

Adaptations in Science Teaching for Students With Mobility Problems After the Pandemic of Corona-Virus Disease 2019

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The inclusion of students with special needs in science courses has been a cause for concern among the scientific community in recent decades. Taking into account the changes caused by the pandemic corona-virus disease 2019 in the educational process, we studied the adaptations that could be made to the teaching of science for students with mobility problems in order to be effectively integrated. Exploiting the adaptations that are described in the literature for the teaching of science for these students we defined the possible modifications that could be made either to distance learning or to hybrid learning systems that use both in-person and distance learning.

Keywords: science teaching, mobility problems, teaching adaptations, pandemic

Introduction

Typically developing children, who are at the first year of their life in order to learn how to walk they acquire movement skills that expand their capability to learn from experience (Kamil & Devries, 1978). Until the age of five, they enrich and refine their gross skills (e.g., standing position or moving), enhance their motor skills (e.g., manipulating objects), and they improve their coordination and balance, that allow them to extract data out of the surroundings (Wickstrom, 1977). Gradually, during childhood, children develop more complex movement skills, such as balance, agility, ability to jump, strengthening the arms, and manual dexterity (e.g., ability to catch, roll, toss, etc.) (Gallahue, 2002). As children move around or touch things they become aware of the shape and size of the objects, they realize their dimensions, the directions, or the notion of trajectory and they do not settle only for what they just see. According to Piaget (1972), a child learns through his/her hands but thinks and responds through the body.

On the contrary, children with motor disabilities face significant difficulties in their daily lives and as a

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result they do not have the same experiences as children with typical development. The play in the early age and the physical activity and sports later (in open-air stadiums or indoor courts), as well as the use of sport equipment (e.g., horizontal bars, swings, slides, labyrinths, etc.) equip children with a source of stimulations and knowledge that provide opportunities to boost their imagination and develop their social and emotional skills (The American Occupational Therapy Association, 2011). The shortcoming of participation to these activities causes children with mobility problems to show deficiencies in the above areas. These children also may be led to a divergent body image or restrain the cycle of their peers and adults that can come in contact with. This may severely affect children's learning ability, their ability to process information and consequently their cognitive and psychological development. Moreover, fine motor problems affecting the upper limbs hamper achieving refined motor skills, such as drawing and proper handwriting. In the school environment, students with motor problems may face difficulties accessing several parts of the school building or the classrooms (Ministère de l'Éducation, de l'Enseignement supérieur et de la Recherche, 2015).

When typically developing children reach school age, they already have acquired the knowledge and skills that enable them to observe, to comprehend concepts, to act, and to experiment in science classes (The American Occupational Therapy Association, 2011). But for students with limited free movement, minus participation to game activities and exploration of the surroundings understanding of several concepts of the physical world may be very difficult. Therefore, for students who are deprived of motor experiences and ensure that the appropriate teaching materials are combined with digital technologies (Basilaia & Kvavadze, 2020; Fletcher-Janzen & Reynolds, 2009; Saridaki, Gouscos, & Meimaris, 2010).

During the pandemic of corona-virus disease 2019, distance education has changed the lives of students in many countries around the world. New challenges have emerged regarding the integration of children with disabilities, such as the use of technology and internet access, but also the willingness of teachers and parents to continuously support these students (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 2020). The distance learning is a model that has been applied for many years in adult education for working students, but also for adults who decide to obtain a new degree during parenting periods, as they provide time flexibility (Osguthorpe & Graham, 2003). The application of mixed learning combination of face-to-face teaching and distance learning will possibly create a new perspective in the field of education, as new ideas will be born and both the roles of teachers as coaches and the motivations of students will be redefined (Pokhrel & Chhetri, 2021; Dhawan, 2020; Puente & Engeln, 2015). For students with mobility disabilities, attending online courses is a real challenge. There is a number of students with mobility disabilities that responds positively to distance education which offers flexibility of time and location (Dhawan, 2020) as they do not need to move in order to attend the teaching of their courses for life (Basilaia & Kvavadze, 2020; Foley & Regan, 2002).

Regarding the above remarks for students with mobility problems and the perspective of face-to-face teaching or/and distance learning after the end of pandemic of corona-virus disease 2019, we conducted a review of the literature in order to organize the adaptations that were described by the researchers for teaching science to students with mobility problems. We categorized the adaptations taking into consideration the needs of the teachers of science and the implications referred in the papers of science education and special education. Subsequently, we defined the modifications of the adaptations that could be applied by the teachers of science regarding the characteristics of the students with motor problems and the possibilities of face-to-face teaching and distance learning (Smith & Basham, 2014).

