An assessment of inclusion practices in a secondary biology classroom via a metaphorical approach to the cell model

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Abstract:
This paper offers a critique of "inclusion" practices in public, secondary science classrooms. The term inclusion refers to the practice of placing all students who qualify for special education into mainstream classrooms. The practice became nationwide policy after the 1994 IDEA law was passed, which, in part required that all students be taught in the "least restrictive environment." This critique is based on one-on-one work with a 16 year old special education student placed in a mainstream, sophomore level Biology A classroom. The majority of the study focuses on the modifications and accommodations given to this student on a typical "cell model" assignment and the student's success with the assignment.
Overall, the assignment was successful; the student did well on the assessment and seemed interested in her work. In addition, a comparison with models turned in by mainstream students, shows that the essence of the assignment had not been lost in adaptation. It was also clear that providing this level of modification and accommodation on assignments for all qualified students would be unrealistic. In the final section of the paper, a set of suggestions on educating intellectually disabled students included in biology classrooms is given. The paper concludes that inclusion continues to be an uphill battle.

In 1974, Public Law 94-142 was passed by President Ford in response to the realization that more than half of the nation's children with disabilities were not being educated[i]. The *Education for All Handicapped Children Act,* as the act was called required that all children with disabilities have access to a "free and appropriate education", this meant that children with disabilities be would educated amongst their peers, follow the general education curriculum and be given relevant grades[ii]. The act has been amended many times since 1974, in 1986 the law was expanded to include infants and toddlers (P.L. 99-457), and in 1990, the law's name was changed to the *Individuals with Disabilities Education Act* (P.L. 101-476). In 1994 and again in 1997, the IDEA law was comprehensively revised (P.L. 108-446 and P.L. 105-17 respectively), each time providing a much more specific prescription for how students with disabilities were to be identified and educated.

Today, the revisions of the original law create clear and specific requirements for the education of students with disabilities in public schools. The current law requires that each child who is identified as having a disability must be given an Individualized Education Program 'IEP', which is a written statement put together by teachers, parents and administrators which outlines the goals and methods for educating those particular students[iii]. The law requires that the student's IEP must include a statement of services provided to the student which will help him or her "be educated and participate with other children with disabilities and non-disabled children" and also, to "be involved in and make progress in the general education curriculum"[iv]. This dual requirement that students be educated along with non disabled children *and* at the same time make progress in the general education curriculum is the driving force behind the policy of "inclusion". The law also requires that provisions, meaning modified assignments and accommodation of the student's needs, are provided so that the student's inclusion is beneficial for all[v].

In 2008, the National Center for Education Statistics reported that 95% of children with disabilities were enrolled in regular public schools. It was also reported that 58% of those students spent at least seventy-nine percent of their school day in a general education classroom and another 22% spent at least forty percent of their days in general education classrooms[vi]. This paper attempts to explore how well the students who fall into this eighty percent are being served by their inclusion in a general education classroom.

Since the law's formation in 1974, there have been advocates and critics of the policies laid out by IDEA, especially the policies regarding inclusion. As the law has developed to become more comprehensive and specific in its requirements, the opinions of the law have only become stronger. Many critics say that inclusion does not benefit the special education student, the regular classroom students or the teacher; and in many cases, more damage than good is done[vii]. Perhaps the most compelling and widely agreed with argument is that allowing disabled children to be educated in an environment that is specially designed for them gives these students the greatest chance at meeting *their* personal potential, and that a full inclusion model robs them of the provisions that their success requires. Opponents of the IDEA law say that calling for all disabled students to be placed in regular classrooms regardless of the severity and nature of their difficulty, is simply "in just"[viii]. Other arguments revolve around the burden that full inclusion puts on regular classroom teachers; in discussing the limits of IDEA, the Honorable Michael N. Castle stated, "the excessive amount of paperwork requirement simply, frankly, overwhelms teachers and robs them of valuable time to educate their students. Teachers must have the ability

to spend more time in the classroom rather than spending endless hours filling out unnecessary forms.[ix]"

Proponents of the policy argue that with a proper support system in place, inclusion can be of great benefit to disabled and regular students. "Good" teachers, proponents claim, are those who can meet the needs of all the students, regardless of what those needs may be. Many classroom teachers support the policy of inclusion and report finding inclusion to be a successful and beneficial experience for all. Sandy Merritt describes her observations and experiences with two disables students that she had in her first grade classroom, "Kim's and Sara's[x] classmates accepted and supported them. The other girls included the girls in everything we did. It was heartwarming to see the students respond to the girls' individual needs. When they worked in small groups, teammates managed to find suitable jobs for Kim and Sara. The girls weren't the only ones who benefitted from their inclusion in the classroom; the other students in my classroom that year learned acceptance, tolerance and the meaning of community.[xi]"

Aside from the dispute over potential academic success of disabled students, funding and discipline are points of strong animosity between proponents and opponents of the IDEA law and inclusion. The ongoing controversy surrounding IDEA funding concerns whether the federal government is living up to its "promise to fully fund" IDEA. In 2000, a "permanent" formula for the allotment of federal funds was created. This formula authorizes a maximum allotment per disabled child served of 40% of national average per pupil expenditure. However, in fiscal year 2002, states received an average of 16.5% of national APPE per disabled child served.

