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FROM ARTIFICIAL INTELLIGENCE TO MUSICAL INTELLIGENCE FOR INCLUSIVE EDUCATION: REFLECTIONS AND PROPOSALS

DALL'INTELLIGENZA ARTIFICIALE ALL'INTELLIGENZA MUSICALE PER UNA DIDATTICA INCLUSIVA: RIFLESSIONI E PROPOSTE

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Abstract

The field of new technologies is constantly in evolution. It requires continuous training for anyone wishing to access it for research purposes. The advent of Artificial Intelligence (AI), which now permeates every aspect of society, is a growing research area that requires to be explored in depth. It is also gradually finding its way into the world of education, being used as a teaching aid to work with learners, especially those with Special Educational Needs. Therefore, the interest is to be directed towards the strategies and the methods used to improve the special teaching-learning process. Using methodologies centred on play, as well as through operational paths that use arts and music, can increase the motivation and the learning process. Thus, the connection of such means with AI can prove to be an alternative, vicarious, non-linear method of working, capable of stimulating the different forms of child's intelligence. In this contribution we will try to examine the possible connection that can be made, specifically, between Musical Intelligence, introduced by Gardner, and AI. Using AI programmes focused on music, hybrid activities can be created, capable of stimulating Musical Intelligence in the child.

Il mondo delle nuove tecnologie è un campo in fase di continua evoluzione, e richiede a chiunque voglia effettuarne ricerche, una formazione costante e continua. L'avvento dell'Intelligenza Artificiale, che permea ormai ogni aspetto del sociale, è un terreno in crescita e che esige di essere approfondita. L'interesse educativo verso tale risorsa è dato dallo studio di quali possano essere strategie e modalità con cui migliorare il processo di insegnamento-apprendimento *speciale*, facendo leva su questo potente mediatore. In particolar modo, il tentativo è quello di legare l'uso dell'Intelligenza artificiale con pratiche didattiche durante le quali lo studente abbia un ruolo attivo nel proprio processo di apprendimento. Tale lavoro può risultare, quindi, un sistema operativo vicariante, non-lineare, atto a stimolare le diverse forme di Intelligenza di cui è dotato il fanciullo.

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In questo contributo si cercherà di prendere in esame la possibile connessione da poter realizzare tra l'Intelligenza Musicale, analizzata da Gardner, e l'Intelligenza Artificiale, evidenziando come, mediante l'utilizzo di programmi di Intelligenza Artificiale incentrati sulla musica, si possano dar vita ad attività *ibride*, in grado di stimolare l'Intelligenza Musicale nel fanciullo.

Keywords:

Artificial Intelligence, Musical Intelligence, Inclusion, Special Education, Hybrid Education.

Intelligenza Artificiale, Intelligenza Musicale, Inclusione, Didattica Speciale, Didattica Ibrida.

1. Introduction

The field of Artificial Intelligence (AI) is a highly complex one and in continuous evolution. The progress brings to revise all precedent studies, both profile of theory that practice. AI characterizes every aspect of society, starting from its use in everyday life, such as with robots or other technological means capable of performing certain functions originally made by humans. For example, modern virtual communication systems, based on AI systems, capable of connecting multiple subjects within virtual spaces, or the new field of *metaverse*. AI, therefore, turns out to be a tool capable of accompanying humans, giving them support during the day. However, AI is also a tool that, over time, is penetrating the school environment. Various studies are trying to understand how it can support students, especially those with Special Educational Needs, in the teaching-learning process. The new technologies represent an advanced frontier of the right to study, capable of offering greater educational opportunities, as well as operational trajectories capable of respecting the legislative principles of *personalisation* and *individualisation* of learning (Sibilio, 2020). The use of new technologies, if connected to practical activities, can be a powerful inclusive means. In this contribution, an attempt will be made to examine a possible junction between Artificial Intelligence and Musical Intelligence (MI) for the realisation of inclusive activities. Specifically, the attempt is to analyse how the use of means centred on Artificial Intelligence in music can support the student with Special Educational Needs to improve not only basic skills, but also social and motivational skills, even when used in a *blended* mode. The first part of the paper will focus on the analysis of MI in didactics; the second part of the paper, on the other hand, will examine AI and its value from an educational point of view; the third section of the paper will aim to show some open-source software, built with the AI system, useful for students to create musical bases in a totally autonomous way, respecting the development of their own MI and creativity. In the conclusion phase, a reflection will be made on how such systems can support teachers in the realisation of hybrid activities with students with Special Educational Needs, in the perspective of an education that is for *everyone*.

