

My manipulatives consist of three large, three-dimensional shapes (triangular prisms, square prisms, and hexagonal prisms) each with a “hole” placed throughout the middle of the entire manipulative (if you pick up these manipulatives you should be able to see right through to the other side). In addition, I have 6 thinner manipulatives (3 triangles, 3 square, and 3 hexagons) each of a different size, yet only one of each shape will fit perfectly through the middle of the larger manipulative of the same shape. For my final interview I was able to print the large square prism, the large hexagon prism and a variety of inserts that would and would not fit these prisms.

I had come up with a few manipulatives in Tinkercad but decided to let them go due to the nature of the second interview with my child. For example, I wanted to make a hexagon by having six smaller triangles placed over the hexagon to show how you could make different shapes and patterns using the existing shapes. However, Victor demonstrated some of this knowledge during the second interview when he began arranging the triangles in the shape of a hexagon, and therefore, I decided to create a new manipulative to challenge him with. I was also planning on color coding the manipulatives so that all of the square pieces would be red, the hexagons would be blue, and the triangles green. However, I then thought about making the shapes different colors thinking that this would inform me whether or not Victor was able to visualize the correct size that will fit into the “hole” as opposed to matching the colors that go together. In the end, I realized that the shapes could be the same color because Victor would still need to visualize the correct size insert that would fit into the “hole” regardless of color.

First, I am very curious to simply present the manipulatives to Victor and let him explore the manipulatives. After, I would like to present Victor with a number of questions to see how

he reacts to them. One of the first questions I would like to ask Victor is if he could tell me the shapes that he is exploring. I am asking this because I believe that he can identify and label the triangle, square, and hexagon on the large manipulatives, but I am curious what he would say for the longer and thinner manipulatives. The longer and thinner manipulatives have two ends that look like triangles, squares, and hexagons, but they do look different when observing them from different angles. Another question that I would like to ask Victor is if he could tell me the shape of the “hole” that is in the middle of the larger manipulatives. This will require Victor to “think outside of the box” because the “hole” is in the outline of the shape, but its not a tangible three-dimensional shape. With this in mind, I would like to observe Victor’s thought process during this task. Overall, I want to see how Victor observes these longer and thinner manipulatives and what he does with them.

A third question I would like to ask Victor is how he could fill in the “hole” inside of the three larger manipulative prisms. It would be fun and interesting to see Victor’s attempts when given such a task. I will learn whether Victor grasps the concept of my question as he attempts to fill the “hole” in with the different inserts. Victor may attempt to place the triangle insert into the larger manipulatives to see what fits or he may understand that the two triangle manipulatives must go together, and the same for the squares and hexagons.

A fourth question I would to ask Victor is if he could fill in the “hole” of one of the larger manipulatives, such as the square prism, (e.g. square) and give him all of the square inserts where only one will perfectly fit and slide into the large square manipulative. He may make attempts via trial and error or he may recognize that some shapes of the smaller manipulatives

are too big or too small and may correctly match the larger counterpart by visually observing the manipulatives.

Lastly, I will ask Victor to make a square using the thinner triangle manipulatives. Victor may use the square as a model and place the smaller triangles manipulatives together to make a square. It would be fascinating to see Victor create new shapes using other shapes that will show just how versatile and dynamic shapes and geometry can be.

I think it would be very hard for Victor to reason throughout my tasks without using the manipulatives. Victor would have to be so familiar with shapes that he could picture just how many sides there are. He would need to visualize and verbalize that two triangles placed together could make a square. For my other tasks, I am challenging Victor to explore the manipulatives, the “holes” inside the manipulatives and their longer, thinner counterparts. Without the manipulatives, Victor would be unable to answer my questions because he would have nothing to reference or experiment with by trial and error. Victor could use paper and crayons to show how different shapes can create other shapes, but some tools would be needed.

Victor would have a much easier time being able to reason throughout my tasks if he was presented with manipulatives because I am asking him specific questions about them. I think Victor will most likely reason through my tasks by picking up the larger manipulatives, studying them, and seeing how he could fit the thinner ones into the “hole” in the center. However, with the manipulatives present, there is the the potential for some hiccups. Victor may not take the time to try the different manipulative shapes to find the correct size in the “hole” if he is attempting to solve the task by trial and error. He also may find it difficult to to identify some of

the shapes due to the unique shape of the manipulatives as this will most likely be the first time seeing a manipulative like this.

Victor is such a clever and curious boy that I do believe there are other possibilities for reasoning that my manipulatives can provide. For example, by asking Victor to use the shapes to make a house, it would grant me the opportunity to see how Victor generalizes shapes and visualizes shapes in different environments and settings as well as the purposes they may serve (e.g. square for the foundation of the house, triangle for the roof) from his point-of-view.

