https://doi.org/10.36315/2024v2end040
Education and New Developments 2024

S.T.E.A.M. AND D.D.A.T.A.: A MULTISENSORY APPROACH TO MUSIC AND DEVELOPMENT OF SKILLS AMONG STUDENTS WITH INTELLECTUAL DISABILITIES

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Abstract

The Differentiated Didactic Approach to Teaching the Arts (D.D.A.T.A.) is a contemporary pedagogical method which proved thoroughly successful when applied to almost 300 students with intellectual disabilities, in five Special Needs schools and a private, Special Education unit. The learning facilities were located in two cities of Greece and the D.D.A.T.A. method was applied within the framework of those schools' music lessons. Combining the principles of D.D.A.T.A. with those of the Science, Technology, Engineering, Math and the Arts (S.T.E.A.M.) method, and learning Music from a multisensory pedagogical angle is an altogether new approach in international literature. By means of a series of sensors and controllers, multisensory learning can help people with intellectual disabilities to play music notes and generate music by touching conductive objects (S.T.E.A.M.). By using a computer under the guidance of a controller, and through a source of visual signals (D.D.A.T.A.) provided by the teacher, learners can arrive at the musical composition desired. In that manner, persons with intellectual disabilities can participate inclusively in an ordinary musical ensemble. The present work aims at recording the multisensory approach to Music via a combination of D.D.A.T.A. and S.T.E.A.M. Its purpose is to help learners with intellectual disabilities to develop their musical skills. The research was based on a methodology that relied on systematic observation within the framework of applying the above multisensory approach of teaching (D.D.A.T.A. & S.T.E.A.M.) to a group of middle school learners during the school music lessons, for a period of three months (Autumn 2023). In terms of both psychology and pedagogy, results were as spectacular as they were significant. The multisensory approach to Music through the use of D.D.A.T.A. and S.T.E.A.M. encourages learners to participate and improve their self-confidence, bolsters their self-expression skills, and helps them communicate and socialize. At the same time, learners acquire a range of kinetic and cognitive skills such as focusing their attention, and honing their perception, memory, and thinking.

Keywords: *S.T.E.A.M., D.D.A.T.A multisensory, music, intellectual disabilities.*

1. Introduction

The D.D.A.T.A. method (Differentiated Didactic Approach to the Arts) is a contemporary pedagogical method that has been successfully applied in Greece to almost 300 students with intellectual disabilities (Makris, 2022). D.D.A.T.A. emerged as a necessity through the clinical work (2014-2024) of Dr. Ioannis Makris (Makris 2015a; Macri & Makris, 2014a, 2014b, 2014c) and focuses on individualized (personalized) teaching. It cultivates the skills of learners with intellectual disabilities by utilizing their strengths and taking into account each one's specific needs and abilities. (Makris 2015a, 2015b, 2019; Makris & Mullet 2009; Mullet & al, 2012). It tailors lessons to each student's strengths and needs, allowing them to actively participate and develop musical skills. This approach emphasizes five key principles: (a) Individualization: content, methods, and activities are adapted to each student's learning style; (b) Multisensory Learning: sight, sound, and touch are engaged to lead to deeper understanding; (c) Positive Reinforcement: successes are applauded, fostering encouragement and self-confidence; (d) Collaboration: teamwork and peer support are cultivated; (e) Technology integration: digital tools enhance learning, creativity, and participation.

D.D.A.T.A. benefits learners by improving musicality, creativity, social interaction, self-confidence, and reducing anxiety. It can be implemented in Special Education schools, conservatories, and therapy programs, promoting inclusive and effective music education. Successful implementation requires collaboration among educators, parents, and specialists, ensuring a holistic

student support. Further, combining D.D.A.T.A. with S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics) creates an empowering learning environment: (a) Individualized learning: technology is adapted to student needs during music activities; (b) Multisensory experience: visuals and touch enrich the musical experience; (c) Skills development: critical thinking, problem-solving, communication, and digital skills grow (d) Enhanced self-confidence: success in dealing with technology motivates students. D.D.A.T.A. with S.T.E.A.M. fosters holistic development and a smoother integration of learners with intellectual disabilities into the world of Music.

2. Design

Our research was carried out in the period September 2018 to December 2023. It is based on systematic observation during implementation of the multisensory approach mentioned earlier (D.D.A.T.A. with S.T.E.A.M.). It was conducted in three middle school (Gr: Gymnasium), 7th-grade classes, each in a different type of Special Education school in Athens, where we taught music for one hour weekly. We held an overall of fourteen (14) such classes. The total sample size is shown in Table 1 and comprises seventeen students. In the first Special Education Middle School (School 1), we implemented a combination of D.D.A.T.A. & S.T.E.A.M. in a 7th-grade class. In the 7th-grade class of the second Special Education Middle School (School 2), we carried out our session using D.D.A.T.A. only. In the 7th-grade class of the third Special Education Middle School (School 3), we conducted the music lesson in the conventional manner that Greek schools follow when teaching Music. More specifically: At School 1 (Peristeri EEEEK), we applied the D.D.A.T.A. method using D.D.A.T.A. in combination with S.T.E.A.M. controllers, in a class consisting of students with significant learning difficulties. In School 2 (Ilion Special Education School), we implemented the D.D.A.T.A. method alone, using only visual cues, in a class of learners with mild learning difficulties. Last, in School 3 (ENEGY-L Ilion Special Education School), we conducted the music lesson in the conventional manner for learners with small learning difficulties.