2. Musical Intelligence and its educational potential

The concept of Musical Intelligence (MI) is inseparably linked to the analysis about Multiple Intelligences. Multiple Intelligences are related to Gardner, who states that "*the traditional notion of intelligences as measured by IQ tests is too limited, and that there are not just two ways of being intelligent, but many ways*" (Gardner, 1987, p.51). The diversity of intelligences that characterises the various human beings is also capable of generating the *variability* that characterises the different social aspects. Specifically, in the educational field the different intelligences delineate the heterogeneity of classes, in which a plurality of students coexists. Probably, students would have different cognitive style, which depends on the way their intelligences are interconnected. Therefore, the teacher's aim, is to try to identify, during the work with his or her students, what is the characteristic cognitive styles of each one is, emerging from the presence of these individual intelligences. The aim is also to choose different teaching methodologies, based on the *peculiarities of the learner.*

Specifically, analysing MI and its potential in terms of learning, we must recognize that it belongs to the domain of *analytical intelligences*, that is, those of a logical, musical, and naturalistic (McKenzie, 2003). These are the intelligences that promote the analysis of the knowledge presented to the learner. They are analytical because they promote the processes of analysing and incorporating data into existing patterns, although they may have additional components. In addition, MI develops in parallel with *Linguistic Intelligence*, as it allows one to listen to and appreciate everything related to music and sound production, starting from speech, up to listening to a melody or a piece of music, exploiting the pitch and rhythm component in the first stage, and then arriving at timbre.

For this, it is important that the child, from a very early age, be *immersed* in environments that are stimulating in terms of sound, because music is useful to increase neuronal connections (Proverbio, 2019). Gordon himself, from whom a learning system centred entirely on music emerged, claimed that good stimulation through music is important for the development of *brain architecture* (Gordon, 2003).

It should not be forgotten, however, that the use of MI, its exercise in school, is a benefit to develop creative, inventive skills, to acquire ability of problem-solving, necessary to solve the complex problems of society (Sternberg & Kibelsbeck, 2022). For this, at school, it is necessary, to search for strategies that are *no-linear* (Sibilio, 2013, Sibilio & Zollo, 2016), in centred on the use of creativity, inventive skills, working on a problem trying to find different and innovative solutions.

Ericsson & Pool (2017) recognise that most learning occurs through *practical* rather than theoretical exercise. Music is a discipline that makes practical activity, concrete exercise, its basic constituent. Therefore, musical practice is useful to further refine learning, through recourse to the concrete exercise that characterises it, developing skills that can be spent in real and everyday life.

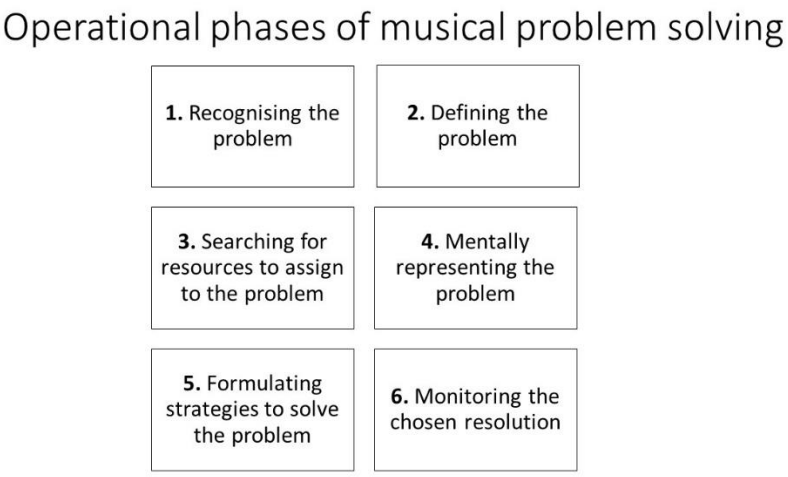


Chart 1: operational steps of a Music Problem Solving, revised from Sternberg & Kibelsbeck, 2022

Work carried out using MI, in the adolescent period, can be useful to work not only on basic skills, such as reading, writing and calculation, but also on emotional ones. Music requires the ability to *discover oneself*, building confidence in one's abilities and in one's way of working (Pelayo, 2018).

It follows, therefore, as a summary, that MI, although present as human characteristic, needs to be constantly increased, if appropriately connected to transversal work carried out on memory, on group work, so that the learning generated becomes meaningful (Velez & Rico 2017). Of course, being a discipline of a practical nature, it is necessary that work focused on the development of MI in the educational context requires participation, continuous executive stimulation in the student in the *sense-motor profile*. The skills developed by the student through musical intelligence led to the maturation of additional capacities, such as focusing on motor rhythm, the development of melody,

which in turn become means of expression, according to natural impulses such as moving, speaking, hearing, touching, and observing, among others, are emphasized (Díaz et al., 2014). This is important to understand how, when working with students with special educational needs, this mode of action is fundamental to ensuring the subject's well-being in terms of operational autonomy, personal orientation in life contexts, which are also fundamental domains in defining Quality of Life (Schalock & Verdugo Alonso, 2002).