The proper discipline of disabled students who are included in regular education classrooms has been frequently debated since IDEA's implementation in 1975 also. When the original act was passed in 1975, it included a "stay put" provision, which said that if there was a dispute between the school and the parents regarding the discipline of the child with a disability, the child must "stay put" in his or her current educational placement until the dispute can be resolved[xii]. This provision was designed to prevent teachers from using discipline problems to remove an included student removed from their class. However, in many instances these provisions immunized disabled students from receiving any significant form of punishment such as suspension or expulsion. In the 1997 rewriting of the law, the provisions regarding discipline were significantly changed. The new policy allows a student to be suspended for up to ten days with no educational services. Additionally, if the misbehavior is found to be independent of the disability, the student may be expelled, but educational services must continue. If the misbehavior is found to be a result of the disability, the student will be evaluated for new educational placement, during the reevaluation; the student can be placed in an interim alternative education setting for up to 45 days[xiii]. Teachers and administrators have reported that since the new provisions for discipline have been in place, serious problems with disabled students are less. However, discipline of these students continues be a constant battle for classroom teachers; many report that disabled students generally do not respond to the successful management techniques that they use with the general education students.

Few studies have been done to produce comparative, quantitative data on disabled students' successes (academic gains, graduation rates, preparation for post-secondary schooling, work, or involvement in community living) based on their placement in inclusive vs. non-inclusive settings. Therefore it is incredibly difficult to give a *quantitative* argument for or against inclusion. Rather, most opinions are based on one teacher's or parent's or lawmaker's personal experiences with inclusion, and these experiences of course vary widely. There are also few standardized teaching strategies that have been produced to aid regular classroom teachers in

including students. A set of standard teaching methods would make the observations and opinions collected more reliable and based on similar standards and expectations. However, until such a standard can be set, we are left to base our opinion on studies such as the one presented here, which are generally focused on a small group of students for a short amount of time.

This paper provides a case study of one disabled, partially included student, whom we will call Louise[xiv] and her academic and social experiences during one trimester in sophomore level biology. These experiences are reported as I, the researcher observed them. The bulk of the study focuses on Louise's academic performance on a classic "cell model" assignment. The assignment was modified to fit her needs, and accommodations to assist her in completion of the assignment were provided. The provisions laid out in the Louise's IEP were directly followed in forming the assignment; the objective was to provide her with all of the possible benefits of inclusion that IDEA stipulates and determine if she could, in fact be successfully included. During and after the cell model assignment process, Louise's experience and academic achievement on the assignment were observationally compared to her experience and academic achievements on other assignments and projects during the term which were not as comprehensively modified. This first comparison was done to determine if Louise would benefit from the modifications and accommodations described in her IEP when they were administered properly, and if she could succeed in her placement. Her experience and achievement on the cell model was then compared to the experience and achievement of non-disabled students whom had completed similar non-modified assignments. The second comparison was done in an attempt to determine if Louise had made progress in the general education curriculum as required by IDEA[xv]. Beyond a close study of Louise's completion of the cell model, general observations were made of the benefits and disadvantages Louise faced in her placement.

The study began a week after the start of school in the fall. Louise was a sixteen year old girl who was classified as a sophomore and had been placed in a general education Biology A classroom. The first week was spent observing Louise in the class without full knowledge of her needs and IEP goals. On the first meeting, Louise seemed physically and emotionally similar to the general education students in the class; she greeted others who greeted her back, she smiled and sat happily in her desk and took out her text book. However, as the class began to take notes, Louise did not. Shortly into the lecture, it became clear that Louise was completely disengaged from her classmates, her teacher and the material. In the following days, Louise did not turn in homework or take quizzes with her classmates and took no notes. It was difficult to determine what, if anything, Louise was gaining academically from her time spent in the class. Louise reported that she was content with her placement but described the subject of biology as "confusing and very hard". She was aware that she did not comprehend much of the material that her classmates were.

Upon reviewing the goals and prescriptions given in Louise's IEP, the reasons for her complete lack of participation and comprehension in biology class became clear. Louise had been diagnosed as having Significant Limited Intellectual Capacity (SLIC), meaning she struggled to comprehend or retain information given. Students with SLIC often take much longer to learn and comprehend content, and there will usually be some content that a SLIC student will be unable to comprehend even with time. Students with SLIC are generally unable to solve critical thinking problems, follow logical processes and think abstractly. They struggle

to analyze and make connections with the information given in class. Additionally, many students will need extra help with life skills like cooking, cleaning and getting dressed as well as more help in social skills and communication skills[xvi].

Louise's IEP prescribed a "quantity vs. quality" approach to her completion of high school. The IEP allowed for modifications that "simplified and cut down" on the amount of work required of her however, those modifications could not diminish her ability to gain "what general education students were supposed to gain from the assignment". She was to be given modified exams and quizzes which were to be written by the special education specialists at the school. Additionally, Louise was allowed multiple accommodations including extended testing time, pre-written notes and study sheets which could be used on exams, she was to be given extra time to complete assignments and projects.

In her sophomore year Louise had been placed in classes so that roughly 70% of her day was spent in general education classrooms. She was placed in two "pullout classes" designed especially for students with disabilities similar to Louise's. One pullout class was an academic support class that resembled a study hall, the other was called a "life class" and was designed to help students learn skills such as cooking, cleaning and obtaining transportation. Louise reported that she usually enjoyed school; she said that math was her hardest class and that she most enjoyed her two pullout classes. She stated that the pullout classes were "easier to understand", but didn't seem to make a connection with the fact that these were not general education classes and believed that all her peers took those classes as well.