When I reflect on the design of the tool I created, it tells me a lot about my understanding of mathematics and how learning happens. Throughout the process of creating my design, I had made numerous changes. Some changes were logistical while others were tweaked based on my interview questions and responses Victor provided. These experiences have helped shape my understanding of mathematics and how learning happens. I have a better understanding of just how versatile mathematics is and that some of the best tasks and learning takes place when the problem presents itself. Specifically, this occurred when the skinny inserts were mismatched. Instead of discarding them, my professor suggested that I use the inserts and test them with my student to see what he would do with them! This is when some of the best teachable moment takes place. Furthermore, I think it is important to introduce these manipulatives and shapes as they are developmentally and age appropriate for Victor. This is further detailed when Van de Walle, Karp, & Bay-Williams (2013) write, “students need experience with a wide variety of two- and three-dimensional shapes” (p. 408). In addition, I think it is so important to let Victor explore these manipulatives as I observe him without impeding or stepping in to “correct”. If I was identifying the shapes for Victor and all the things he could do with them, I would not know

if Victor is duplicating my actions compared to what he knows and learns through experimentation. Evidence shows the importance of letting students explore shapes. Van de Walle, Karp, & Bay-Williams (2013) writes that “students need to freely explore how shapes fit together to form larger shapes (compose) and how larger shapes can be made of smaller shapes (decompose)” (p. 409).

I would consider this project to be successful in terms of learning if by the end of the interview and tasks Victor not only had fun, but was able to explore the manipulatives and come up with something new or figures something out with the manipulatives that he did not know before (e.g. arranging the smaller manipulatives by size order (small, medium, large). If Victor is unable to answer my questions I would still consider the project to be meaningful for the following reasons: if Victor was able to take these manipulatives and make something new, if Victor was able to fill in the “holes” recognizing that the shapes look different but can fit inside their three-dimensional components, or if Victor plays with the manipulatives and finds enjoyment with mathematics and geometry.

I would consider this project to be unsuccessful in terms of learning if Victor rejected the manipulatives and showed no interest in them or did not respond to my questions. Not responding to my questions is different than attempting the task, but not knowing the solution or answer that I was looking for or expecting. By not responding to my questions, it shows me that Victor has no interest in the manipulatives or may not have an interest in mathematics. Overall, I look forward to showing Victor the manipulatives and what he may or may not do with them.

During phase 1 of the 3<sup>rd</sup> interview, I took out all of the manipulatives I made for Victor and let him explore them and play with them without any interruption. Immediately, Victor seemed interested and began picking up some of the thinner inserts and trying to place them in the large prisms. He was methodical and patient as he attempted to find the correct insert that would fit perfectly inside the prisms.

During phase 2 of the interview, I explained to Victor what the manipulative was designed to do. I explained that I made the shapes (Victor told me they were hexagons, squares, and triangles) with lots of inserts that may or may not fit into the “hole” and that he would have to see which ones would fit by experimenting and playing with them. I also told Victor that these different size inserts could be used to understand size concepts such as: small medium, and large. Lastly, I shared that the shapes and inserts could be used to stack and build designs upwards, or vertically.

During phase 3 of the interview, I asked Victor some basic and straightforward questions about the manipulatives to ensure that he could answer some questions before getting into the more complex questions. I asked Victor if he could tell me the color of the square prism and he was able to and told me that it was “blue” and that the shape was “a square”. I then gave him a moment to explore some more because he was fascinated with the square prism inserts after showing him how he could stack them to make a “house”. After, I asked him what was the shape of the front insert was and what was the shape of the back insert and he responded with “a square”. Furthermore, I asked him to look at the “hole” of the large prism and tell me the shape, and again, he responded with “a square”. We explored other shapes and pointed to the “hexagon” and “triangle”. Next, he took the hexagon and square prism and made a telescope, held it to his

eye to see all the way through. In addition, Victor told me there were 4 sides on one of the square prism inserts. I told him because it was 3-dimensional shape, that there were actually 6 sides! Last, I repeated this step with the hexagon and he told that there were 6 sides.

