Understanding Learning in Culturally Relevant Artificial Intelligence Education

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Abstract

Artificial Intelligence (AI) has increasingly gained attention in recent years, and with it, the need to involve youth in responsible uses of this technology. I propose a method to teach young students about AI, including the necessary knowledge and skills to identify, describe, interact, and create with AI in a responsible manner. Furthermore, I am interested in understanding learning outcomes (cognitive, affective, and behavioural) from a Constructivist perspective using insights from self-reports, observations, and system logs. Particularly, my research aims to engage students in culturally relevant learning integrating music as a cultural signifier. By situating the study in two different socio-cultural contexts, this study aims to characterise the extent to which different local cultures influence learning outcomes when learning about AI. Outcomes of this research aim to illuminate opportunities and challenges for teaching AI in a given cultural context, and whether students' learning outcomes (cognitive, affective, and behavioural) are influenced by culturally relevant curriculum.

Keywords

Artificial Intelligence Education, Student Engagement, Culturally Relevant Education

1. Introduction

In recent years, educational research in AI education has led to evidence-based guidelines, recommendations, and design considerations about what students in K-12 should learn about AI [13]. Nonetheless, while recent developments in AI curricula for K-12 aim to provide a comprehensive understanding of technical and ethical aspects of AI, little do we know about the influence of students' cultural background and personal interests and identities over their learning outcomes when learning about AI, including cognitive, affective, and behavioural.

Culture is defined as the set of practices within a group that are different to other groups, and that gives identity and belongingness to members of such group [10]. Culture is embedded in many everyday practices, for example, language, rituals, and artefacts. In my research, I am interested in the use of music as a maker of culture. Music helps in establishing a collective identity well differentiated from others through style and genre,

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particularly among the youth [2]. In this way, music provides the sense of authenticity and belonging to a particular identity of the local culture and makes possible the expression of a plurality of identities through construction and consumption of different musical genres [2]. Taking advantage of this, music has been widely used in computing education research to study its potential for providing meaningful and authentic learning, especially among K-12 students (e.g. [21]). Specifically for AI education, Fiebrink [8] implemented an AI curriculum and creation tool for artists and musicians to learn about AI by creating musical artefacts using Machine Learning (ML) algorithms. Nonetheless, the potential of music for leveraging AI education in the K-12 context is yet to be explored.

The use of music as part of the cultural framing of this study calls for a culturally relevant educational practice. Framed under social constructivist theory, the work of Au [1] and Ladson-Billings [12] has been instrumental in the field of culturally relevant education (CRE). CRE places learning at the intersection of culturally relevant practices and individual knowledge construction, and acknowledges that social interactions between students, their peers, teachers, and the environment shape knowledge and understanding. In this way, sociocultural perspectives in learning place culture as central piece in knowledge construction, highlighting the locality of such processes [15]. While these approaches have been studied in classrooms where a variety of marginalised identities often collide with, or are oppressed by, the dominant culture [16], I frame this study under the sociocultural and constructionist theories to understand how local culture, which encompasses heritage culture and at the same time is highly dynamic and community oriented (ibid), can influence learning through making of personally relevant artefacts. In this study, local students in a fairly homogeneous learning environment will enact musical practices, unique to them but similar to their local peers. This study is situated in two different socio-cultural contexts, namely Mexico and Hong Kong. Thus, by understanding how students build from within their own local culture to experiment with sound and music for learning about AI, we can have a better understanding of students' learning outcomes (cognitive, affective, and behavioural), allowing an exploration of any possible differences between the two regions, and whether these differences can be attributed to a culturally relevant curriculum.

Through a purposeful curation of the curriculum to include music that is familiar, or not, for students as a way to promote culturally relevant learning, this research aims to answer two research questions: For secondary school students, (1) what are the best practices for designing and implementing a culturally relevant AI curriculum?, (2) to what extent the use of music in a culturally relevant AI curriculum influences learning outcomes?