3. Artificial Intelligence and its application in education

In the educational field the trend, regarding the use of Artificial Intelligence (AI), is twofold. On the one hand, AI is becoming a *topic of study*, to be studied at school, to develop knowledge and skills about it and its use, in the future, during design phase. On the other hand, using AI as an opportunity for improvement the teaching process (Cesaretti, 2021). The objective, didactically, is to develop in the pupil the *reflective capacity* regarding both the advantages and risks interconnected with the use of this support.

In Italy, the link between AI and education has not been dealt with recently. As early as the 1980s and 1990s, in fact, several research programmes on the subject appeared. The topics covered were manifold and ranged from the importance given to simulations, to the subject of *Machine Learning* (ML), to evolutionary robotics and artificial life.

The use of AI in the educational field would seem to guarantee the teacher the immediate detection of the results achieved by his or her students, the variations of learning, the prediction of possible success or failure of proposing activities, based on the results obtained and provided by the intelligence itself (Rienties et al., 2020). An example is *Machine Learning* (ML) techniques. The operational techniques of ML involve machines being able to process data, based on mathematical algorithms and codes that allow the machines themselves to learn and operate. It is used especially during tutoring activities, as Intelligent Tutoring Systems (ITS). This AI, starting from specific data, allows the child to work on progressively more difficult tasks.

Another applicative use of AI in the educational field to foster didactic and inclusive processes is given by Robots. The use of robots in didactics guarantees work ranging from the sphere of learning to that of emotionality, useful for intervening in the case of pupils with Special Educational Needs. The work on robots has been a real challenge for education, for the idea of an AI as support for student and its properties (Falcone et al., 2018). Over time, several projects have been implemented using robots and have shown how they are useful for working on specific areas of learning, such as *autonomy*, *attention development*, *collaboration*, and *problem solving* (Grimaldi et al., 2021). Educational robotics is also a powerful tool for developing emotionality and control, necessary to work with students with Special Educational Needs, such as in the case of Autism Spectrum Disorder, where it is required to implement the child's social skills (Campitiello et al., 2022; Menichetti, 2019; Giaconi et al., 2018).

4. The interconnection between Artificial and Musical Intelligence for hybrid and inclusive didactics

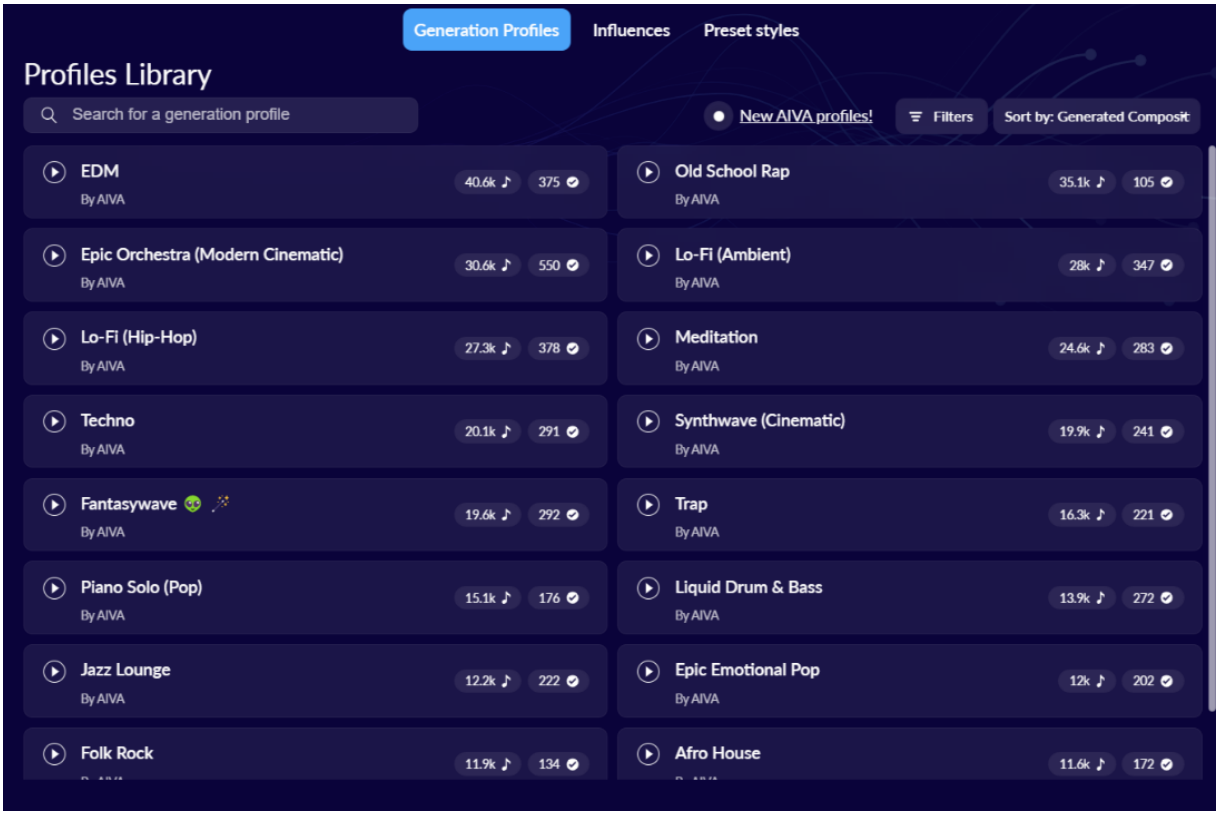
Working in a school context implies, from a didactic point of view, the search for ever new and continuous ways of working, through which to foster the teaching/learning process. Specifically, the teacher's objective is to align his or her work to the learner's training needs. Such a work implies the search for *vicarious modes* through which to adapt the material at his disposal (Sibilio, 2017). It remains to be understood how it is possible to draw a connection between it and Musical Intelligence, and how it is possible to implement Musical Intelligence through the aid of Artificial Intelligence for the realization of hybrid environments in which the specificity of each and the potential of each is enhanced, according to an inclusive vision.