3. Objectives

There were two objectives: (a) evaluate the effectiveness of D.D.A.T.A. when combined with S.T.E.A.M, and (b) evolve and improve existing teaching strategies and materials for use by the D.D.A.T.A. and S.T.E.A.M. combination. We evaluated the effectiveness of that combination with a view to assessing: (a) the developmental impact the D.D.A.T.A. & S.T.E.A.M combination had on the musical skills of learners with intellectual disabilities; (b) whether that multisensory approach to music bolsters the self-confidence, expression, communication, and socialization of intellectual disabilities learners; (c) the developmental impact of the method on the special needs learners' motor and cognitive skills (concentration, perception, memory, thinking); and (d) the results of our research efforts to record and analyze in detail the experiences of students with intellectual disabilities during their participation in the D.D.A.T.A. & S.T.E.A.M. project. We also aimed at: (a) comparing and contrasting the effectiveness of this method with that of other traditional music education methods for intellectual disabilities learners; (b) identifying any challenges/ difficulties faced by students/teachers during implementation with a view to developing and improving existing teaching strategies and materials already in use by the D.D.A.T.A. & S.T.E.A.M. combination so that we may more efficiently address the needs of intellectual disabilities learners; and (c) disseminating our research results to the broader educational community so that even more learners with intellectual disabilities may benefit (see Table 3, Objectives).

4. Methods

Data were gathered through systematic observation although legal restrictions did not allow for video recording. The methodology implemented involved three phases: (a) preparation (5-10 minutes) during which we held a reflective discussion with learners. In School 1, where we had four students with learning difficulties (Table 1), we briefly talked with the only student who could communicate through speech. It is worth noting that, early in that year, the three students who could not communicate had been engaged in other activities (e.g., painting, doing puzzles) and had taken no music lessons; (b) music interpretation (30 minutes) dedicated to music teaching and song interpretation; (c) reflection (last 5 minutes), focused on discussion and reflection. During the session, we closely observed the progress and development of each student, continuously making adjustments to improve both the technical and musical content. After the lesson, we recorded all of those observations keeping in mind the objectives we had already set (Table 3): observation and systematic recording were the key elements by which we could analyze overall progress.

We organized data analysis as follows. (1) Data: a spreadsheet was created, with columns per learner, observation date/time, observation category (e.g., preparation, music interpretation, reflection), detailed descriptions of observed behavior, and progress towards objectives (Table 3). (2) Category analysis: (a) preparation: content, time spent, and effectiveness in engaging learfners were analyzed, and differences between schools based on student capabilities were examined; (b) music interpretation: student participation, level of interest, understanding song interpretations, and any technical challenges were analyzed; and (c) reflection: content and quality of discussion, student reflection on their progress, and any insights were analyzed. (3) Student progress analysis: (a) comparison of observations: trends in each student's performance across different phases and observations were identified; (b) monitoring progress towards objectives by comparing our observations to the set objectives (Table 3) in order to assess student achievement; (c) accounting for individual needs: the analysis was differentiated so that we may understand how individual learner differences (language skills, prior experience) impacted progress. (4) Overall effectiveness analysis focuses on: (a) combining student analysis by identifying common themes across all student observations so that we may gauge the teaching method's overall effectiveness; (b) areas needing improvement which, based on the analysis, we identified as areas in which the program could be improved in terms of content, delivery, or student engagement. The key findings of the data analysis were summarized and are included in the Results section.

5. Results

The results were impressive for School 1 where we implemented the D.D.A.T.A. & S.T.E.A.M. combination. Results were equally impressive for School 2, where only D.D.A.T.A. was implemented. More specifically: (A): At School 1 (the school with the most difficult cases), where the D.D.A.T.A. & S.T.E.A.M. combination was carried out, the students reached the point where they could prepare for their first public performance (March 21, 2024). After fourteen sessions, learners were able to function as a group and showed that their musical and cognitive skills had improved significantly. S.T.E.A.M. technology proved an additional incentive in their progress, as technology had made it possible to combine objects with sensors transforming them into musical instruments. Two of our learners handled the sensors while the other two played keyboards. (B): At School 2 (D.D.A.T.A. method only), despite the fact that we did not use the foot-operated, visual-cue generator and worked only with visual colored cues, progress was remarkable: students reached the point of being able to respond to a wide musical repertoire with astonishing promptness, just like the students at School 1. (C): At School 3 (the easiest cases), neither the D.D.A.T.A. nor the S.T.E.A.M. methodology was applied: we followed the classic, conventional teaching program. Student enthusiasm in participating dropped to such a degree that learners were not even interested in singing one single song as the conventional music teaching method did not foster a climate of team spirit as in the cases of Special School 1 (D.D.A.T.A. & S.T.E.A.M.) and School 2 (D.D.A.T.A. method only). All we observed at School 3 was the predictable cognitive progress of a typical student reacting to a conventional lesson.

