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Applying Constructivism in Neurodiverse Classrooms

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ABSTRACT

Cognitive development theories differ on how young students can meaningfully process new information and retain that information for future knowledge-building through scaffolding within their zone of proximal development. More traditional theories like the cognitive load theory adhere to the rote memorization approach by categorizing students as passive learners and the teachers as initiators who provide information in a structured, often rigid format, to be stored and retrieved for future application using their working memory. In contrast, the more progressive theories, like constructivism, are premised on the belief that students should proactively initiate their own learning while teachers act more as facilitators. The current trend in government policy under ESSA is to embrace the latter approach in the classroom, which is also more inclusive of all types of students, especially neurodiverse students. Moreover, teachers can utilize the wider range of assistive technology tools to accommodate and support their students' unique learning styles.

1. Introduction

When children struggle academically in the classroom, the traditional recourse may have been to address their needs for support by classifying them as limited in intelligence and capability before placing them in special education classrooms under the presumption that they would hold back the rest of the class in a regular classroom setting [1]. However, the more progressive pedagogical approach is to integrate these students, recognizing them as equally valuable and beneficial to a dynamic classroom environment. They may have different methods of learning, as well as their own challenges, but their unique set of circumstances can be overcome with the right accommodations and support.

Constructivism is a theory that allows these types of students flexibility in their mode of learning rather than forcing them to abide by a rigid set of expectations which may not be effective or in alignment with their learning style [2]. This theory, along with the more traditional teaching theory known as cognitive load theory, will be explained and discussed in detail in this paper. In addition, the paper will delineate how educators can implement effective teaching strategies in their classrooms, especially with the increasing availability of more advanced assistive technology to support students with varying academic and intellectual needs.

2. Constructivism, Cognitive Load Theory, and the Zone of Proximal Development

To implement a more effective instructional design in alignment with the cognitive development of young students, one must consider the leading theories on how they process new information. Cognitive Load Theory asserts that cognitive functions, such as short-term and long-

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term memory, are essential considerations of instructional design [2]. The theory is, in part, based on evolutionary educational psychology which posits that processing biologically secondary knowledge mimics the architecture of biological evolution [3]. Specifically, while biological primary knowledge such as language skills are naturally acquired, biological secondary knowledge is acquired through problem-solving, reading, listening, and researching in a more structured educational setting. Writing, science, and math also fall within this latter category [2].

Before secondary knowledge can become part of one's general knowledge base, the information must first be organized in the working memory, also known as 'short-term' memory, which is limited in capacity and duration. Once the information is acquired and interpreted, it can be stored in the long-term memory, which has much greater capacity [4]. For example, in the process of reading, knowledge stored in the long-term memory region can be retrieved as working memory in order to generate an action. In other words, the knowledge of how to read, which is stored in the long-term memory of a literate individual, may be brought back as working memory to function together with the new information to facilitate learning [4]. Moreover, although working memory is limited when working with new information, it is not when working with information previously learned and processed before being stored in one's long-term memory [4].

Based on cognitive load theory, building a breadth of information stored in long-term memory can be efficiently achieved through a commonly practiced teaching method called the "worked example effect" [2]. This approach encourages showing a learner an example of the completed work before asking them to perform the task. Studies have proven this method to be effective in improving student performance [2]. The rationale for this method is that a "worked example" reduces the workload of the working memory, because it eliminates possible alternative actions. With more "worked examples" stored in the long-term memory, students can learn to develop solutions based on previous "worked examples" and think deeper by themselves. Essentially, to formulate better solutions while processing new information, general knowledge acquired from previous learning, including worked examples, must be stored in the long-term memory [2].

Over the years, cognitive load-based approaches have been criticized as ineffective in teaching students to self-monitor or self-regulate [5]. Specifically, some cognitive development theorists believe that self-regulation should be cultivated in a learning environment in which students have more autonomy and are encouraged to be proactive in acquiring knowledge. They argue that self-generated thoughts, feelings, and behaviors can be channeled to attain desired goals, thereby increasing self-satisfaction and sustained motivation [5].

Applying this cognitive development theory to the classroom setting, constructivists advocate that teachers should foster a deep and meaningful learning environment in which the students develop their critical thinking skills [6]. Constructivist approaches, which recognize the interplay of individuals with their environments, were first applied in classrooms as early as the 1960s [7]. Jean Piaget, a Swiss psychologist, was one of the first people to develop the idea of constructivism [7]. Piaget's theories, especially those related to the early years of development, are still used today, such as the idea that as neurotypical children (children without clear developmental disorders or drawbacks) grow, they reach milestones at certain ages [7]. These approaches are used in teaching institutions across the world in a wide range of subjects such as math, science, and humanities.

3. Methods

The constructivist method usually calls for more group work, as students are encouraged to critique each others' ideas and answers while working together to solve problems in experiments and projects [6]. Allowing students to work at their own pace and learn with their own understanding of things creates a more flexible learning curriculum than would be likely if all subjects were taught through a single method from one teacher. Research shows that constructivism promotes creativity and engagement in students, although many different contextual factors and individual personality traits, as well as learning abilities, must also be considered [8].

