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The Two Types of Assessment Tasks and What They Tell a Teacher

I. Introduction

The OECD (Organization for Economic Co-operation and Development) measures mathematical performance internationally and produces a ranking for each country based on the mean score of a 15 year old student's capability to formulate, employ and interpret mathematics in a variety of contexts, to describe, predict and explain phenomena, and recognize the role that mathematics plays in the world. "The study shows that in 2012, the United States was ranked 11th out of 38 countries in mathematics performance worldwide". **(**https://data.oecd.org/pisa/mathematics-performance-pisa.htm**)** This low ranking leads to a variety of questions based on the role of the teacher, student, and required content and their affect on our education system as a whole. Moreover, educators are constantly trying to research new ways to shift learning environments and create new approaches in hopes of increasing the United States' performance. One of these main shifts is the change from the traditional classroom to the collaborative classroom. This collaborative classroom promotes instruction centered on student thinking. That is, in the math classroom, connecting math with real world applications, asking challenging questions, and analyzing fewer problems that require a greater depth of thinking. However, the problem with this classroom environment seems to always lie in assessments. More specifically, what kind of questions should a teacher ask a student on an assessment to accurately determine his or her student's knowledge about the content?

After completing college math courses, I started to notice the difference between the assessments given in high school versus the assessments given in college. My high school teachers usually gave out multiple-choice tests and the standardized tests are always multiple choice. However, I was not prepared for the common college open-ended tests. I started to ponder why this was the case and due to my desire to pursue a career in education, I wanted to know which kinds of questions would tell me the most about what my student understands. More specifically, are content specific open-ended questions:

- Said to be easier or more difficult than comparable closed questions?
- More likely to elicit higher level responses?
- More susceptible to see misconceptions?
- Able to tell teachers information about their students' knowledge and understanding?

II. Literature Review

Assessment is used worldwide and is therefore very important in determining a student's success. Likewise, educational assessment is one of the most essential aspects in determining a student's knowledge and growth. NCTM(2000) presented six principles for school mathematics. One of these is the Assessment principle. The NCTM assessment principle states, "Assessment should support the learning of important mathematics and furnish useful information to both teachers and students." (NCTM, 2000, p.22) They believe that assessment should be done for students, not to students, assessment should become a routine part of the ongoing classroom activity rather than an interruption, and assessment is a valuable tool for making instructional decisions. However, there is always a gray area for secondary mathematics teachers when determining this knowledge. After gaining more understanding on the importance of assessment in the math classroom, I became more interested in how a teacher should assess his or her students.

"Assessment for learning is the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there." (Key Questions) More times than not, it seems that students have not learned as much as a teacher wants or thinks they have. When assessing, teachers notice that there are gaps between what was taught and what has been learned. This quote speaks to me in regards to being a student and a future teacher. As a student, I believe it is best to be able to demonstrate what I understand and do not understand rather than what I memorized on an assessment for a teacher to act on or modify his/her teaching to help me succeed. Due to the many experiences I have had as a student, I know this difference and unfortunately it is a big one. As a future teacher, I believe that it is important to be able to assess your students on their understanding, even if it requires more work, rather than their pure memorization. This will help see where the student stands in terms of the content and if you, the teacher, need to revisit, explain differently, or move on.

Types Of Assessment Tasks

There are a wide variety of types of questions that teachers put on an assessment and every piece of research on the topic classifies them differently. Bush (2000) states that there are three kinds of tools for assessments. These include closed tasks, open-middle tasks, and open-ended tasks. Each of these tasks have disadvantages and advantages but are all supposed to be incorporated in a teacher's assessment to be considered effective.

Closed assessment tasks ask students to provide one correct answer where there is generally only one valid way to get to that answer. These tasks usually require students to memorize or perform a procedure/algorithm. Moreover, the most common examples of closed tasks are fill-in-the-blank, multiple choice, and simple computational questions. Most people may say that since this type of question does not assess understanding and problem solving or show if a student guessed or not, they are not useful. However, closed tasks tell a teacher whether or not the student can perform a skill or learned a definition or fact. This can be effective when evaluating skill proficiency and memorization of important information.

Open-middle assessment tasks have one correct answer, but there are many different paths for a student to take to get that answer. Although similar to a closed task, these questions are more effective when looking at a student's thought process. This means that they reveal student thinking, show how a student thinks about math, and provides a way for students to use their own strategies to solve problems. One example of this is a true false question that requires students to explain their answers.

The last task described is open-ended. This type is very different from closed where the problem has many correct answers and different routes to get to those answers.

A common open-ended task is one that poses questions based in real life situations. This is important in the mathematics classroom because it shows students the importance of math outside of school. Questions that require students to explain, justify, make conjectures, solve non-routine problems, and make predictions provide teachers with the opportunity to see how students make problem-solving decisions and how they apply the concepts they have learned.