There are many features to define the importance of these new approaches using AI and the improvement of MI for an inclusive education. It's important to specify that the different support given from teacher is based on school years. Teachers have to be trained for the use of these tools, to allow a good comprehension either to understand deeply the useful application the tools could have been for a student. In the primary school, teachers use these tools as a complete didactic support. During the first grade of secondary school students start improving their abilities using these tools but always supported by teachers. The situation starts to be different at second grade secondary school, where students are more independent, and they can use tools by their own. The aim of these new tools is trying to practice metacognition, improving creativity and working on multiple intelligences at every level of instruction.

Artificial Intelligence systems capable of guiding the learner in the realization of musical activities have sprung up on the market, both paid and open source. Specifically, there are systems that allow the learner to be able to realise musical pieces in a usable manner, without the possession of any cognitive requirements, in an automatic manner, as well as responding to specific needs from an emotional point of view, having the possibility to do so starting with the choice of mood

From an analysis with respect to which are the best existing programmes to operate in this sense, AIVA (which can be reached by clicking on the link (https://aiva.ai/) is particularly useful and intuitive for working with students with Special Educational Needs. The advantage of this programme over others, which perform the same tasks, is first and foremost the fact that it is free of charge and can also be used by those who do not enjoy favourable economic conditions.

Once you have selected the style you wish to work with within the song to be generated, the programme redirects you to a further screen, in which you can select the mood that should characterize the song being created. The virtual environment, in fact, must become a system in which each student can achieve their own autonomy, can be free to explore, manipulate, even make mistakes, to implement their own learning (Averna, 2022; Yeh et al., 2018; Cottini & Bonci, 2016).