Lev Vygotsky, a psychologist from the same era as Jean Piaget, posited a similar theory about the cognitive development of children,. Vygotsky, however, placed greater emphasis on the importance of societal and cultural impacts. He argued that social interaction is the most essential component of learning and development and that biological development and environmental factors conjointly affect learning outcomes. His social theory consists of three principles: (1) social interaction plays a key role in the acquisition of knowledge, (2) some aspects of cognitive development are limited to a specific developmental periods, and (3) that the process rather than the product of learning must be assessed for humans to fully learn and understand [7,9].

Vygotsky furthered Piaget's theory by classifying all tasks into three categories: (1) those we can do by ourselves, (2) those we can do with guidance, and (3) those we cannot do at all [9]. The first and third categories are

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not particularly helpful to learning, as doing something one is already good at does not help them develop, and attempting something that is too advanced or unfamiliar for a particular age will be too frustrating to facilitate learning [9]. For example, assigning basic addition tasks to an average high schooler would be pointless, just as a kindergartener should not be attempting calculus without having first mastered basic addition. Instead, the focus of learning should fall within the second category wherein students attempt things that they can do with some guidance.

In developmental psychology, the second category, where most learning occurs, is called the zone of proximal development [4,9]. This zone can be applied in a wide range of subjects, from mathematical calculations to daily problem solving, to aid a child's cognitive development. The zone itself is essentially the gap between a learner's task completion level and their potential for task completion under guidance. Vygotsky contention was that the potential for future development, and not a simple evaluation of task completion, is crucial for assessing and promoting cognitive development [7,9].

Similar to Vygotsky's zone of proximal development, scaffolding refers to interactive instructional relationships between teachers and their students that enables students to solve problems beyond their unassisted efforts [4,10]. Scaffolding involves providing assistance to students only upon reaching the upper threshold of their respective zones of proximal development. Through scaffolding, students learn new skills or concepts, which culminates in completing a task successfully, ultimately reaching autonomy via a gradual transfer of knowledge or learning strategies from the teacher to the student [10].

4. Results

4.1 Constructivism in the Neurodiverse Classroom

Over the years, constructivism has moved from research into classroom application. Traditionally, too much emphasis was placed on curriculum and not on student thinking, which discouraged viewing students as original thinkers with opinions about the emerging world around them [11]. While some may argue that explicit instructions better serve neurodivergent students, others have promoted constructivist strategies that encourage students to develop ideas by collaborating with their teachers and peers [6]. Constructivism has also helped bridge the learning gap in inclusive classrooms by assisting a student with special needs with active participation and learning tailored to the student's own learning characteristics, the task at hand, and contents that are already familiar to the student [12].

Since constructivism is based on the notion that people acquire knowledge by constructing their own understanding of the world around them, it prioritizes student-dominated learning and interaction [4]. However, teachers in the classroom still play a critical role as facilitators rather than information conduits. As facilitators, teachers must show students scaffolding techniques through which they can connect their past experiences to new information, thereby enhancing their knowledge [6]. Moreover, with careful design appropriate technology tools can provide additional assistance in supporting the students' learning especially in neurodiverse classroom settings [6].

Constructivist classrooms emphasize real-life problem-solving, problem-based learning (PBL), independent investigation, the pursuit of personal interests, simulation, discussion-collaborative learning, think-pair-share, and the utilization of higher-order thinking skills [14]. Constructivism is based on the idea that everyone, whether neurotypical or with special needs, learns differently. Therefore, student-centric learning can allow all students to build their own ideas and learn in their own ways. Others believe that constructivism can help students with neurological conditions such as ADHD, bipolar disorder, or fetal alcohol spectrum disorder because it allows them to pace the lessons themselves and still learn alongside their peers [12].

In this spirit, the Every Student Succeeds Act (ESSA) replaced No Child Left Behind as the national educational policy in 2015. ESSA states that the Individualized Educational Plan (IEP) team determines when a student with a significant cognitive disability should be evaluated under an alternative assessment standard so long as the determination is consistent with guidelines established by the state (Section 1111 (b)(2)(D)(ii)(I)). ESSA applies more constructivist approaches to both assessment and instructional design, even permitting the use of assistive technology when appropriate, especially for students experiencing learning disabilities or neurodivergence. Despite these potential benefits, some argue against constructivist approaches in teaching because tailoring lessons to accommodate each student may be time-consuming and inefficient [13].

4.2 Working Memory of Neurodivergent Students

Working memory is a basic mental skill which allows the brain to hold information in the short term, thereby facilitating learning and completion of tasks. Moreover, new information once acquired can be stored in long term memory but potentially retrieved as working memory when the need arises again in the future [2,3]. Children with learning difficulties such as ADHD or those with other executive function disorders who are neurodivergent

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may struggle to utilize this brain function and to perform everyday tasks [17].