Statistics

As mentioned before, the realm of education is shifting. This shift is mainly seen in the style of learning environment. Most teachers teach a so called "traditional" class while teachers are now being pushed to teach a "collaborative" class. Some causes of this are pressure to increase rigor, knowledge of how students learn math, and the support of student participation. "Too often in school, students learn what they need to know for a test an them revert to misconceptions in their daily lives, failing to make critical connections between what they learned and how they lived."**(**Horn, 2012, p.3) Traditional learning environments focus on learning terms, recalling facts, and repeating procedures. Likewise, correct answers conduce these classrooms. Learners in this type of setting receive information passively and are under the impression that math problems only take short periods of time to solve. "Educators generally agree that teachers should emphasize the development of students' skill in critical thinking rather than in learning and recalling facts." (http://www.jstor.org/stable/1169463) Thus, they believe that a collaborative classroom, one that instruction is centered on student thinking, students become the basis of instructional dialogue, encouragement of persistence by offering opportunities to revise, and where students can make sense of mathematics is more efficient. Gall(1970) states:

> "Probably the first serious study of this issue was done by Steve (1912). She found that, for a sample of high-school classes varying in grade level and subject area, two-thirds of the teachers' questions required direct recall of textbook information. Two decades later, Haynes (1935) found that 77% of teachers' questions in sixth-grade classes called for factual answers; only 17% were judged to require students to think. In Corey's study (1940), three judges classified all questions asked by teachers in a one-week period in a laboratory high school. The judges classified 71% of the questions as factual and 29% as those which required a thoughtful answer." (http://www.jstor.org/stable/1169463)

Although this study continues into the 1960s, the majority of questions asked are closed. The article describes that some reasons for this may be "although higher-cognitive objectives are valued in American education, teachers need to ask many fact questions to bring out the data which students require to answer thought quest, although educators have for a long time advocated the pursuit of objectives such as critical thinking and problem solving, only recently were these objectives incorporated systematically into new curriculum, and the lack of effective teacher training programs." (http://www.jstor.org/stable/1169463)

The article from the 1990s discusses the student's views on the different questions. Observe the chart below:

Table 1

Percentages of Students' Responses to Items on Year 9 Open Questionnaire

Items	Amber Hill	Phoenix Park
Enjoy open-ended work	14	38
Dislike textbook work	22	0
Can't understand work	20	6
Can understand work	3	5
Work is interesting	4	21
Want more interesting work	15	19
Enjoy either working alone or with others	8	4
Pace is too fast	9	3
Pace is about right	0	3

This chart states that students enjoyed open-ended work and wanted more interesting work. I believe that this study proved that most students would rather do math instead of repeat steps in a textbook. (Boaler, 1998, p.52)

It is difficult to find statistical data about the types of questions asked in today's classrooms, but I assume that this number did not change much. This assumption motivated me to do a study by survey in regards to in-service and pre-service teachers.

Worthwhile Tasks

Van de Walle (2016) gave a Task Evaluation and Selection Guide designed for teachers to use to ensure that a created task has the maximum potential to help their students learn mathematics. Likewise, this potential is seen when students engage through inquiry. It is stated that the idea is not for all boxes to be checked off, to consider to what extent the task you are analyzing meets the criteria. This selection guide is used for teachers to see what was not marked and potentially edit their task to make such changes. As the whole chart consists of the sections task potential, problem solving strategies, worthwhile features, and assessment, I only used worthwhile feature and assessment in my research. The worthwhile feature box includes high cognitive demand, multiple entry and exit points, and relevant contexts.

- Cognitive demand is explained as how a student is thinking mathematically, but can also be used when assessing a task. This is separated into two levels, low and high. Low-level cognitive demand includes memorization and procedures without connections. Likewise, the students are completing routine problems or low-level tasks. Low-level cognitive demand is not one in which students are engaged in productive struggle. On the contrary, high-level cognitive demand is associated procedures with connections and doing mathematics. A task that is promotes high-level cognitive demand is one in which students engage in productive struggle as well as employ problem solving strategies and are challenged to make connections to concepts and to other relevant knowledge.
- The book explains multiple entry and exit points by a task that can be approached in a variety of ways and has varying degrees of challenge within it. Having multiple entry and exit points can accommodate different learners and encourage each student to think differently. Most of the time, the way students think is based on their prior experiences and as a teacher I want to encourage that the different ways of thinking are acceptable. This choice also lowers the anxiety of students and allows them to complete a task in a way that makes sense to them.
- The third thing described was relevant contexts, or something that gets students engaged. Relating your task to a real life situation, literature, or other disciplines are ways to get your students engaged and show that math is seen and important in everyday life. Finding a relevant context can sometimes be

> difficult, especially in a class of diverse learners. But, you can always find relevant contexts in other subjects that your students are studying. This is the basis upon STEM or STEAM lessons.

The second section was assessment. The purpose of this section is for teachers to evaluate in what ways does the task provide opportunities for them to gain insights about their students' knowledge and understanding.

III. Methodology

I conducted my research in Dr. Santarone's MAED 3100 class in the Fall Semester of 2016 at Georgia College and State University. This class meets on Tuesday/Thursday at 9:30 and is made up of middle grades pre-service teachers of all subjects. I first gave out an assessment when Dr. Santarone completed her integer unit for each student to complete. This assessment consisted of four closed and four open ended questions, where each has a pair. Note that the questions were related to the unit being taught and asked the student to follow a procedure or formula, draw a picture, or write an explanation. See Appendix A for an example of the given assessment.

I then used a rubric to grade/analyze the assessments. The rubric inserted in the findings section was based upon how much the teacher would be able to infer about the student's understanding of the problem. It was also related to mathematical proficiency and the types of cognitive demand and which are easily displayed by the student's response. Likewise, I analyzed the results and decided what each type of question told a teacher in regards to the depth of student thinking, sources of error, and places of misunderstanding, or how a teacher can ask these questions to get an expected answer. This will encourage teachers to purposefully insert certain questions on an assessment when looking for specific things. At the end of the assessment, I handed out a survey to the students in Dr. Santarone’s class. This survey asked a variety of questions pertaining to the two different types of tasks I am researching. Furthermore, what type they think is easier, what they think displays a better understanding of the student knowledge, and what they will use in their classroom and why. This same survey was also given out to high school and college mathematics teachers via the Internet. This was done by means of e-mailing secondary math teachers a consent form and link to my survey. After the deadline, I received nineteen student responses and sixteen teacher responses. I analyzed both the teacher and pre-teacher surveys by paying attention to the answers of the questions and comparing them based on future teacher/teacher, class/types of questions, easy/challenging etc. Other means were analyzed as well. I will present this data in means of charts and graphs in my presentation. Refer to Appendix B for the pre-service teacher survey and Appendix C for the in-service teacher survey.