As part of a larger program in the high school, Louise was given a student buddy, who will be called, Lexi[xvii]. Lexi accompanied her to her biology class daily and assisted Louise in taking notes, completing her assignments and understanding the material. Lexi was a general education students who had previously taken Biology A, she was enrolled in a class called "Kids to Kids", a program designed to give disabled students assistance from their non disabled peers. Lexi stated that she took the Kids to Kids class because she was interested in becoming an occupational therapist when she finished high school and her counselor had recommended the course. Throughout the term, Lexi had a wonderful attitude and was willing to help Louise with whatever was needed. It is important to note that this positive attitude made Lexi an asset to Louise, but a different buddy could have easily been a hindrance.

The next two weeks of the study were spent observing and working with Louise on the notes, assignments and tests that she received from the general education biology teacher. It became clear during these two weeks that the requirements of her IEP were not being met. Louise was usually expected to complete the same unmodified versions of assignments as her general education peers, Lexi's assistance and extra time were generally the only accommodations provided to her. Lexi was willing to help, but clearly had no training in helping Louise complete her own work, rather than simply stepping in and doing it for her. The extra time given on assignments was unlimited and no formal due dates were given, resulting in very little of Louise's work actually getting turned in. Although her IEP required that modified tests be given to the teacher by the special education specialist, this was observed to occur only once in the trimester of observation. When Louise took the general education student's test, she averaged a 20%. On the one modified tests that Louise was given (besides the one given as a part of this study) Louise scored a 29%. It was clear that test taking was the area where Louise most struggled. After the third week of school, Louise was failing the class. Presumably this was because such little effort was being made to modify the standards that Louise was being held to.

The "cell model" was assigned to the class as a whole at the beginning of the fourth week of school. The general education students were required to complete the classical form of the assignment. They had one week to create a 3D model of a plant or animal cell that had nine distinct objects which represented the nine organelles of a cell. They were required to find objects that each represented the *form* of the cell and arrange the model with the organelles placed as they exist in a real cell. Students were also required to label each organelle or type a key explaining the function of each organelle shown in the model. A copy of the original assignment and its rubric can be seen in figure one in the appendix. This assignment was an intro assignment to a unit on cells. It was worth ten points, about one tenth of the total points for the unit. The unit exam was taken by the regular education students a week after their cell models were due.

In an attempt to observe how Louise would perform if the guidelines of her IEP were more closely followed, the cell model assignment was completely modified and approximately ten hours were spent accommodating her learning needs. In her modified assignment, Louise was required to complete a "cell house". The modified assignment had four critical elements. First, she was required to build a miniature house with at least six objects placed inside the house that represented the *function* of six different cellular organelles. Second, she was required to choose the objects she used and understand how the object related to the organelle. Third, she was required to label each organelle. Lastly, she was required to create a key which connected the household object to the proper organelle and then described the function. The point value of the assignment was set at 24 points; one point for each organelle in each category. Including six organelles earned her all six points for the first requirement. Understanding the connection to all six organelles earned another six. The final two requirements would earn her the additional 12. Two days after completion of the cell, Louise took an exam. The exam was modified to better fit Louise's assignment and learning style; it was only on the six organelles in Louise's model, and consisted of simple definitions which she was required to match to the proper organelle by drawing a line. This exam was used as the grade on the unit exam, although it did not encompass all the material covered in the unit. Louise was not given direct assistance on the exam; she was also not allowed to use her key. She was allowed to use her "cell house". The test was worth 12 points, two points for each correct match. It should be noted that, for the general education students, the test was worth almost seven times more points than the model assignment. However, it was important to modify this ratio for Louise, because of her struggles with test taking. The 36 combined points were the points that Louise could earn for that unit.

Louise worked at a slow pace; she had poor coordination with her hands and wrote very slowly. For this reason, Louise was given the accommodation of having physical help constructing her model. Lexi and I cut the cardboard and Louise was given direct instruction on how to form her miniature house. Lexi and I both participated in all activities that involved significant or high level motor function. We all worked together to color the images, cut them out and glue them into the house. Lexi and I worked quickly, under Louise's instruction, and, in this way the project was completed in a reasonable amount of time.

Accommodations were also made in the assistance that Louise was allowed to have on choosing the objects to put in the house. She was given help brainstorming and discussing function of various household items. Louise chose a giant brain to represent the nucleus because her understanding of that organelle was that it "controls everything". She chose a man running on a treadmill to represent the mitochondria because she understood that the mitochondria had to

do with "energy" and saw the running man as energetic. However, because mitochondria do not expend energy (as a running man does), but rather create energy, I instructed her to also use an electrical outlet to symbolize another mitochondria in the cell. We discussed the difference in energy, but Louise struggled to understand the distinction I was trying to emphasize. Louise understood that the function of a lysosome is to remove the waste products of a cell, or what she thought of as trash. For her, the logical object to represent this organelle was a trash can because they "take out the trash". She was taught that vacuoles were for storage and that they stored things such as food and information for the cell, she chose a refrigerator because they store food and a bookcase was suggested to show a vacuole that stored information. Centrioles which are involved in the division of the cell were represented as a pair of scissors because they "cut things in half". Lastly, the cell membrane was discussed, at first Louise thought that she needed to choose another object. After great discussion she understood that the walls to the house represented the membrane because the walls kept everything inside (or outside) of the house. One struggle she continued to have was understanding that the floors and walls separating the two stories and rooms of the house could not be considered the membrane because they were inside the house. In a future application of this assignment, a one room house would eliminate this misconception. We used multiple vacuoles, mitochondria and lysosomes because, as we discussed, cells have more than one of these organelles.

After the household objects had been chosen and written down, Louise went on the Internet to find images of the objects which she could glue into her house. She was given assistance searching the internet for the types of pictures she needed. Louise chose and printed the images that she thought were best to use. She was also required to type labels for the organelles in the cell; she was given assistance on spelling, but typed herself. She was very happy to demonstrate that she knew how to send items to the printer and understood how to give the computer basic other commands.