2. Related Work

2.1. Artificial Intelligence Education and Music

Recent advancements in the field of AI have brought a renovated interest in creating music with this new technology. Machine Learning (ML) in particular, has been understood as a new interface that allows new forms of intuitive performances, removing the barrier of rule-based algorithms to enable real-time interactive music experimentation [9]. Following this reasoning, Fiebrink [8] explored the affordances of ML-based music creation in the context of higher education, where students implemented their own ML music experiments with an

IDE that integrates the ML-pipeline, i.e., data collection, model training, testing, and deployment, for computational applications with music -and art in general-. Such IDE allows students to understand and apply different ML algorithms (e.g., decision trees, regression, neural networks) in embodied performances using different types of controllers. A limitation, however, is that it requires students to implement their own input and output scripts, i.e., write code for connecting computers to sensors that will be used as inputs and defining the desired music output using programmable audio synthesis. Removing this barrier would allow learners not yet initiated in programming, or computational music synthesis specifically, to participate in interactive learning about AI (i.e., ML algorithms) with music.

2.2. Understanding Learning in Computing Education: Multicultural, Artistic, and AI Education

The interest in understanding how students learn computing concepts is not new. Methodologies that implement computational and probabilistic approaches to understand student learning progressions in computing education have been popular with the advent of integrated development environments (IDEs) that allow the collection of students' programming practices. Nonetheless, understanding of learning from these unstructured learning environments remains challenging [5]. Common approaches for defining individual learning progressions during programming activities derive from micro-genetic approaches. For instance, Blikstein et al. [6] study coding behaviours of novice programmers in learning programming methodologies in Java, while Berland et al. [4] developed their own coding platform where students program soccer playing robots to assess tinkering practices as demonstration of increased programming proficiency. In both studies, the assessment of learning is done using metrics of code editions that capture the rich data from students' tinkering practices during coding sessions. Other metrics to evaluate goodness of the solution can be included on top of keystroke level data, such as syntax or compilation errors. Integration of these findings with qualitative methods can lead to the discovery of learning trajectories and a process-oriented assessment that looks at different dimensions of learning additional to cognitive, such as affective and behavioural. For example, Bosch & D'Mello [7] collected video of students while solving coding assignments to analyse their affective response and Rodrigo et al. [17] conducted a comprehensive mapping of compiler logs and observations to understand the affective response of students when coding. Yet, in the field of artistic computing education, implementations of learning analytics (LA) techniques are scarce. Yee-King, Grierson & d'Inverno [20] evaluated the programming patterns of undergraduate students in a STEAM-based introductory computer science course to evaluate the benefits of purposeful tinkering in artistic computing. Similarly, Zhang, et al. [21] analysed middle school students programming behaviours while using a block-based programming platform to create music. Both results put emphasis in purposefully designed activities that guide students through tinkering and learning.

LA approaches have also been taken to study programming practices in a multicultural classroom. In the study conducted by Tsai et al. [18], students from two different Chinese

ethnic groups in an introductory programming course exhibit correlation between programming behaviours (e.g., syntax errors, time on task) and affective outcomes (e.g., motivation, social expectancy, and self-expectancy). Students self-identifying with the minority ethnic background underperform in class activities and self-report lower scores in the affective outcomes measured, thus revealing the need of culturally relevant computing education to promote equitable learning outcomes for student from all backgrounds.

Moreover, few studies have investigated the behaviours of students while learning about AI. For example, Hsu et al. [11] analysed video-recordings of students who participated in project-based, cooperative AI learning, and coded their activities into 14 behaviours that emerged from these observations. Although these results offer an innovative methodology for studying learners' behaviours in an ample range of computing education scenarios, to the best of our knowledge, there is no implementation of a learning environment that allows to systematically collect and analyse students' interactions when learning about AI.