IV. Findings

Assessment

I gave students an assessment on integers that consisted of eight questions. More specifically, the assessment had four closed questions and four open questions that paralleled each other. By parallel I mean that the two questions were very different but about the same content. This reasoning was due to the fact that when analyzing, I wanted to be able to see students’ true understanding of the content. Based on my findings, it was easy to see that all students got the four closed questions correct. This may have been for a number of reasons. The first reason may be because the student understood the concept.

Another may be the student memorized the algorithm learned in class. The last reason may be the problem was too simple for a college student. However, when analyzing the open questions that paralleled, there were many incorrect answers. Some of these answers were simply due to not following directions while others it was evident that students did not conceptually understand the concept. Not following directions included not explaining an answer or not giving the correct number of examples asked.

I graded these assessments on a 0-1 point scale for each question. For the closed questions, the student scored a 0 if their answer was wrong and a 1 if their answer was right. This binary choice is due to the fact that a closed question is either right or wrong, there is no in between. On the other hand, the open questions varied and had more room for partial credit. I have analyzed each individual question and decided what the partial credit represented based on each. The rubric is shown in Appendix D.

After analyzing each student's response, I saw that every student scored a 1 on the four closed questions. This implies that the average score of each question was 1 and therefore the average score of all closed questions was 1. On the other hand, the open questions facilitated very different averages. On question five the average was .657, question six the average was .816, question seven the average was 0.5 and on question eight the average was .618. These averages resulted in a combined average of the open questions of .648. As you can see, the students had more difficulty and room for error in the open questions.

I will turn my focus to two of the open-ended questions that I saw had the widest range of responses. Questions seven and eight were easily chosen as these problems of focus due to having the two lower averages of the four. Note that problems one and four were these questions' closed ended parallels. Moreover, I wanted to see these questions compared.

I first will dissect question seven. This question was "Find -12x3 in two different ways. Explain your answer." The closed question that matched was "Solve (-12)/3". Both of these questions asked the students to recall facts on the multiplication and division of integers. Here is a reminder of the rubric used to grade these two tasks.

	0	.25	.5	.75	1
Question 1	Incorrect	X	X	X	Correct
Question 7	Incorrect	X	1 correct example OR 2 correct examples with no explanation	X	Correct

The chart shows the number of correct student responses of both questions.

Questions 1 & 7	Points	# of Students	Percent out of 19
Closed	1	19	100
Open	0	4	21.05
	½	11	57.89
	1	4	21.05

I applied the checklist from Van De Walle that was discussed prior and checked off the appropriate features.

Question 1:

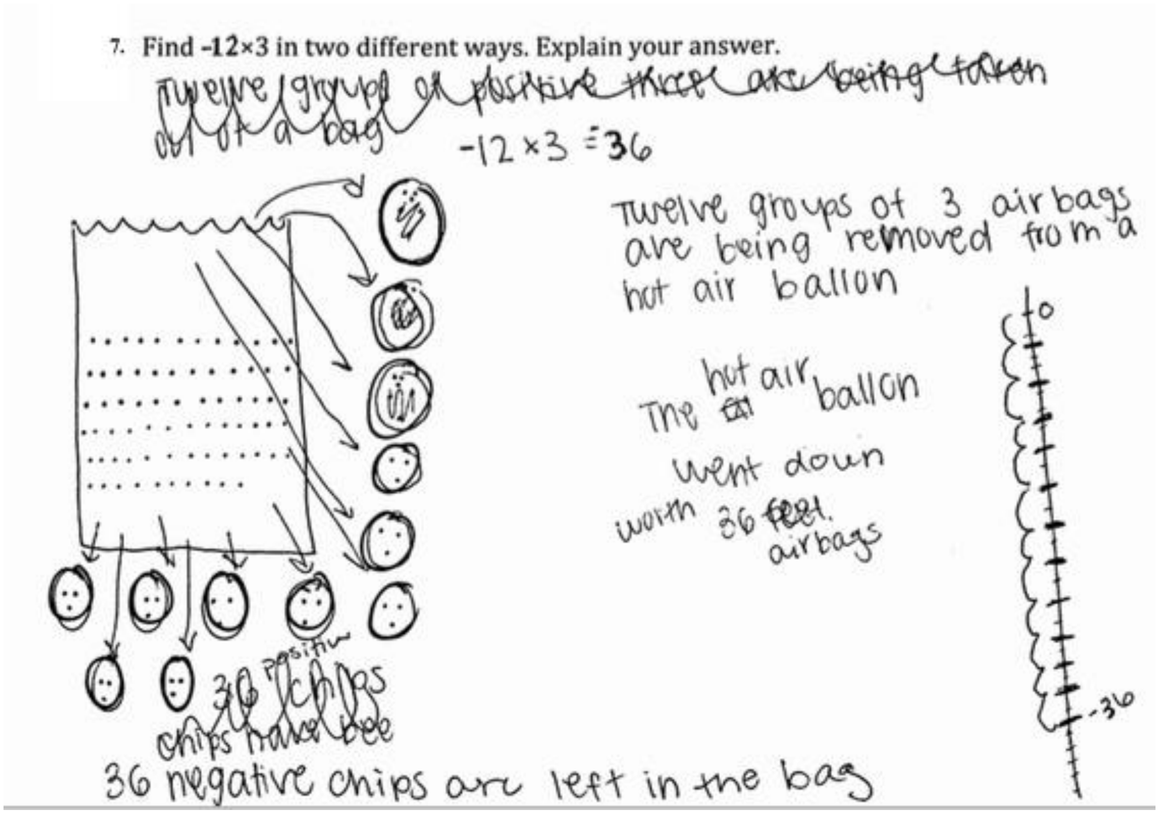
Worthwhile Features	☐ **High cognitive demand** ☐ **Multiple entry and exit points** ☐ **Relevant Contexts**