Intermittently, we would take breaks from building. During these times, I talked with Louise about what a cell actually was and how it influenced life. These discussions would be the only direct instruction on "cell theory" that Louise received. This was something focused on more heavily for the general education students and the concepts were included in their unit exam. I explained that cells make up all the parts of our bodies and the bodies of all living things. We looked at pictures and images of cells in her textbook as well as *Elodea* cells under the microscope. We also focused on connecting the cells that we looked at in pictures to the house we were making. Louise understood, and was able to explain back to us that we were making a "blown up" version of a real cell, meaning it was much bigger. We also discussed that all the things inside the cell, the organelles, worked together to make the cell work. We related this to the way that all the things inside a house made the house useful. For example, "without trashcans, we would walk all over trash everyday".

One weekend and one day that Louise was absent separated the day that Louise glued her Images in and the day that she had to glue her labels in. When she began to place the labels, it was clear that she had not fully retained all of the functions of the organelles over the three nonworking days. She easily recalled the organelles that corresponded to the images of the brain, the running man, the refrigerator and the trashcans, but struggled to recall what the other images represented. She struggled most on the functions of the wall of the house and the outlet, which she had not chosen for herself. After reviewing and placing the labels, Louise was asked to fill out a key for her cell. The key had been modified to a fill in the blank format, it listed the name of the organelle, she was required to fill in which household object represented the

organelle and describe the function of those items. Louise needed assistance with spelling, but was able to fill out the key with her own memory of the connections made between object and organelle. Images of Louise's finished cell and an image of her key can be seen in figures two through four in the appendix.

One obstacle in completing the cell assignment was that Louise was often required to be absent from biology class. Although seven class periods were spent completing the cell, twelve days of school passed from the beginning of the project to the end. Louise missed five class periods while we were working together. One day she was ill. Three of the other absences were due to activities that she was completing with her life skills class, the final absence was due to an administrative meeting she had to attend. The repeated absences were troublesome because Louise had enough trouble remembering concepts from one day to the next; it became even harder for her to remember when one or two days separating each work day. Louise seemed frustrated that she was being taken away from something that she was eager to complete.

Approximately two days after Louise completed her cell model, she was given the modified exam on the organelles of the cell. Louise missed two connections on her exam, she connected both "vacuole" and "centrioles" to the definition "stores food and information". She also connected to mitochondria to two definitions; the correct definition "give the cell energy" and the definition meant for centrioles, "cuts everything in half". An image of the exam that Louise was given can be seen in figure five in the appendix.

Assessment of special education students is an area that is all too often overlooked. However, assessment of a modified assignment must be precisely modified to fit what the assignment asks for. It is important for both the general education students and the included students to feel that all grades for all students are accurate and fair[xviii]. Both the assignment and the exam were assessed differently than the assignments were assessed for the general education students. The assignment modifications necessitated that the assessment strategies be adjusted. The grade that Louise earned on her cell model was a 92%. The grade was based on her earning 22 of the possible 24 points. Louise earned the full six points on the first requirement; she included six organelles. She also scored a full six points on the third and fourth requirements; she labeled all her organelles and made a correct key. Louise scored four points on the second requirement; she fully understood the function of four organelles and could relate these organelles to the household items. However, Louise did not seem to fully understand the house walls as the cell wall or the outlet as the mitochondria. Louise scored ten of the possible twelve points on her exam. Although, she made two incorrect matches, she matched *mitochondria* to two definitions and one was correct, therefore she correctly matched five out of six organelles. She did not lose points for the incorrect matches that she made.

Overall, Louise seemed to enjoy the process of making the cell and was proud of the grades that she earned. Each day she came to class ready to work on the house that she was building. Both Lexi and her life skills teacher reported that she talked about her cell outside of class. Once the model was complete, Louise was able to put her cell house in the school's cell museum. She received many compliments from the general education students who unanimously stated that the metaphors created by Louise in her cell helped them to remember the function of many organelles. The general education students in Louise's class had been intrigued when they saw her putting together the house and three students offered to help her on three separate occasions. The first time she refused the help because as she said "they aren't patient", but the second two times, she allowed the others to help her. Based on comparison with observations made throughout the term, the time she spent on the cell was the most interaction

that she experienced with her classmates – aside from Lexi. One of the goals in Louise's IEP was that her social skills and comfort level in social situations improve by the end of high school, clearly the cell house was one instance in which inclusion helped to meet this goal.

After completion of work on her cell model, my observations continued for three more weeks. This allowed for repeated comparisons to be done between her work on the cell house and her other work for the class. The classroom teacher struggled to modify most assignments effectively for her. Although the classroom teacher was overall a good teacher, she had never received training in teaching learners like Louise. She was also given no additional prep time to work on assignment modifications, as a result Louise received the same assignments as the general education students. Generally, in order to complete the assignment, Lexi would dictate the correct answers to Louise who would dutifully write them down. Whatever was done by the end of the period was all that got turned in, because if Louise took her work with her, it would inevitably be lost by the time she came back to class. She averaged a 51% on assignments for the term. Because Louise's IEP strictly stated that she was to take modified exams, the classroom teacher stopped giving Louise the exams that the general education students took after the first two weeks of school. A modified exam was provided only once during the trimester by the special education team, on this test she scored a 29%. Other than this grade and the grade on her cell exam, Louise was "exempt" from the other test grades. For the remainder of the term, Louise continued to miss class one or two days a week.