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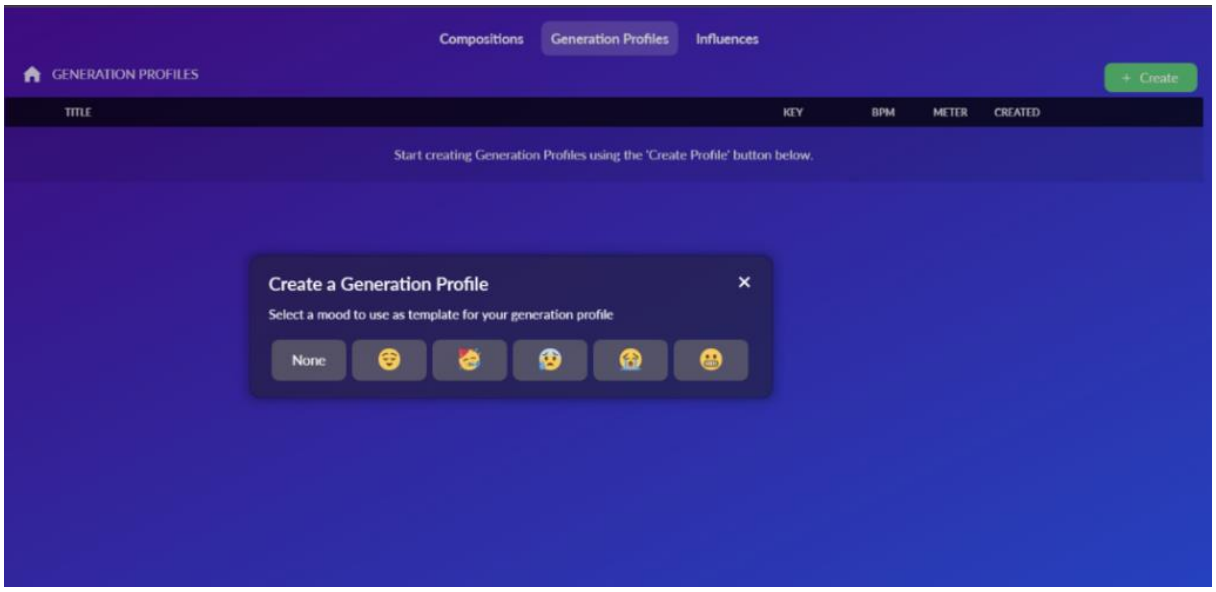
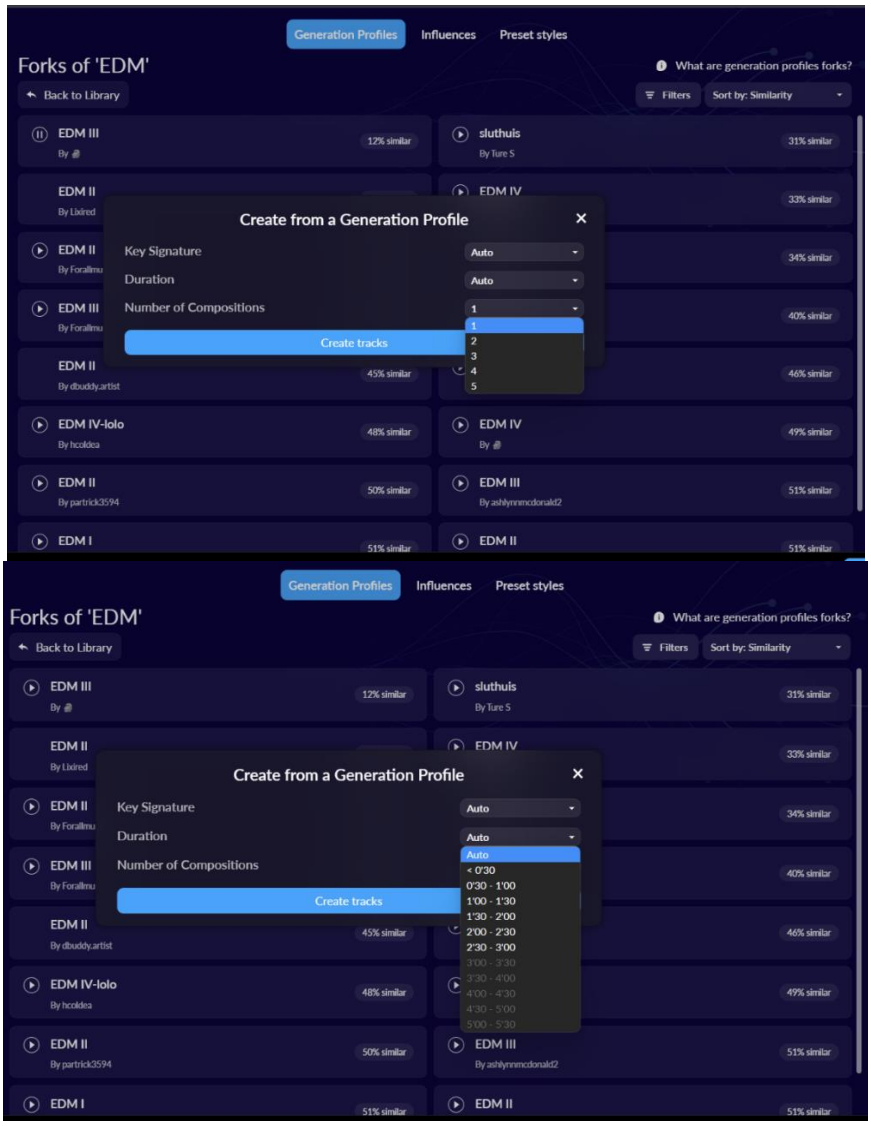


Images 1-2: first screen for the realisation of the song, with the choice of both style and mood

Once you have selected the mood with which you want to set the song, you can also choose the duration of the song, starting from 30 seconds up to 5 minutes and more. Once the duration has been selected, it is also possible to choose how many songs to create by selecting a single query.

Once the selection phase is complete, the programme immediately starts to process the information and produce the song or multiple songs in a very short time (starting from 15 seconds).



Images 3-4: internal programme display for choosing the number of tracks to be made and the time

Analysing the result, it is possible to see how the artificial intelligence has automatically created the song, working on the timing, dynamics, and colours of the same, without the need to choose anything except the desired mood, tempo, and number of compositions.