Assessment	☐ **Using tools or models to represent mathematics** ☐ **Student reflection, justification, and explanation** ☐ **Multiple ways to demonstrate understanding**

Question 7:

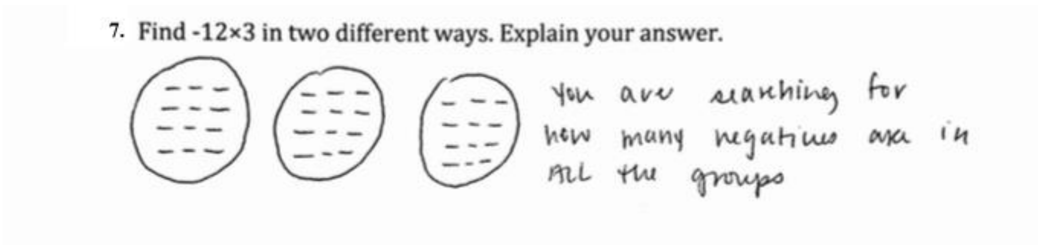
Worthwhile Features	☑ **High cognitive demand** ☑ **Multiple entry and exit points** ☑ **Relevant Contexts**
Assessment	☑ **Using tools or models to represent mathematics** ☑ **Student reflection, justification, and explanation** ☑ **Multiple ways to demonstrate understanding**

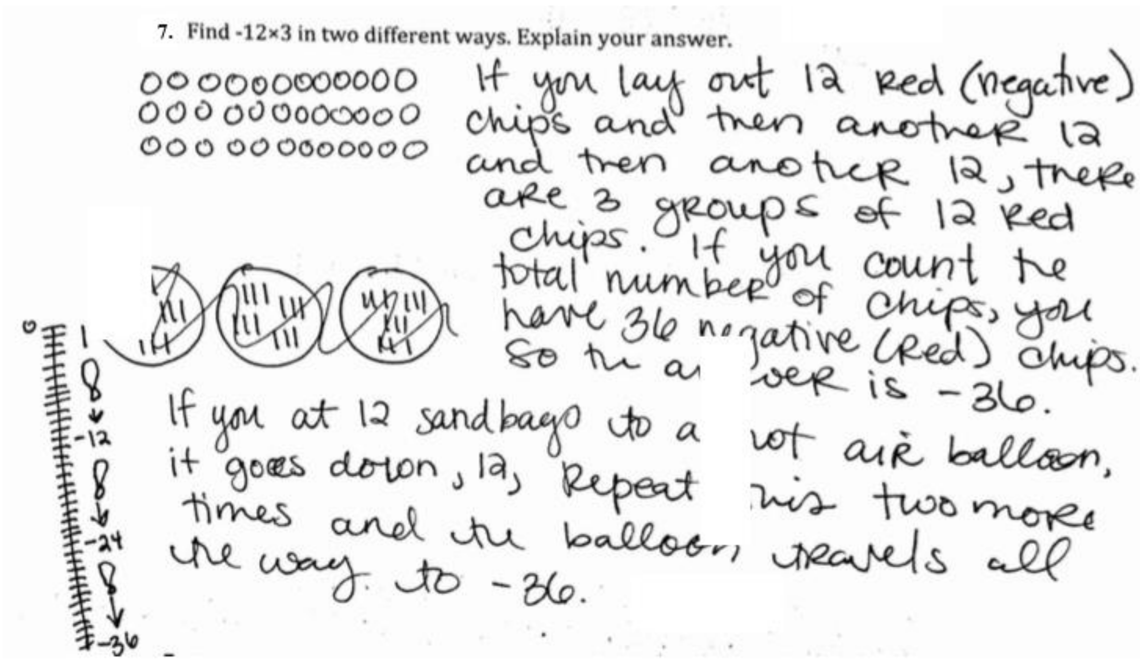
It is first important to note that every student got the closed answer correct. However, only 1/5 of the students received a score of 1 on the open question, leaving about 4/5 or 80% not receiving the perfect score. The checklist shows that question one did not satisfy any requirements, which leads to it not being considered a worthwhile task. Question one also does not show a teacher a lot about student understanding as it did not satisfy any of the requirements of the assessment portion. Question seven satisfied all requirements under worthwhile features and assessment meaning it is considered a worthwhile task and tells a teacher a lot about student understanding. Note that in class students were taught that the first number in a multiplication problem is the number of groups and the second number is the number of objects in each of thee groups. For example, in this problem there would be negative twelve groups with positive three objects in each group. A correct answer is as follows:



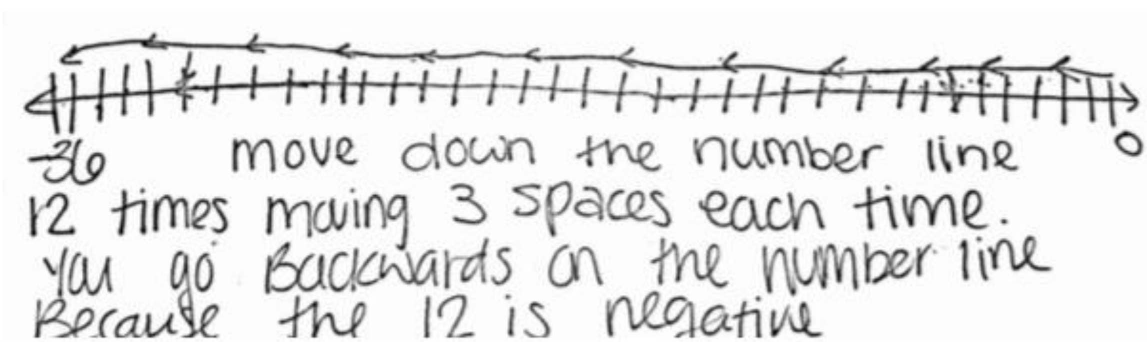
This student created zero pairs in the bag and removed twelve groups of three and saw that there were 36 negative chips left in the bag. They also used the hot air balloon model that was discussed in class.

After further analyzing, I started to notice a couple of trends when investigating student responses. The first misconception was (3)(-12). Students usually wrote this as “three groups of negative twelve” or “twelve negative objects in three groups”. Some examples of this misconception are:

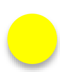
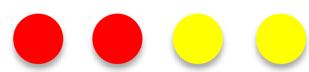




Likewise, another misconception was (12)(-3). The student that gave this response did not accurately draw their model. For instance, the arrow is representing negative three by pointing to the left, instead of the arrow pointing to the right for the correct positive objects.



These misconceptions may be considered common because students do not understand the difference or importance of groups and objects in multiplication problems. Although students were exposed to this information in class, it seemed that they could not demonstrate the multiplication accurately. Some may say that computationally these problems are the same, they both give you -36, but conceptually they are very different. If one were to apply context to the problems they would be very different and we can see this in the variety of groups that the students created. This led for me to think of some reasons why students could not completely answer the question. I came to a few conclusions. The first is that some students may only be able to think of one way to do a problem, not two. Likewise, are students flexible or is knowing one way good enough? Or Are students usually ever asked for more than one example? Another reason may be that students wanted to make the problem easier.

I will now look at question eight. This question was "Use a real life context to explain what a zero pair is". Question 4, question eight's closed parallel read ". Let  be -1 and let  be 1. What is the value of these chips? 

Both of these questions asked the students to recall facts on zero pairs or more generally, negative and positive integers. Here is a reminder of the rubric used to grade these two tasks.

	0	.25	.5	.75	1
Question 4	Incorrect	X	X	X	Correct
Question 8	Incorrect	X	Reasonable scenario but wrong/no explanation	Reasonable scenario with correct explanation but made an incorrect statement	Reasonable scenario and explanation

This chart shows the number of correct student responses of both questions.

Questions 4 & 8	Points	# of Students	Percent out of 19
Closed	1	19	100
Open	0	5	26.32
	1/2	4	21.05
	3/4	1	5.26
	1	9	47.37

I applied the checklist from Van De Walle that was discussed prior and checked off the appropriate features.

Question 4:

Worthwhile Features	☐ **High cognitive demand** ☐ **Multiple entry and exit points** ☐ **Relevant Contexts**
Assessment	☑ **Using tools or models to represent mathematics** ☐ **Student reflection, justification, and explanation** ☐ **Multiple ways to demonstrate understanding**

Question 8:

Worthwhile Features	☑ **High cognitive demand** ☑ **Multiple entry and exit points** ☑ **Relevant Contexts**
Assessment	☐ **Using tools or models to represent mathematics** ☑ **Student reflection, justification, and explanation** ☑ **Multiple ways to demonstrate understanding**

Question eight had 2 partial credit options between an incorrect and correct response. Over half of these responses fell in the partial credit or incorrect category, leaving 47% of the responses being correct. It is important to note the checklists with these two questions. Question four does satisfy the using tool or models to represent mathematics requirement due to the use of the chips to represent values. However, no others are satisfied making the task not worthwhile. Question eight did satisfy many more requirements, and is considered worthwhile, but not all boxes are prominent. The students in the classroom were exposed to zero pairs and many examples. They were taught about how some examples were more accurate representations than others and how zero pairs do not just “cancel each other out”. A few correct responses are as follows:

Use a real life context to explain what a "zero pair" is.

If you had to take one step forward (1) and one step back (-1) you would end up in the same place.

8. Use a real life context to explain what a "zero pair" is.

A zero-pair is two components that individually have their own number or integer associated with them, but when they are paired together they equal zero. for example, if you have one dollar (+1) and you have an I.O.U from your friend for a dollar (-1) you would actually have 0 dollars or a zero-pair.