One challenge that neurodiversity presents when being applied to autism is the fact that autism encompasses a wide range of learning disabilities that presents a multitude of different circumstances and challenges [18]. Further exploration is needed regarding how to address some of these learning challenges such as assisting in developing one's working memory in the classroom and beyond.

The ability to use working memory is especially important for young children in school because working memory is needed when performing tasks such as mental math, including helping children to visualize numbers and to apply mathematical functions in their heads [17]. Children working memory deficits have difficulty picturing numbers and holding them in their working memory order mentally manipulate them and produce correct answers. Working memory deficits may also hinder children's performance of physical tasks, as they may not remember in which order the tasks must be completed, or they may not be able to make sense of the instructions they are provided [19].

Children who appear to have working memory deficits may instead have attentional deficits [20]. In other words, rather than having difficulty holding the information in mind, the child may have initial difficulty paying attention to the instructions provided. It is worth noting that in the past few decades, studies indicate that many disorders of the brain or mind are not without benefits. For example, those diagnosed with autism spectrum disorder (ASD) appear to have strengths working with systems and identifying tiny details in complex patterns just as those with dyslexia seem to perceive peripheral or diffused visual information more quickly than neurotypical individuals [15]. Given such varied presentations and capacities, a full evaluation of a child's cognitive abilities may help uncover the factors involved in their academic difficulties [21]. This improved understanding may help assist educators in determining what, if any, assistive technologies may be effective in addressing the student's individual learning style.

4.3 Importance of Assistive Technology in New Education Policy

Assistive technology refers to any technological device, item, piece of equipment, or product system that improves the functional capabilities of individuals with disabilities in bolstering their cognitive skills as well as in maximizing their attention span and time management [22]. Assistive technology may be viewed as more appropriate for low-functioning students, especially when mainstreaming them for social reasons, but high-functioning, learning-disabled students may benefit from such academic support as well [22].

To manage tasks and succeed in goal-directed activities, students need to have a wide range of executive skills, which consist of metacognition, appropriate behavior and actions, mental shifting, and sustained attention. When these executive functions are weak or lacking, the student can be hindered academically [23]. In order to reduce such obstacles, various assistive technologies may be employed to help meet each student's individualized needs. For example, for students who struggle with self-control, Book Creator, a software application, helps students with self-management in social situations [24]. In addition, the Self-Management Checklist Maker is a website that teachers can use to monitor their students, and which, in turn, can aid the student [24].

Low-tech prioritizing strategies, reflective journaling, and capturing thinking can help students develop their metacognition skills. Capturing thinking can be done through the utilization of technologies such as the SmartPen or AudioNote app, both of which record students as they talk themselves through an activity or assignment [25].

Cognitive flexibility, shifting, and organization manifest in the student's ability to follow a schedule and make connections across situations. These skills can be aided with technology such as Choiceworks, First-Then Visual Schedule, Time-Timer, and Wunderlist to help students manage time and make sure not to get lost throughout the day. Similar to scheduling, goal-directed persistence--the students' ability to maintain their focus to accomplish a goal--can be extremely difficult for some, especially if they struggle to follow a schedule [24]. Goal-directed persistence can be aided with simple things such as calendars, checklists, and data chart organizers [24].

One effective strategy teachers use to jog students' working memory is the KWL (Know Want Learn) activity before introducing new but related information [25]. Another form of assistive technology can be software applications like graphic organizers or other visual aids like slides and flashcards used to further support learning. Moreover, websites like Khan Academy provide user-friendly tutorials online about multiple subjects.

While these learning tools assist students in the classroom, neurodiverse students also need social and emotional support. Despite the wide range of assistive technology available today, one of the most important factors in the successful mainstreaming of neurodiverse students is dependent on the positive attitude projected by the classroom teacher [28]. Hence, the teacher still plays a significant role by reinforcing the belief that the neurodiverse

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students are actually adding value to the classroom.

5. Conclusions

In recent years, appreciation for active learning through constructivism, wherein students acquire and process new information, has drawn attention to the importance of including and embracing neurodiverse students in the classroom. In the past, learning processes such as cognitive load theory expected students to simply absorb information instead of taking a more proactive role. Constructivism's broader acceptance has encouraged children to take greater initiative in the learning process, while teachers serve as facilitators rather than rote pedagogues. This approach can be more beneficial to neurodiverse students because students can tailor their learning experience to what fits them, rather than attempting to learn through a more rigidly structured methods. This cultural shift in learning may fundamentally change the structure of classrooms in the future.

More traditional, rigid learning models required students to absorb information as passive learners. Those who could not process the information readily were often placed in special education classes, in part because classroom teachers could not accommodate the unique learning styles of every student in their class. However, with the growing acceptance of constructivism, more educators are implementing student-led learning while utilizing advances in assistive technology. While educators recognize the importance of mainstreaming some neurodiverse students, teachers continue to play a critical role in supporting students socially and academically regardless of neurocognitive status. Teachers are indisputably vital to the learning process, even in constructivist classrooms.

Conflict of Interest

There is conflict of interest.

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