6. Discussion

The usefulness of D.D.A.T.A. (Differentiated Didactic Approach in the Arts) and S.T.E.A.M. (Science, Technology, Engineering, Art, Mathematics) in music education for intellectual disabilities learners is reinforced by the research findings presented in this study that involved the three Special Education schools mentioned earlier. D.D.A.T.A., as cited in the works of Macri & Makris (2014), and Makris (2020), tailors teaching to the individual needs and abilities of each learner, ensuring equal access to music education (Macri et al., 2019). D.D.A.T.A. encourages active participation and autonomy of learners, contributing to the development of critical thinking, problem solving, and creativity (Macri et al., 2019), skills that are all too necessary for the 21st century (Makris, 2015a). That type of approach also contributes to the reinforcement of empathy, teamwork, and socialization (Macri et al., 2019), cultivating meaningful relationships and interactions that contribute to the learners' wellbeing (Peterson & al, 2008; Slavin, 2012). The D.D.A.T.A. & combination enriches music education with visual, tactile, and auditory stimuli, facilitating the understanding and assimilation of new knowledge (Macri et al., 2019). S.T.E.A.M. also contributes to the development of Science, Technology, Engineering, and Mathematics (S.T.E.A.M.) skills in an entertaining and engaging way (Macri et al., 2019), preparing students for the demands of the future job market (Makris, 2015a).

7. Conclusions

Our research highlights the benefits of D.D.A.T.A. and S.T.E.A.M. in music education for learners with intellectual disabilities. D.D.A.T.A. personalizes learning, while S.T.E.A.M. adds a multisensory experience. Together, they promote skill development, self-confidence, and holistic growth. Future efforts should focus on training educators, creating accessible materials, and ensuring program sustainability. This research paves the way to improved music education among intellectual disabilities learners.

Table 1. Schools.

	Case	**Sex** M: male F: female	**Age**	**Prior Knowledge of Music**	**Verbal Communication**	**Non-Verbal Communication**
School 1	1	M	12	None	Yes	Yes
	2	M	12	None	No	Yes
	3	M	12	None	No	No
	4	F	12	None	No	No
School 2	5	M	12	None	Yes	Yes
	6	M	12	None	Yes	Yes
	7	M	12	None	Yes	Yes
	8	M	12	None	Yes	Yes
	9	F	12	None	Yes	No (blindness)
School 3	10	M	12	None	Yes	Yes
	11	M	12	None	Yes	Yes
	12	M	12	None	Yes	Yes
	13	M	12	None	Yes	Yes
	14	M	12	None	Yes	Yes
	15	M	12	None	Yes	Yes
	16	F	12	None	Yes	Yes
	17	F	12	None	No	No

Table 2. Equipment.

	Technical Equipment	**Music Equipment**
School 1	Optical Signal Generators Operated by Foot Pedals, Laptop, Electronic Circuit for Converting Electrical Signals into Audible Frequencies (Notes), Conductive materials, Sensors	Two keyboards, Guitar, DAW Cubase VST, Tambourine, Daf (drum)
School 2	Visual, colored indicators	Two keyboards, Guitar, Tambourine, Daf (drum), Maracas
School 3		Guitar, Keyboard, Tambourine, Daf (drum), Maracas

Table 3. Objectives.

	Objective	**Description**
Evaluation of effectiveness	**Developing Musical Skills**	Assessment of the impact of the D.D.A.T.A. method in combination with S.T.E.A.M. on the development of musical skills in students with intellectual disabilities
	Improving self-esteem, expressiveness, communication and social skills	Exploring the potential of this particular multisensory music intervention to enhance: Self-esteem,Expressive abilities,Communication skills,Socialization
	Improvement of motor and cognitive functions	Measuring the impact of the method on the development of motor and cognitive skills, such as: Concentration, Perception, Memory, Cognition
	Recording of children's experiences	Recording and detailing the analysis of the experiences of students with intellectual disabilities during their participation in the program by combining the D.D.A.T.A. and S.T.E.A.M. methodologies.
	Comparison to traditional methods	Comparison of the effectiveness of the specific method with other traditional music education methods for students with intellectual disabilities

	Identification of challenges	Identification of any challenges or difficulties faced by students, teachers and/or educators during the implementation of the method
Development and improvement	**Strengthening of teaching approaches and materials**	Development and improvement of existing teaching strategies and materials used in the D.D.A.T.A. methodology in tandem with S.T.E.A.M. to better meet the needs of students with intellectual disabilities.
	Dissemination of results	Dissemination of the research results to the broader educational community so that even more children with intellectual disabilities may benefit.

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