Both of these students gave reasonable scenarios of zero pairs with correct statements. Steps and money are two great ways to explain this concept. When looking deeper into this open-ended task, I noticed that there were two main misconceptions. The first of these misconceptions was the difference between difference and displacement, and which accurately exemplify zero pairs. Note that distance is a scalar quantity that refers to how much ground an object has covered during its motion while displacement is a vector quantity that refers to how far out of place an object is, or the object's overall change in position. Here is an example of a student response with regards to this misconception:

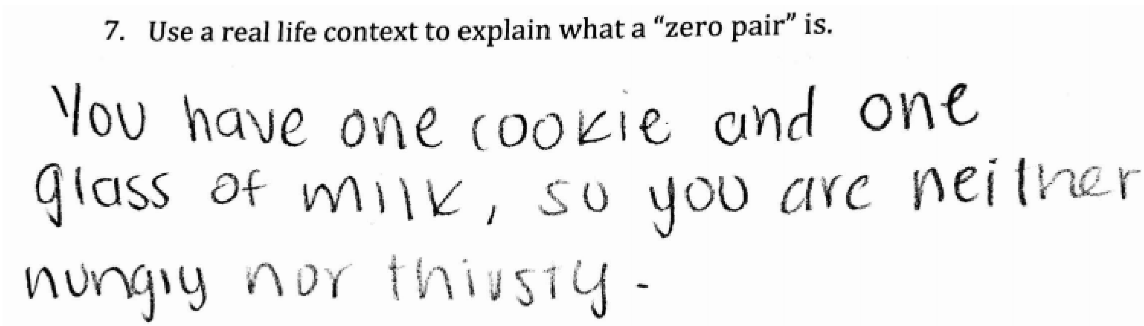
. Use a real life context to explain what a "zero pair" is.

if you move foward +1 unit (step) and then move back -1 unit (step) you are where you began and moved 0 steps.

The student used an accurate representation of a zero pair, steps, but made the incorrect statement "you are where you began and moved 0 steps". This student fell into the notion that zero pairs represent displacement only, when they represent distance as well. For example, if someone were to take one step forward and one step back, he or she actually took two steps; they just had a displacement of zero. Many students said things similar to this or that the pairs cancel each other out, which are not correct statements. Another misconception seen was giving something a value. Students did not seem to understand what the value of the chips represented in class and could not pick something they that were able to have values, and even more were opposites. Here are some of these responses:

8. Use a real life context to explain what a "zero pair" is.

In squash casserole you have two main ingrediants cheese and squash. The two combine to make casserole. In a zero pair you have a positive and a negative that combine to make zero.


7. Use a real life context to explain what a "zero pair" is.

You have one cookie and one glass of milk, so you are neither hungry nor thirsty.

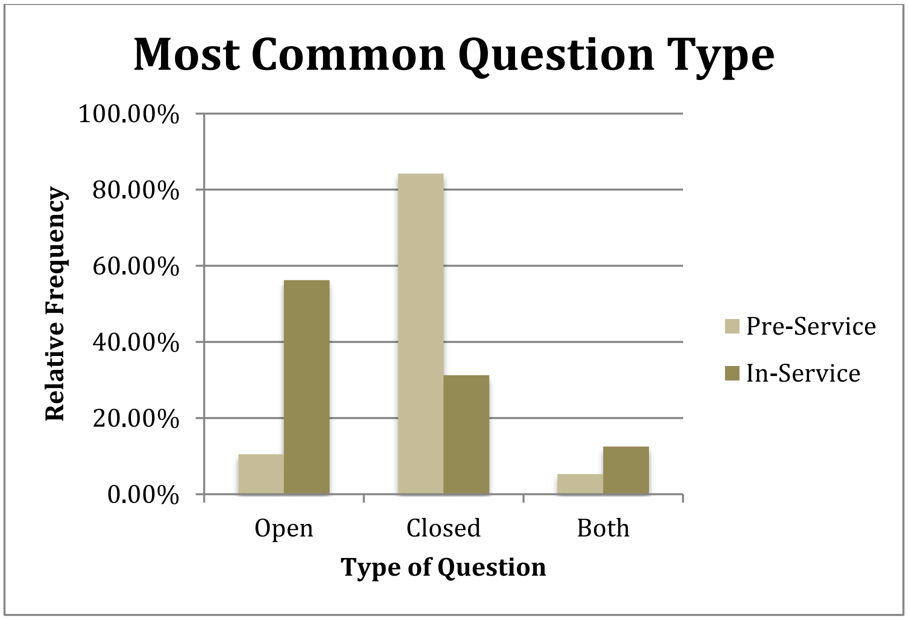
Both of these students gave values to things that cannot have values. For example, the second student gave the value of positive one to the cookie and the value of negative one to the milk. Both cookies and milk are objects that cannot be given these values, and they are also not opposites. Thus, these items are not a zero pair. Not to mention, being neither hungry nor thirsty has nothing to do with zero pairs.

This misconception was seen in a variety of ways among the students' responses. In conclusion, when looking at the open -ended questions a teacher can see a lot more about student's understanding. Moreover, when a student does not understand, the misconceptions can be easily determined.