After observation of the trimester as a whole, it was clear that Louise had gained significantly more knowledge from the cell house assignment which had been heavily modified than she had on virtually all other assignments that she completed that trimester. Also, the test which had been modeled after the cell assignment and modified towards her understanding was the only test she received a passing grade on. Although labor intensive for all, the modification and accommodation of the cell assignment was an overall success for Louise. This indicates that according to the guidelines of IDEA, Louise's placement in the class was correct; when given the support that her IEP calls for, Louise benefited from the class. However, Louise's placement was not successful under IDEA's requirements because her needs were rarely being met in a way that allowed her to succeed in the class.

To determine whether the benefit that Louise experienced from the modified assignment allowed her to make progress in the general education curriculum, her cell model was compared to cell models that had been completed by general education students and had received high grades. Two examples of cell models completed by regular education students can be seen in figures six through eight in the appendix. Some key similarities and differences can be found that indicate how well Louise's assignment met the general curriculum requirements. The cells made by both Louise and the general education students included labels of the organelles; both were required to make keys that described the organelle's function. Louise's cell included only six organelles while the general education students included nine. In retrospect, Louise could have completed the three organelles that were omitted from her assignment. The omitted organelles were the smooth and rough endoplasmic reticulum and the golgi apparatus. Adding three more household objects to the cell house would be quite feasible in future applications of the assignment, this would allow the assignment to better align with general education.

The most significant difference in the cell that Louise completed compared to the cells by the general education students was representation that the model gave. Louise used images of objects that directly correlated to the *function* of the organelle it showed. Her cell house was a metaphor for the cell rather than a realistic representation. This was ideal for Louise because it

allowed her to relate something incomprehensible to something that she was familiar with. However, the general education students were not asked to make metaphorical cells, they were required to find objects that directly correlated to the *form* of the organelle that the object represented. This allowed the general education students to understand how *form relates to function* in the operation of the cell. For example, one of the students used a shower loofa as the rough endoplasmic reticulum; the folds of the loofa represented the way the membrane that makes up the rough E.R. folds over and around itself. She then attached the beads that she used to represent ribosomes to the loofa to show that ribosomes existed not only in the cytoplasm, but also on the rough E.R. Both general education students' models shown in this article show proper placement of the organelles in relation to one another, proper placement of the organelles relates form to function. Louise's cell did not demonstrate this correlation between the form and placement of organelles and their function. By not focusing on the form and function objective of the model, Louise's model did not fully align with the general education curriculum. Form and function is a critical concept in biology, not just as it relates to the organelles of the cell, but also as it relates to other things such as enzymes, botany, anatomy and evolution. However, this concept could be taught separately from the cell model with the same effectiveness.

Another tenet of the general education curriculum that Louise's modified cell did not thoroughly completely meet was the concept of *what* a cell is, or "cell theory". The overall concept of a cell was discussed and Louise was able to visualize living cells. However, formal assessment was not given on these concepts; therefore it was difficult to determine how much she understood of a cell's purpose in a living organism. Louise did demonstrate understanding that a cell could be broken down into smaller parts called organelles, and that all the organelles worked together to make the cell function; this was evidenced by her ability to explain the idea to me. The general education students were required to specify whether their cell was a plant cell or an animal cell, and use the appropriate organelles for their type of cell (a few organelles such as chloroplasts and a central vacuole exist only in plant cells, there is also a difference in the membrane structure of each type). One the cell in figures seven and eight correctly represent an animal cell, while the cell in figure nine correctly shows a plant cell. Louise's cell was not specifically a plant or animal cell. The comparison to the work of general education students shows that modification of the assignment appears to have misaligned with the general education curriculum only in the breadth of concepts it covered. Additional modified assignments could easily make up for this lack of breadth in future applications.

The observations made during the assignment and over the trimester demonstrated that inclusion of secondary students with intellectual disabilities *can* be successful in many ways. However, its implementation is time consuming and requires the involvement of many people other than the classroom teacher. The study also showed that when the time and manpower is not given to implementing modifications and accommodations effectively for disabled students, inclusion does in fact begin to have negative impacts on those involved. Based on this evidence, it seems the most effective way to approach inclusion of students like Louise in secondary science classrooms is to develop a set of assignment modification "models" which can be easily applied to many types of students and lessons. The modification used for Louise and her "cell model" could be expanded into a general model easily, by retaining the idea of using a metaphor as the assignment's driving force.

Clearly, for Louise, the most successful aspect of the assignment's modification was the use of a metaphor that related the scientific concept to the student's real world. In my first conversation with Louise, she spoke happily about her home, the people who lived there and the

chores she did. She also expressed that she enjoyed her "life" class because, as she put it, she liked to "play house". A house and the objects in it were obviously things that Louise experienced and understood from her everyday life. Allowing Louise to choose the items in the house whenever possible was clearly important to the assignment's success. She felt more ownership of the project as a result of having chosen the items herself. As the test demonstrated, she was better able to recall the functions of the organelles for which she chose objects. Louise participated in all steps of the cell's creation and Lexi and I continually talked with her about how the organelles worked together in a cell, and what a cell actually was, this seemed to help Louise develop the connection between the organelles and the house. Furthering the assignment's success, Louise created something that she could share with others and the project's completion appeared to give her a sense of pride and accomplishment.