A second interesting programme for automatically generating musical bases, in an easy and intuitive manner, is Mubert Stock (available at the link: https://stock.mubert.com/). Mubert Stock is easy to use for both the child and the teacher, as it offers the possibility of creating music tracks very quickly, through a few simple steps. The track will be generated automatically and can be listened to in streaming free of charge. The only limitation of this resource is being able to download the created track, an option only possible by choosing the paid subscription. In any case, for use both in and out of the classroom, because of the simplicity of the steps and the clear and supportive approach offered by the site, the system is useful in encouraging hybrid and autonomous work, as well as encouraging experimentation and the *active role of the student*.

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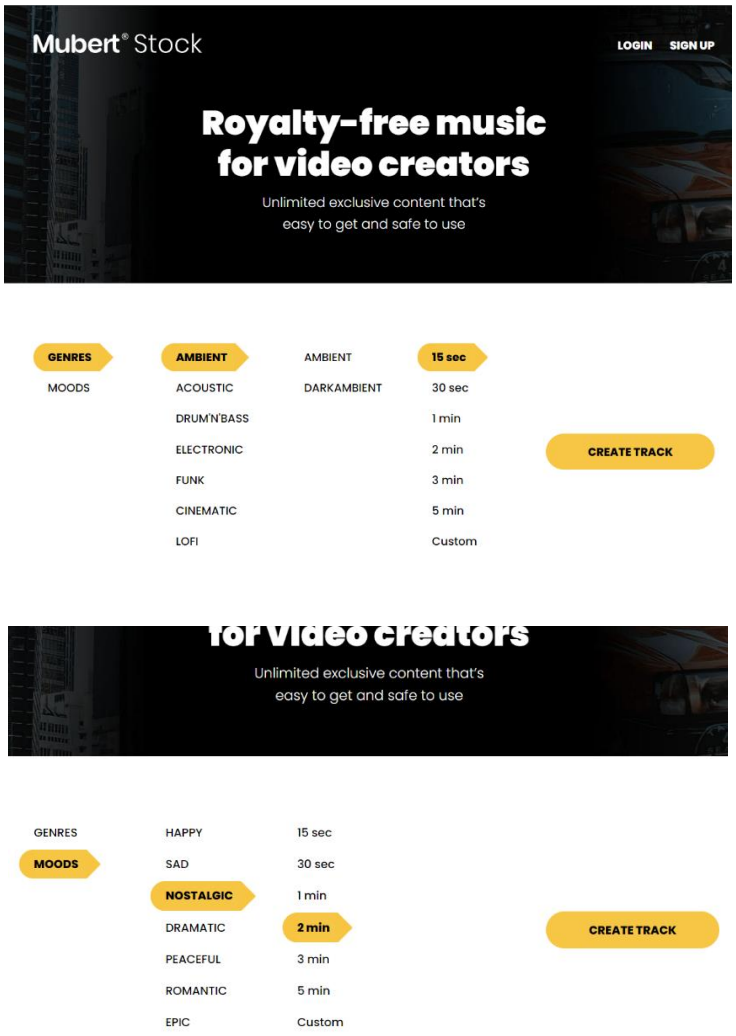

Pictures 5-6: Mubert Stock programme interface, with the possibility of creating the track by choosing both genre and mood

Useful for creating backing tracks in an intuitive manner is the programme Soundraw (available at https://soundraw.io/). The programme, again online, allows the user to generate music, starting from the selection of a mood, which can be selected through the choice of a photographic image that acts as a synthesis. The iconic element already appears extremely useful, as it could be a facilitator when the student has reading difficulties, needing to resort to the visual to make their choice. Having selected the mood on which to build the track, the user will have the opportunity to choose the style and length of the track, also being able to detail whether the track should be fast/slow or played with one instrument or several instruments. Once the creation has started, the programme returns several tracks generated based on the choices made previously. Again, the site offers the opportunity to listen to the track for free, as it can only be downloaded by selecting a monthly or annual subscription.