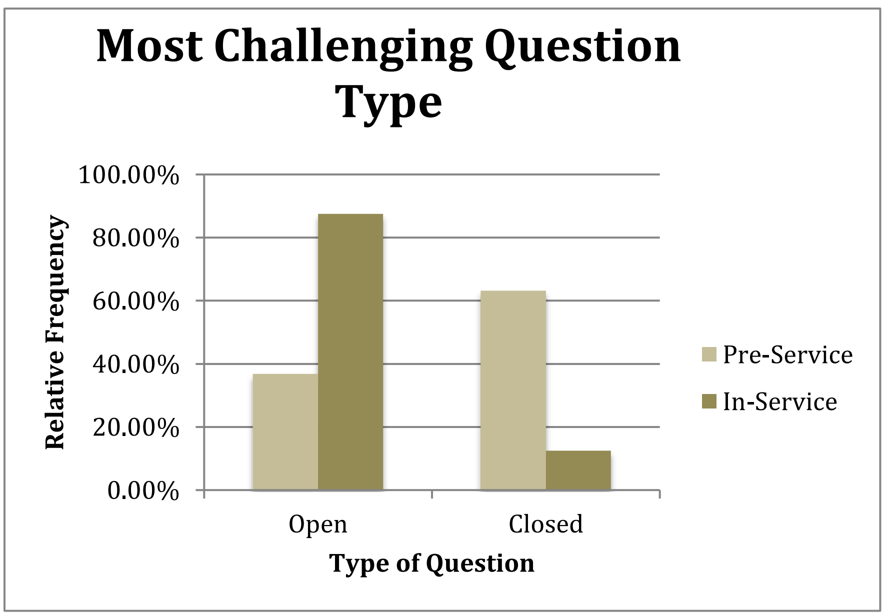
Survey

I had 19 student responses to the given survey and 16 teacher responses. Most of the questions were similar on both the in-service and pre-service surveys. After analyzing these responses, I found that 93.75% of in-service teachers reported that they ask open-ended questions. Because of the numerous amounts of questions, I chose to look deeper into just a few. Specifically, numbers two, four, and five. Here is the data from each:

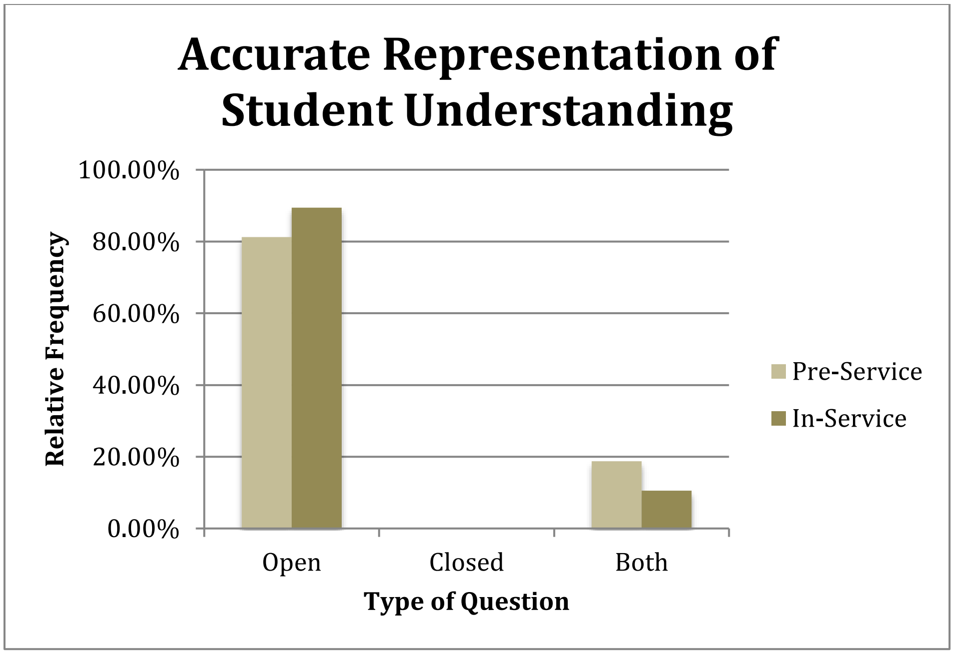
Question 2:



Question 4:



Question 5:



However, I thought it was interesting that both in-service and pre-service teachers said open tasks are the most accurate representation of student knowledge, but the most common questions students see is closed. Even though teachers may value open questions, I received a few responses saying they do not ask them because of the state mandated tests. Here are a couple of responses from question number six. I thought this was interesting and also unfortunate that these tests influence a teacher's classroom.

Q6: **As a teacher, which types of questions do you use to assess your students? Justify your reasoning.**

I use a variety of questioning techniques. We cannot get around multiple choice questions as they appear on all standardized tests. However, as students formulate their understanding, I think it is important to assess them in a way that will allow them to communicate what they know about the process.

Q6: **As a teacher, which types of questions do you use to assess your students? Justify your reasoning.**

Both Open/ closed. Open response b/c it is the best way to see exactly what they no (can't guess) and closed due to the fact that the state mandated tests are mutliple choice in nature and students need practice at this type of question.

6. As a future teacher, which types of questions will you use to assess your students? Justify your reasoning.

both. They need the closed to practice for State test, but I hope to use more open because I can see where the students struggles lie.

6. As a future teacher, which types of questions will you use to assess your students? Justify your reasoning.

An array of questioning. It might not be possible but I would like to assess students in ways each individual student feels comfortable. I will probably end up basing my questioning off of standardize test so they have seen that type of questions before that test.

With regards to the chart about the most challenging question, one can see that the results are pretty much half and half. Some think that open questions are more difficult while some think that closed are more difficult. I also wanted to show a few examples of responses in regards to easy and challenging questions. Some teachers think that closed are more challenging because they base it solely off of the student's grade in that they can receive no partial credit. While others think open is more challenging because students have not had the experience needed to answer them.

Q3: What type of question do you think is the easiest for your students? Explain why.

Free Response. Since there are variety of ways to reach the answer, the students have an opportunity to use a variety of methods.

Q4: What type of question do you think is the most challenging for your students? Explain why.

Multiple Choice. As there is only one correct answer, and no partial credit, all the solutions may look reasonable. I minor miss calculation can lead to an incorrect answer.

Q3: What type of question do you think is the easiest for your students? Explain why.