The use of metaphors would be useful in many other content areas of teaching biology and other sciences to the intellectually disabled. The metaphor could be explained in many ways other than building a model; therefore assignments could be easily modified to fit the student's individual needs. Perhaps most importantly, the metaphor can be tailored to something that the student can understand and relate to. If a student expresses awareness of where different "cliques" hang out in the cafeteria, this knowledge can be used to form awareness of ecosystems and biomes. A student who is able to keep a schedule and talk about his/her daily routine can use this knowledge to understand life cycles. Popular culture can be utilized easily, for example, movies in which the plot involves only the survival of the most clever characters can be used to illustrate the idea behind Darwin's theory of natural selection. A dramatic "love story" between two elements can be used to illustrate chemical bonding and the introduction of a third element can illustrate a chemical reaction. The type of metaphor will simply depend on what the student does and doesn't understand about the world around them and what they can and can't relate to.

If model building is not appropriate for a particular student or metaphor, other methods of showing the metaphor can be used. Dioramas or posters or maps could be made relating the biomes to the cafeteria districts, neighborhoods or parts of a room. Graphs and pocket charts can be used to relate schedules to life cycles or behavior or patterns. A skit can help students retain the love story through which they learn about chemical reactions. Metaphors can easily be molded and altered to fit a student's and a classroom's different needs.

Lexi was of great assistance to Louise in two distinct ways; she was able to help Louise understand the material in a different way and reinforce what had been taught and she was also able to physically help Louise accomplish tasks which she otherwise would have struggled with. Having other, general education students participate in the modified assignment, or incorporating the included student into some aspect of the class's group work can be very useful in making a metaphor assignment reasonable for the student and the teacher. Further, this group aspect of the assignment helps meet the requirement of IDEA that disabled students, "be educated and participate with other children with disabilities and non-disabled children". Social interaction is one of the clearest benefits of inclusion. When designing these modified assignments, as much possible social interaction as possible should be included in the assignment.

It is very likely that the general education students will experience benefits from helping the included student with his/her project. Students in Louise's class expressed that they had an easier time remembering the functions of an organelle after seeing the cell house in the cell museum. The metaphors that these assignments demonstrate have the potential to broaden the understanding of not only the disabled student, but the entire class. There are many students in the classroom who do not qualify under IDEA and do not have an IEP but still require some form

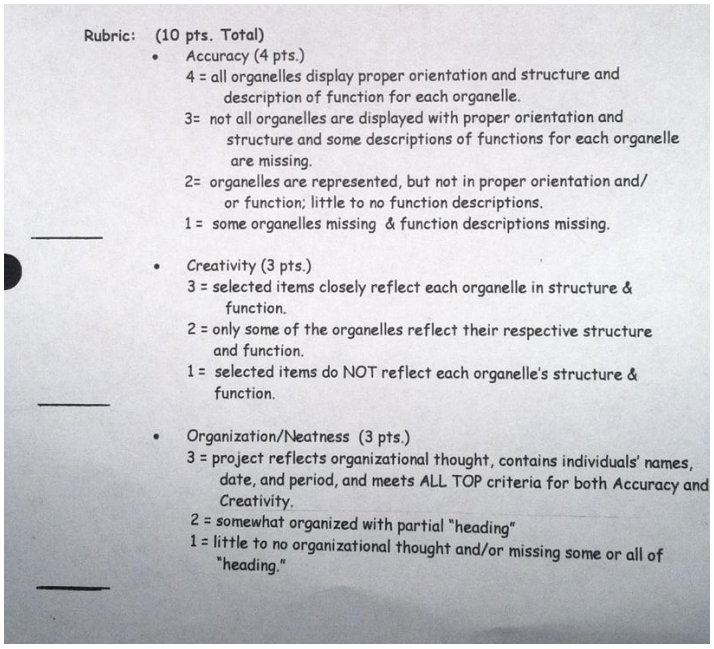
of differentiation. The number of English Language Learners in our public schools is constantly growing and successful inclusion of these students – who are not included under IDEA – is an increasingly large challenge for teachers. Making the included student's metaphor project a group effort or an effort assisted by one or two other students can make the time put in to modification beneficial to more than one student.

Assessment of this type of project is critical to its success. It is important that the student's grade be as accurate as possible. Grades and assessments for these exceptional students should be based on the successful completion of a specific set of requirements, not overall assessment of student learning[xix]. It is important to make a set of objectives which the particular student can reasonably meet. The objectives should be clearly laid out to the student before the assignment process begins, this way, the student can work towards meeting the goal. It is also important that the student not be judged strictly on the metaphor, but rather on the symbolism that the metaphor conveys. For example, it may seem odd to have a large brain sitting in the living room of the cell house; but the brain as a symbol made sense to Louise and helped her understand the nucleus of the cell. It would have been incorrect to take points away simply because the brain did not perfectly fit into the house. It is generally best to grade based on the individual steps a student completes, benchmarks should be created so that even without holistic learning, students can still earn points.

Education of children with special needs and disabilities is an ever changing art; one that is informed by countless differing opinions, multitudes of qualitative data, practically no quantitative data and ever-changing legislation and funding. The policy of inclusion has great potential and great disadvantages. The inclusion of one student can enhance an entire classroom's experience, it can bring that student to a level of understanding that they would not have experienced in a pullout classroom, and inclusion can also allow connection between the different types of people roaming American high schools. But inclusion can also hinder a teacher's ability to teach the majority and hinder the majority's ability to learn, it can eat away at teachers' and administrators' valuable time and a school's valuable funding, and often it can leave the included student feeling more lost and left out than ever.