Teaching Adaptations

Computer Technology

The use of computer technology concerns either face-to-face teaching or distance learning. For students with problems in the upper limbs, the mouse control and the use of keyboard are the most important and obvious obstacles (Hudson, 2002; Web AIM, 2012), as their inability to respond promptly can cause problems connecting to their computer or making it difficult for them to actively participate in modern discussions (Burgstahler, 2002; Crow, 2008). These difficulties can be overcome with various tools that can facilitate these students depending though on the severity of their motor disability by replacing the functionality of a mouse, with foot switches, hand switches, virtual and alternative keyboards touch screens with sticks, head pointers, voice control, and speech recognition. These tools may allow students to interact successfully with their computer without using their hands (Foley & Regan, 2002).

Science Lab

Teachers can implement alternate procedures during the different stages of laboratory tasks in face-to-face teaching, so that accessibility difficulties can be overcome during the various activities. In this way, all students can equally participate regardless of their mobility impairments (Kucera, 1993; Miner, Nieman, Swanson, & Woods, 2001; Keller, 1994). Furthermore, extra time can be allocated to complete each task. If a second teacher is present, he/she can assist the students to access and handle the equipment. Teachers can boost the students' confidence when they carry out various lab activities on their own and they should plan their lessons, so that students do not miss out the beginning of the session because of the time it takes to move around the school building. Assistive technology (Martakos et al., 2002) in science lab like special software and simulation devices can also help them to overcome the difficulties they face during the execution of an experiment, for example, to record the measurements of the physical or chemical quantities and to advance at their own speed (UNESCO, UNICEF, & World Bank, 2020).

Accommodations regarding the equipment of the science lab include the following (Kucera, 1993; Miner et al., 2001; Keller, 2002): (a) devices that work electronically rather than mechanically, e.g., electronic/digital balances instead of beam balances; (b) storage equipment that is easily accessible to students physically challenged; (c) lab equipment should have larger-sized buttons on switches and potentiometers; and (d) supply little voltage to electric appliances to prevent electric shock. Science lab should have adaptable work surfaces with knee-space for students using wheelchairs. Generally, Science lab settings, chairs, closets, etc. should allow students using wheelchairs to move around and have access to every part of the room. Students could come beforehand in the lab with their teacher to choose where they want to work and try out the devices in order to familiarize themselves with the room and the appliances. Students should never be left on their own at the science lab meanwhile safety rules should be strictly followed to avoid electric shock, fire, and burns.

Equally important for distance learning and face-to-face in higher education teaching are the interactive environments in which the user uses simulation tools to follow the behavior of the experimental system that focuses on the scientific approach of the natural phenomena (Almgren & Cahow, 2005; Coble et al., 2010; Lerro et al., 2008; Nedic, Machotka, & Nafalski, 2003). Interactive simulations like PhET (Physics Education Technology, University of Colorado), Interactive physics, Crocodile physics, Modellus 4.01, etc., mainly in secondary education, are defined as practical laboratorial skills and allow the students to interact online with the experimental device (Almgren & Cahow, 2005), enable the students to play a leading role in conducting the

experiment, while developing practical laboratory skills (De Jong, Linn, & Zacharia, 2013). Most of the simulation software programs and some demo of them are free of charge.

Hands on Learning and Simple Materials

Teachers of science classes may provide opportunities to students with limited experiences on their surroundings to gain hands-on experience and self-mastery (Niazi, Asghar, & Ali, 2018). To achieve these goals, teachers need to keep in mind student's specific needs and experiences. For example, some kinesthetic experiences (Brualdi, 1996) that will help them understand that the basic kinematics concepts could derive from the way they feel the wheelchair using their own hands (K. Bernhard & J. Bernhard, 1999). The different forces they apply in order to move a wheelchair on a lean floor compared to the forces needed to move the wheelchair uphill on a ramp could serve as a teaching example, so that students with mobility disabilities can connect the concept of force to a real-world phenomenon. The above example could be used either in face-to-face teaching or in distance learning with proper modifications. In the first case, the teacher or a classmate could help disabled students to move the wheelchair, so as to feel the exerted force more easily. As for the case of distance education, an adult could help the student with motor problems.

Additionally, teachers may use a variety of simple materials that might help students with mobility disabilities to learn certain concepts. For example, the "three right hand rule" is essential for understanding the direction of the force exerted on a moving electric charge in a magnetic field. To teach this concept to students with disabilities in their upper limbs it is recommended to use a simple device called "artificial right-hand rule device" (Domelen Van, 1999), which represents visually the direction of the magnetic force, the direction of the magnetic field and the velocity of the charged particle. This device is constructed by simple materials, such as a container with flat surfaces. A used oil container can do the job. The three tangential surfaces represent the directions of the three vectors: i.e., velocity (intensity), magnetic field, and force. Students with mobility disabilities in their upper limbs may use this device as long as the symbols of the vectors are marked on the three surfaces. As for distance learning, an adult could mark a used oil container following the teachings of the teacher of science, so that the student with motor problems in the upper limbs has a realistic approach of the three dimensions.