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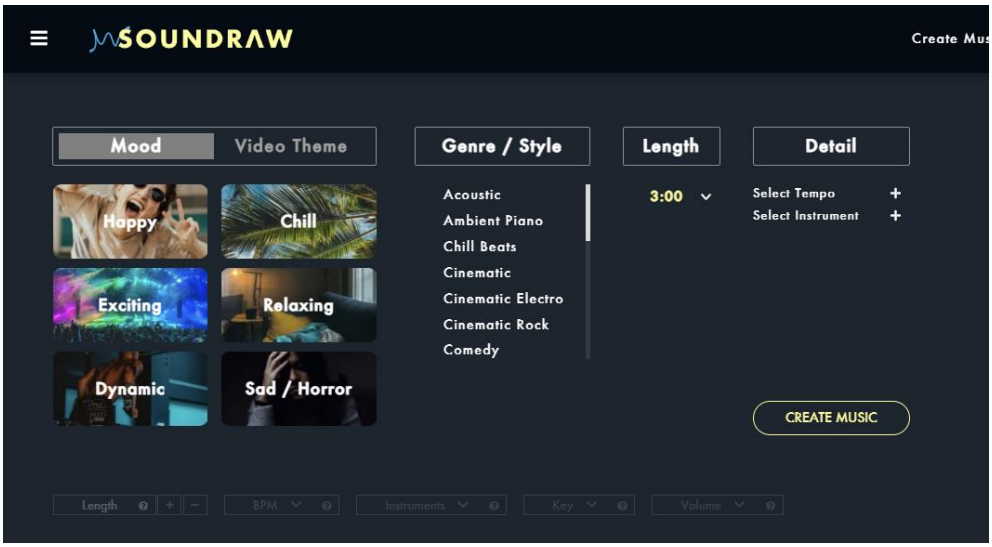
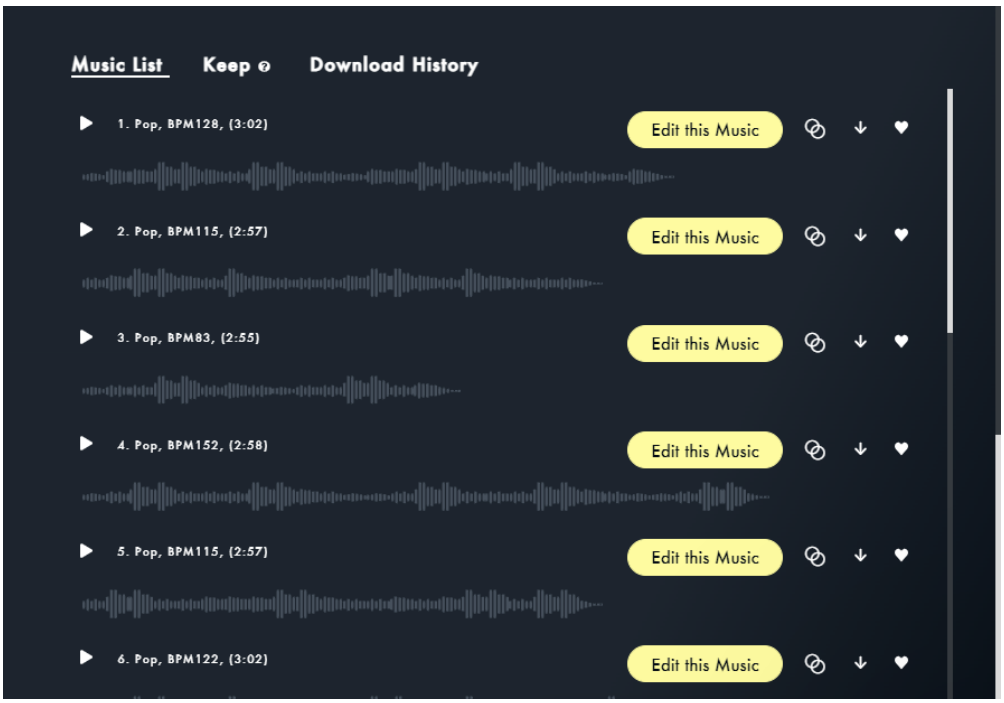
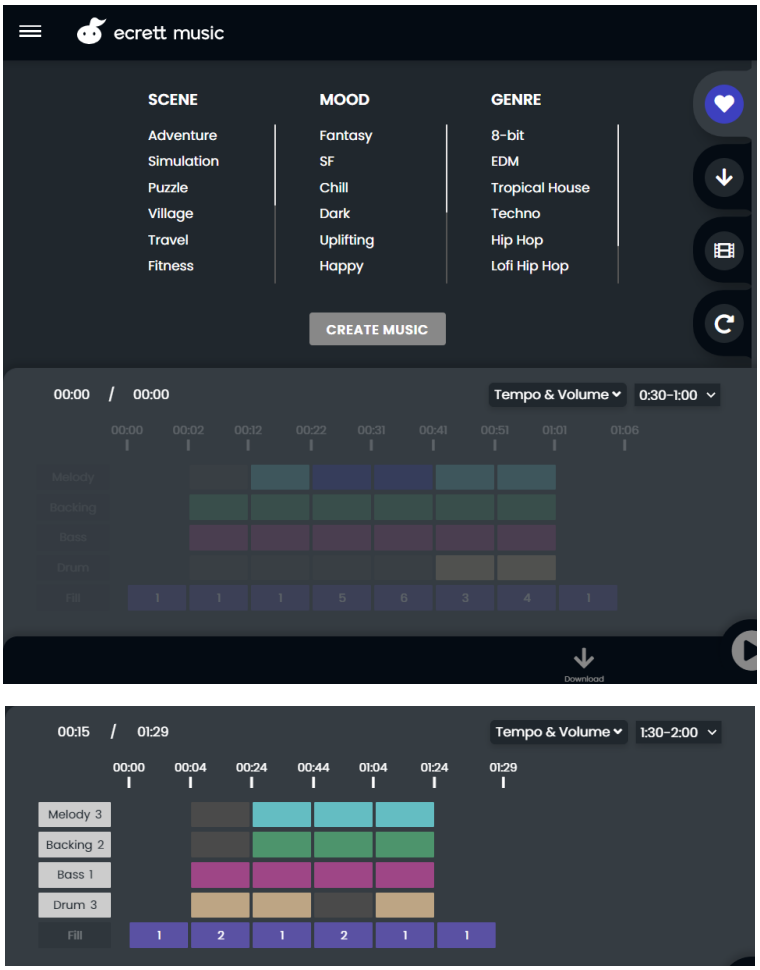