Closed questions, because that's what they're used to in math.

Q4: What type of question do you think is the most challenging for your students? Explain why.

Open questions tend to confuse them because they'll always say, "I don't know what you want me to do." I try to get students out of this mindset, but it's difficult when they've already been taught math that way for so many years before they get to me...

Once again, we see the same thing in regards to the students' responses. The second student said he or she was not challenged enough so open is more difficult.

3. What type of question is the easiest for you? Explain why.
Closed because That is how most of my tests were structured.

4. What type of question is the most challenging for you? Explain why.
open ended question because I was not challenged enough in school to justify my answers, explain my answers, or make predictions

5. What type of question(s) do you feel displays an accurate

3. What type of question is the easiest for you? Explain why.
Open ended because I can show what I know even if it may not lead to the correct answer. At least I can show that I have learned something

4. What type of question is the most challenging for you? Explain why.
~~closed questions because~~ closed questions because I may have the process or steps correct with only a small error, but I will still get the question completely wrong.

What type of question(s) do you feel displays an accurate

V. Conclusions

To answer my research questions, content specific open-ended questions were said to be more difficult, were more likely to elicit higher level responses, more susceptible to see misconceptions, and were able to tell teachers more about a student's knowledge and understanding. When conducting my research and analyzing the responses, Dr. Santarone learned a lot about her students. She said, "For several weeks, the pre-service teachers had been working with integers by engaging in tasks that involved the use of several different manipulatives, such as chips and hot air balloons on a number line. From my observations and conversations with them, I believed the pre-service teachers had a good grasp on how to model the integer operations and could explain how zero pairs played out in the operations. It wasn't until Savanna's assessment, particularly the open questions, which I realized that many of my students held misconceptions of what a zero pair is. After the assessment, I was able to address and hopefully alleviate these misconceptions!"

The implications of my research were that the closed questions may have been to simple for my target group. That is, I asked questions on integers that college students should know without requiring any thought. This could be a factor in which all students got the four closed questions correct. Another implication may fall under the word difficult. Students and teachers usually put a negative connotation with the word difficult, however "difficult" in my case showed the teacher a lot more about a student's understanding.

If I did future research I would want to look into open-middle questions and what they tell a teacher about student understanding. As explained earlier, these are questions that have one correct answer but many ways to get to that answer. Also, I would like to give assessments to a wider range of classes and over more content areas. I only gave one assessment to one class about integers, and I would like to see if my results would change if this varied.

In conclusion, pre-service and in-service teachers said that open ended tasks show an accurate representation of student knowledge and I was able to see this based on the results of the assessments given.

VI. Appendix

Appendix A- Assessment

1. Solve (-12)÷3

   ____

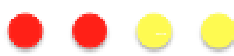
2. Solve 20+(-8)

   ____

3. Is -¾ an integer?

   ____

4. Let  be -1 and let be 1. What is the value of these chips?

   ____

5. List five integers and five non-integers that help define what an integer is.

   ____
   ____

6. Illustrate the following number statement by using a set model (chips) or a measurement model (hot air balloon). Draw a diagram to support your work and explain why in complete sentences.

   10+(-4)

7. Find -12×3 in two different ways. Explain your answer.

8. Use a real life context to explain what a "zero pair" is.

Appendix B- Student Survey

Survey for Students

Closed question- these ask students to provide one correct answer and usually there is only one correct way to reach that answer. (true/false or multiple choice)
Open ended question-these have many correct answers with various routes to get those answers. They require students to explain their answers, solve non-routine problems, make conjectures, justify their answers, and make predictions.

1. What is your ideal subject(s) to teach?
   ____
   ____
2. What is the most common type of question you have seen on an assessment?
   ____
   ____
3. What type of question is the easiest for you? Explain why.
   ____
   ____
4. What type of question is the most challenging for you? Explain why.
   ____
   ____
5. What type of question(s) do you feel displays an accurate representation of student knowledge? Explain why.
   ____
   ____
6. As a future teacher, which types of questions will you use to assess your students? Justify your reasoning.
   ____
   ____
   ____
   ____
   ____

Appendix C- Teacher Survey

Survey for Teachers

Closed question- These tasks ask students to provide one correct answer and usually there is only one correct way to reach that answer. (true/false or multiple choice)
Open ended question-These tasks have many correct answers with various routes to get those answers. They require students to explain their answers, solve non-routine problems, make conjectures, justify their answers, and make predictions.

1. What classes are you currently teaching? Specify grade level.
   ____
   ____
2. What is the most common type of question you give on an assessment?
   ____
   ____
3. What type of question do you think is the easiest for your students? Explain why.
   ____
   ____
4. What type of question do you think is the most challenging for your students? Explain why.
   ____
   ____
5. What type of question(s) do you feel displays an accurate representation of student knowledge? Explain why.
   ____
   ____
6. As a teacher, which types of questions do you use to assess your students? Justify your reasoning.
   ____
   ____
   ____
   ____
   ____

Appendix D- Grading Rubric

	0	.25	.5	.75	1
Question 5	Incorrect	X	Correct examples of integer/non-integer but did not help define integer	X	Correct
Question 6	Incorrect	Correct answer but no diagram or explanation	Correct diagram with no explanation	Correct diagram with explanation but wrong/no answer	Correct diagram and correct explanation
Question 7	Incorrect	X	1 correct example OR 2 correct examples with no explanation	X	Correct
Question 8	Incorrect	X	Reasonable scenario but no explanation	Reasonable scenario with correct explanation but made an incorrect statement	Reasonable scenario and explanation

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