This study revealed a number of challenges and benefits experienced by one student living through the current policy of education for exceptional students. Socially, the inclusion of the student was probably beneficial, certainly the "kids to kids" program was a successful social aspect of inclusion. Academically, the student was being *exposed* to material that she would not have been exposed to in a specialized setting. The modifications and accommodations that she received were not nearly sufficient to allow the student to reach her academic potential in the class. The frequent absences and lack of concern about providing the student with relevant assessment spoke to the fact that there was not any expectation that the included student would do more than appear on the class's roster. However, when the opportunity for success was given through a properly modified assignment, the included student, general education student and even the classroom teacher responded well. The assignment was a small success and speaks to the possibility of successful inclusion in our schools. Perhaps inclusion is best assessed by small successes, if all included students could participate in even one fully modified assignment in each of their classes every semester that would be a huge success for our country. Modifying one assignment is not the overwhelming task that proponents claim overall inclusion is, and is a realistic goal. Reaching this simple goal would be a huge leap forward on the search for the best way to educate *all* our students.

APPENDIX



Rubric: (10 pts. Total)

- Accuracy (4 pts.)
  4 = all organelles display proper orientation and structure and description of function for each organelle.
  3= not all organelles are displayed with proper orientation and structure and some descriptions of functions for each organelle are missing.
  2= organelles are represented, but not in proper orientation and/or function; little to no function descriptions.
  1 = some organelles missing & function descriptions missing.

_____

- Creativity (3 pts.)
  3 = selected items closely reflect each organelle in structure & function.
  2 = only some of the organelles reflect their respective structure and function.
  1 = selected items do NOT reflect each organelle's structure & function.

_____

- Organization/Neatness (3 pts.)
  3 = project reflects organizational thought, contains individuals' names, date, and period, and meets ALL TOP criteria for both Accuracy and Creativity.
  2 = somewhat organized with partial "heading"
  1 = little to no organizational thought and/or missing some or all of "heading."

_____

Figure one: shows the original un-modified cell assignment rubric which the general education students followed.

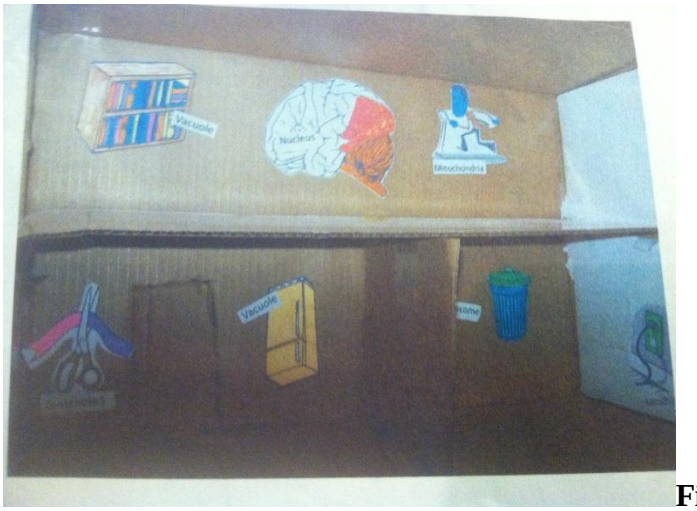


Figure Two: Shows the inside of the "cell house" with seven vacuoles, the mitochondria (runner and outlet), the vacuoles (refrigerator and bookshelf), the centrioles (scissors), the lysosome (trash can), and the nucleus (brain)

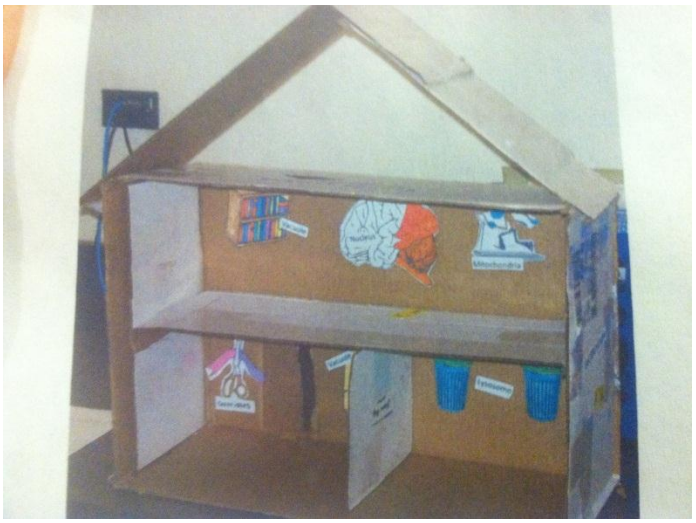
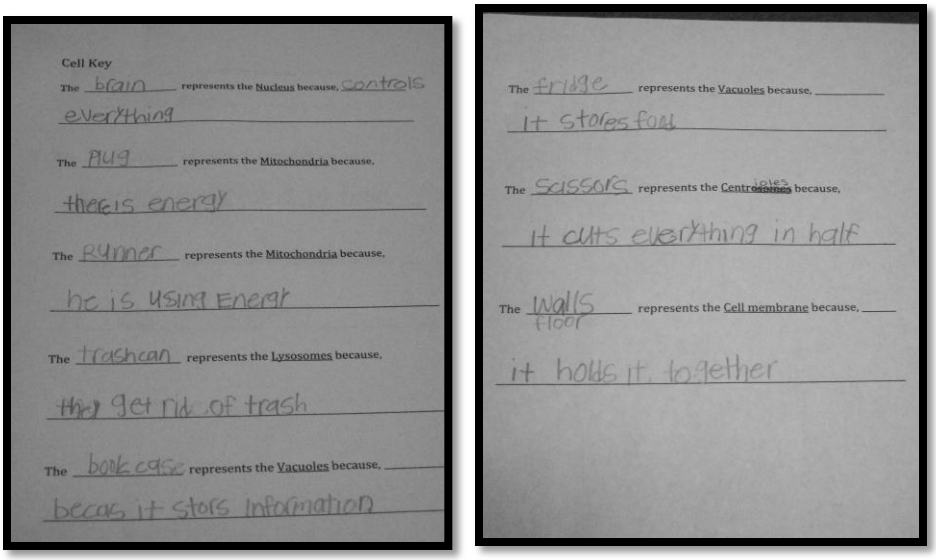


Figure Three: Shows another view of the "cell house". This image demonstrates the problem that the walls and floor created in understanding the concept of the cell wall.