Images 6-7: Soundraw interface. We highlight the easy choice with the image of the mood to set the track to that the plurality of tracks it returns at the end

Another interesting programme that uses Artificial Intelligence to create backing tracks is Ecrett Music (available at: https://ecrettmusic.com/). Compared to the AIVA programme, mood preference cannot be made through emoticons, which are closer to the way both children and adolescents communicate; however, due to the simplicity of the controls, it can be adapted to a learner with initial support from the educator. By accessing the "Create" section from the home screen, it is possible to initially choose the setting in which to insert the piece, the mood with which the composition is to be permeated, as well as the genre. Being a programme set up to be fully utilized only for a fee, it emerges that the choice is not vast, but nevertheless useful to be able to create bases to be used with one's pupils, or to have them design their own. Intelligence, moreover, based on the initial choice of setting, is also able to suggest the ideal mood and musical style for the creation of an original song.



Images 8-9: Ecrett Music programme interface with various editing sections highlighted

These systems are useful to ensure the maturation of a creative instinct in the child, which can emerge through the choice of a track, the ability to intervene directly on the model created by the system. Artificial Intelligence generates the product, but this is always done based on Musical Intelligence possessed by the subject who is generating it, of his own choices that depend on his own *experience*, social and *cultural background*. It is precisely in this that the *hybrid* aspect, somewhere between real and virtual, can be emphasized. The chance of using musical creativity to generate a finished product makes it possible, therefore, to operate along a dual trajectory, which allows the learner to be both agent and user. Operating in this sense also implies a further advantage, from an emotional point of view. Working from the perspective of an educational and didactic action in which the learner is directly involved also guarantees work on *motivation*. Motivation to learn occurs when the subject becomes the direct organizer of his or her own educational process, is directly involved in the realization of educational activities (Froiland & Worrell, 2016). A good degree of motivation, therefore, will also implement the inclusion of the same and its proper inclusion in school (d'Alonzo, 2018). An important resource such as that offered by Artificial Intelligence, if applied wisely in the educational field, can be an important means of developing transversal skills as well, and the maturation and augmentation of Musical Intelligence can be a valid example of such an augmentation, in environments that are not necessarily and totally virtual.

5. Conclusions

From the analysis conducted so far, a fact emerges on which final reflection should fall. The use of artificial intelligence turns out to be a valid tool in every field of reality, capable of supporting humans in the normal exercise of their tasks. It also turns out to be a valuable teaching support tool for

teachers, as it can be easily adapted according to the various needs and according to the emerging *needs of pupils*. When this medium relates to activities that stimulate the child's creativity, as in the case of Musical Intelligence, the tool becomes more important as a didactic *mediator*. It also follows from the analysis conducted that artificial intelligence does not need to work exclusively in the virtual, as it presents itself as a support for activities that can also be performed in the real world. Such Artificial Intelligence systems, in fact, do not require the total immersion of the subject within the spaces set up virtually for work, as they allow him or her to operate also in a *hybrid form*, even in the relationship with the acting machine. The learner, moreover, through the musical exercise performed both independently and with others, can develop a sense of *sociality*, of *interaction* with the other, through the practical and material work that can be used with one's peers for the realization of the teaching activities. One of the objectives of *Universal Design for Learning*, when the new technologies are being analysed, is precisely that of constructing, with the virtual support, learning environments of a participatory nature, through an action that is aimed both at *recognition*, at the development of *strategic learning*, as well as *affective learning* (Aiello, 2015). Working practically and genuinely, even with the presence of the virtual, of an intelligence that acts as a mediator, would seem to be an effective way of reinforcing this principle of *cooperation*, *participatory motivation* (d'Alonzo, Bocci & Pinnelli, 2015). Hybrid practice, therefore, simultaneously enables growth in personal, motivational, social, and interactive skills. Lastly, in the educational field, AI does not become a substitute for the teacher, but a true didactic mediator, through which the learner can implement his own learning, be stimulated to collaborate with others, to develop and mature his own *creativity* in an environment that is hybrid, on the border between real and virtual, between physical and immaterial, standing out against a background that is simultaneously inclusive, respectful of his own individuality and of the community.

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