During phase 4 of the interview, I asked Victor what shape was inside the square and he told me “4”. I acknowledged and validated his response that “yes there were 4 sides you are right”. After, Victor was able to tell me there was a square inside of the whole. We repeated the process for the hexagon and triangle and each time Victor correctly told me the shape of the “holes”. After, Victor began to spin the large square prism and we decided to play with it for a little while making it “dance”. Next, I gave Victor a variety of inserts (a rectangle insert, a hexagon insert, and a triangle insert) and Victor was able to find the correct matches. He also discovered that you could not see through the hexagon once the insert was inside the “hole. After answering the questions, Victor began taking the smaller inserts and dropping them in the “hole” of the square prism to see how many would fit. During this time, I capitalized on the opportunity to explain how some of the inserts must be smaller because many of them fit inside the square prism “hole” and therefore the “hole” must be bigger. I also took the time to compare the prisms to a new toy Victor has been playing with. He has been enjoying playing with the large foam dice so I quickly grabbed the 2 yellow three-dimensional dice to show the similarities between the dice and square prism. We talked about how they are different because the foam dice was soft, yet the prism was hard and heavy. Last, I wanted to give Victor three rectangular inserts that were all different sizes and have him find the one that would fit into the square prism. His first attempt was successful. After, we explored the other inserts to see if they fit and they did not. We repeated the process with the hexagon. I gave Victor 3 inserts, the first did not fit,

the second did fit, but Victor thought it did not. I showed him that he had to push a little harder and then Victor was able to see that it did fit! The last insert Victor tried did not fit. We revisited the second insert that did fit and he told me “yes” to “does this one fit?”.

I asked Victor if he could put the hexagons in order “small, medium, large”. He started to point to the correct order, but said that medium was both “medium” and “large or big”. I showed him how he can put them in the correct order and he tried again. Once he was able to put them in order, we did the same with the squares. With the squares, Victor was able to put them in the correct order by pointing to them and verbally stating the correct order. Last, we looked at the thinner manipulatives together and when I asked Victor if the thinner inserts were hexagons he told me “no” noticing that the sides were not equal.

We discussed and learned that sometimes shapes can fit inside other shapes and learned about size order. Victor also learned about opposites such as: soft and hard, and talked using the manipulative like a telescope by looking through the “hole”. I finished the video with letting Victor play with the manipulatives and stack them very high!

I think Victor learned a lot! I always knew that Victor loved shapes, but has not had the opportunity to explore such large three-dimensional prisms, let alone three-dimensional prisms with “holes” going through them. Victor learned about trial and error when he took his time to try and find the insert that would fit inside the prism. When I first presented the manipulatives, he knew what he wanted to do and that was to try and find the one that would fit inside the “hole”. What I did not plan for or expect, was how much Victor enjoyed placing the smaller inserts into the larger square prism “hole” and seeing how many inserts he could fit inside.



Something else that I did not plan for was spinning the large prisms to make them “dance”. I think that Victor used the tool as it was originally intended, but also used the tool in a way that I did not plan for!

I learned so much through the design process. I learned that every hiccup or unplanned event can be turned into a positive and new learning experience for both myself and the student. For example, I was originally going to have a square prism, hexagon prism, and a triangle prism in a variety of colors. By the last interview, I did not have a large triangular prism, and only one manipulative was blue while the others were gray. This encouraged me to come up with other questions and in the end, Victor was still able to use the manipulatives and have fun with them! I was also able to use many of the smaller manipulatives that were “first take” prints on Tinkercad that were going to be discarded. This mistake turned into a positive and allowed for Victor to experiment with even more manipulatives!

If I had the same manipulatives, but had the opportunity to engage in another design cycle I would like to have used the same prisms but instead of the “hole” in the square prism also being a square I think it would be fascinating to have a triangle or a different shape inside of the square prism. It would be like having two shapes in one. I really enjoyed the interview experience and getting to work closely with Victor. I would not change too much. I do think it would have been beneficial to have multiple cameras used for different views though. One facing us on the floor and one looking down at us so it would be easier to get a view of the manipulatives as Victor played with them instead of picking up the camera and holding it at awkward angles at times. I think this was a valuable experience for Victor because he was able to explore new and unfamiliar manipulatives and use higher-order thinking skills to build and

create. It was also helpful for me because I got to watch Victor and “see” his thought process as he played. It was also refreshing to watch Victor play without interruptions or disturbances. In my ABA program, staff are very hands on so it was great to watch Victor take the lead. I think it would be fascinating to do the interviews with newly created manipulatives and then create even newer modified versions of the same manipulatives to see what Victor would do. He could share similarities and differences.

I feel that this project was extremely successful. In part 1 I stated, “I would consider this project to be successful in terms of learning if by the end of the interview and tasks Victor not only had fun, but was able to explore the manipulatives and come up with something new or figures something out with the manipulatives that he did not know before (e.g. arranging the smaller manipulatives by size order (small, medium, large)”. During part 2, Victor did have fun, and learned something new which happened to be arranging the inserts in size order! We both thoroughly enjoyed the interview process and learned so much!