Cell Key

The brain represents the Nucleus because, controls everything

The plug represents the Mitochondria because, there is energy

The runner represents the Mitochondria because, he is using Energy

The trashcan represents the Lysosomes because, they get rid of trash

The book case represents the Vacuoles because, becaus it stors information

The fridge represents the Vacuoles because, it stores food

The scissors represents the Centrioles because, it cuts everything in half

The walls floor represents the Cell membrane because, it holds it together

Figure four: Shows the modified key that Louise completed for the cell assignment

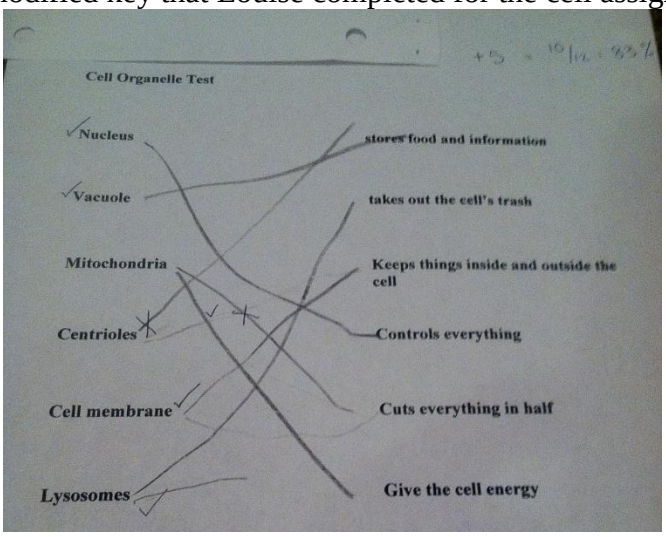
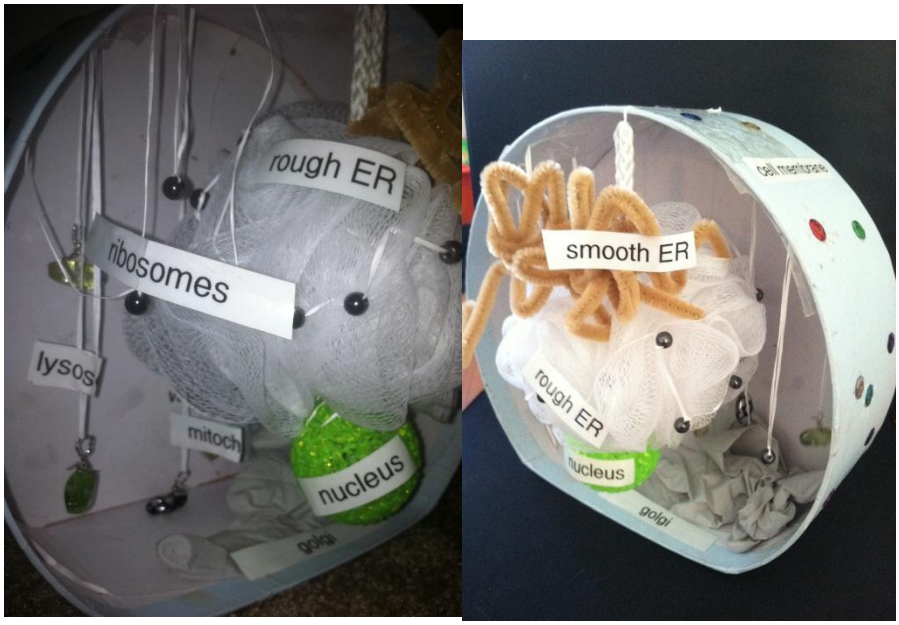


Figure five: shows the modified test that Louise completed after she built the cell house. The only accommodation given on the exam was allowing her to use her "cell house", but no additional notes.



Figures six and seven: Show a cell model completed by a general education student. The cell model is based on form and function. The objects that represent their organelles match the organelle's form and are placed as they exist in relation to each other within a cell.

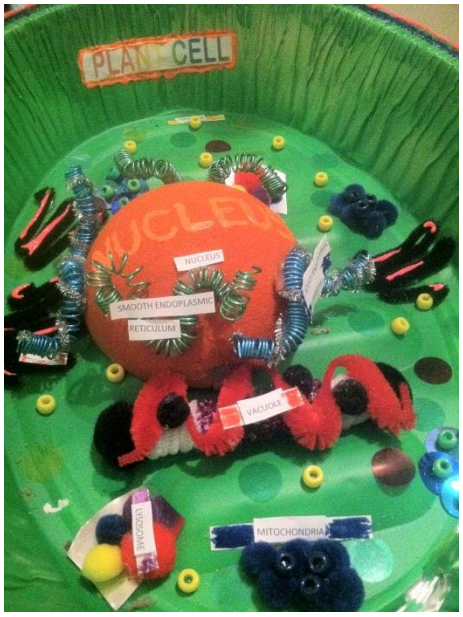


Figure nine: shows a plant cell model completed by a general education student, here, form and position relate to function of the organelles within the cell.

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