3. Method

3.1. Study design and Materials

Participants are secondary school students between 12 and 15 years old, who reside in the two contexts under study. This study will take a quasi-experimental approach in a between-subject design. Since the purpose of the study is to identify the effect of culturally relevant AI curriculum over learning outcomes, music will be the defining factor of cultural relevancy for the learning activities. Culturally relevant music in this study refers to traditional music practices and popular music familiar to the youth culture in each of the two specific regions under study. Conversely, culturally irrelevant music refers to the music that is not popular in a specific context. For example, the rhythms and beats characteristic of reggaeton are widely popular in current Mexican pop music and are potentially more relevant in that context. Similarly, Cantopop melodies and lyrics are instantly recognisable for students in Hong Kong and will be almost unintelligible for students in Mexico. Culturally (ir)relevant curricula will be tested in the two regions along with a control curriculum, thus creating three different conditions in each: AI curriculum that uses culturally relevant music, AI curriculum that uses culturally irrelevant music, and AI curriculum without music or any other culturally relevant aspect. These AI curricula are divided into 4 sessions of 45 minutes, for a total duration of 3 hours. The main learning objectives are for students to understand AI, apply AI, and reflect on the ethical development and uses of AI. The topics include Machine Learning, focusing specifically on supervised learning algorithms (e.g., regression, classification), application of ML for personal projects, and ethical aspects of ML such as bias, fairness, and explainability. For the culturally mediated curricula, the lesson plans include cultural musical practices traditional in the corresponding cultural context, as well as copyright and attribution for the ethical aspects of AI in the arts.

Following a Constructionist approach, in which knowledge and meaning are built through making, an integrated development environment (IDE) that supports sound experimentation with Machine Learning (ML) models will facilitate the learning activities. With this platform, students will collect data from mouse movements or web-camara to create musical outputs that dynamically respond to these inputs by implementing ML

models in real time. The platform is intended to be accessible to students without prior experience with AI or music, or even coding.

This research project consists of four main stages: co-design, pre-assessment of cultural relevance, pilot study, and main study. All stages are accompanied by experts in either teaching information and communication technologies (ICT) related subjects in K-12 level and music in each context. The co-design stage focuses on curriculum design and tool development. In the pre-assessment stage, students are asked to rate the relevance of different sets of music: pop and traditional songs from Hong Kong, Mexico, Netherlands (this cultural context was selected by being separated at least one standard deviation from Hong Kong and Mexico in all Hofstede's cultural dimensions), and pop songs in the global market. Students are asked to rate the familiarity and personal and cultural relevance of each song. These ratings serve as a baseline for analysing relevance of the music used in the culturally relevant curricula.

The pilot study will serve to test the curriculum and AI-music creation tool, and to validate the instruments used for assessment. Finally, the main study will provide the relevant data to answer the research questions.

3.2. Data Collection Instruments and Analysis Techniques

To answer the research questions, data from different sources will be collected. The learning outcomes will be evaluated via content knowledge test, self-reported students' attitudes towards AI (SATAI; [18]), self-reported music sophistication [14], semi-structured interviews, artefacts, video-recordings of lessons, and system logs. All data will be handled with considerations in transparency, privacy, and confidentiality, and complying with ethical considerations for research purposes. Ethical approval for the collection of the comprehensive data set has been granted by the Human Research Ethics Committee of the University of Hong Kong. The analysis of data will be guided by Constructionist theory, which emphasises personal knowledge construction, integrating data from multiple sources. I aim to understand student learning as they create and tinker personally meaningful musical artefacts and advance a Constructionist perspective for multimodal LA [3]. The analyses of the data integrate findings from qualitative and quantitative data to allow for a comprehensive evaluation of students' learning outcomes. Specific techniques will include descriptive and inferential statistics, thematic content analysis, and temporal analysis of system logs (e.g., sequential pattern mining, Bayesian knowledge tracing), emphasising the understanding of the processes that occur during learning.

Outcomes of this research aim to illuminate opportunities and challenges for teaching AI in a given cultural context, and whether students' learning outcomes (cognitive, affective, and behavioural) are influenced by culturally relevant curriculum. Identifying and understanding these differences, if any, can contribute to more effective and culturally responsive AI education practices. Moreover, the systematic collection, analysis, and evaluation of data from students' practices and interactions with the AI-enabled music creation platform will provide rich data from students' learning process, thus facilitating insightful findings that allow us to identify practices that improve AI learning. This study proposes to develop a practice of multimodal LA that looks at learning using quantitative and qualitative data that serves both the analysis of artistic computing and AI education.

4. Current State of the Research

The project is currently at the co-design stage, focusing on the development of the curriculum and music platform. This stage involves K-12-computing and music educators to integrate insights from their teaching practice. At the same time, pre-assessment will be conducted in early Spring 2024, and pilot study will follow. Meanwhile, the initial chapters of my thesis, which include theoretical framework, literature review, and proposed methodology, have been subjected to a rigorous review process and have been approved, marking the confirmation of candidature.

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