Evaluation of Achievement

For students with mobility impairment (Keller, 2002), teachers need to give them more time to complete a given task or test, to allow oral or written assessments, depending on their motor disabilities, to give them the opportunity either to record their answers or to dictate them to their teachers or write them with the help of a word processor. These adaptations could also be applied during distance learning of science courses, because the use of computer reinforces this perspective. Additionally, teachers could use alternative evaluation methods, like portfolios, which include assignments that students have completed on their own or in cooperation with other students. Teachers may also use two numerical scales to evaluate students' level regarding the difficulty they encounter while completing a task (Dobbins & De la Mare, 1997). The first one assesses the challenge that students face due to a specific disability (potential challenge), while they perform a particular activity (e.g., measurements in a lab) and the second estimates the actual difficulty that students face while they execute the same activity again (real challenge), considering the assistance provided (e.g., a special teacher) (Pence, Workman, & Riecke, 2003). In face-to-face teaching, we consider that this approach could be used with the help of a classmate or of the special teacher of science. In distance learning, the teacher of science could

collaborate with the adults that help students with motor problems in order to agree to a realistic application of these two scales.

Other Activities

Cooperation and interaction among students contribute to their active participation and allow them to connect socially even with students with mobility disabilities (Cohen, 1994). Regarding this factor, teachers could take under consideration during their lesson planning the scientific and cultural approach of several physical phenomena for students with mobility disabilities. The teacher can make good use of school activities, such as theatrical plays, games, and outdoor observations during field trips, visits to science museums and interactive exhibitions like National House of Sciences in Youth and Lifelong Learning Foundation in Greece (Feeney, Christensen, & Moravcik, 1996). In such places, students can work in groups, interacting with a number of exhibits in order to stimulate their senses, to conceptualize, to record and document, to compare and generally get themselves familiar with the scientific procedure (Roth, 2009). During the expedition trip, teachers must have their concern on students with mobility difficulties by checking the conditions that exist in the area of the field trip, ensuring the presence of some auxiliary facilities, such as ramps and elevators suitable for wheelchairs, etc. Another important matter that has to be checked is whether the security staff at the museums is able to assist the students who want to move around the exhibits or in another area in the interior of the place (Keller, 2002). In the case of distance learning, the online programs of some museums, exhibitions, and so on could be used, so that the students with motor problems and their classmates understand the scientific method and the cultural approach as well.

During the teaching, procedure referring to scientists with movement disabilities proved to be an effective way to enhance the students' interest about the science courses (White, 1992). We consider that these references could be made by teachers of science either in face-to-face teaching or in distance learning. Teachers can organize their teaching procedure in such a way that it will contain information about scientists whose mobility disabilities did not hinder their carrier. J. Leaman is such an example who had a successful career in the field of astronomy despite the fact that he was paralyzed from his neck to his legs since he was 18 years old (Ebert, 2005). He graduated from the University of Maryland and he was working in NASA, while writing his doctoral thesis. He also became involved in the production of computer software which facilitates the movement of wheelchairs.

Discussion

In this paper, we described the adaptations that could be made to the teaching of science for students with mobility problems during and after the pandemic of corona-virus disease 2019. The adaptations were based on teaching practices that were suggested in the literature for face-to-face science teaching to students with mobility problems. These practices concerned certain aspects of the educational process, such as the use of computers by students, the use of students' experiences, and the use of simple materials in teaching, the laboratory activities, the familiarity with the scientific method and its connection with art, the information for scientists with mobility problems and the evaluation of students' performance. We assume that the proposed adaptations could be modified by the teachers of science regarding the specific needs of their students with mobility problems in order to achieve their equal integration in courses. However, further scientific research is needed on students' attitudes towards online learning, on teachers' different role in these unprecedented

circumstances and on modifications of teaching practices in order to produce research data about the effectiveness of face-to-face teaching, distance learning, and their combined application (Masry-Herzallah & Stavisky, 2021; Greer, Rowland, & Smith, 2014). Finally, it should be noted that the role of teachers in daily practice needs further investigation (Barron, Cobo, Munoz-Najar, & Sanchez-Ciarrusta, 2021) regarding its psycho-pedagogical role during the pandemic period and after its end, taking into account the equal integration of children with special needs in the education system.

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