. Figure 1 shows that this article is listed on the WHO (World Health Organization) search engine as one of the educational initiatives for the COVID-19 period.

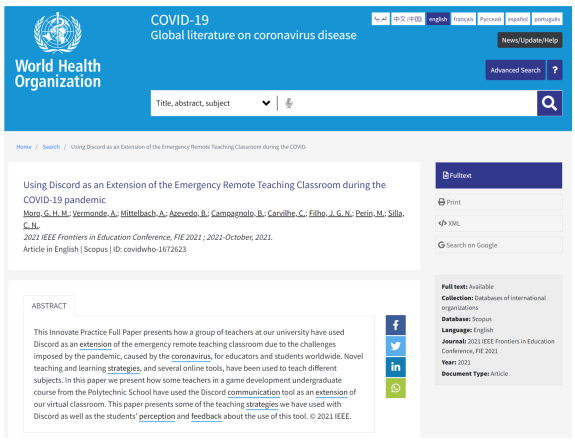

Figure 1. Article listed in the search engine of the WHO.

In 2023 article entitled "*Learning game programming through narrative, sound effects, and music in text-based games: A creative approach to digital game education*", [Moro et al. 2023] reflected about how programming is essential, but challenging for beginners. Narrative, sound, and music can help teaching programming concepts intuitively and engagingly. The experience of teaching a "Text-Based Game Development" module that uses narrative to create contexts, while sound provides feedback, makes programming more accessible. Games as teaching tools foster problem-solving, critical thinking, and teamwork. This article discusses strategies in the module, comparing results from teaching programming alone versus integrating narrative and sound, highlighting the effectiveness of these elements in teaching complex programming concepts.

In 2024 article entitled "*Teaching introductory game audio to undergraduate students using a novel digital game template*", [Carvilhe et al. 2024] introduced PSG - a digital game template developed to support introductory game audio teaching for Digital Games undergraduates. The game allows students to create, test, and refine sound effects and music without prior knowledge of art, design, or programming by easily changing files in the game template folder. An analysis of eight module offerings—four with and four without PSG—taught by the same teacher, showed significant improvement in student learning and a reduction in the number of failing students when using PSG.

4. Conclusion

This short article demonstrated the research group from Onloop center, a summary of its history since 2015, as well as its main publications. The research is conceived by dividing it into two major fronts: (i) *Research in Computer and Music Technology* and (ii) *Research in Education with an Emphasis on Digital Games and Music Production*. The first front is more technical-scientific and aimed at graduate students. The second front is directly related to undergraduate courses. In the medium term, the second front will be where the research will be deepen, for two main reasons:

- Research in education focused on Digital Games and Music Production allows the improvement of pedagogical techniques, envisioning an advancement in classroom work through the use of various technologies.
- Undergraduate students are immediately benefited. Firstly, by experiencing new pedagogical techniques and, secondly, by participating in these research initiatives through scientific initiation scholarships. Currently, there are ongoing scientific initiation projects involving several students from undergraduate courses.

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