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Assessment Literacy in a Mathematics Classroom

Virginia M. Doran
Governors State University

ASSESSMENT LITERACY IN A MATHEMATICS CLASSROOM

By

Virginia M. Doran

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Abstract

The purpose of this study was to determine the effects of using assessment literacy in a math classroom. This was accomplished by analyzing the test results of students in two different high school Geometry B classes. Both classes were taught the same curriculum, with the same textbook and tests, and by the same teacher. However, assessment literacy techniques were only implemented in one of the two classes. Both classes completed a pre and post-test. The researcher compared the growth of both classes. Results of the study showed that incorporating assessment literacy techniques such as student friendly learning targets, reflection, self-assessment, and peer-assessment increased student growth and achievement in a math classroom. The study recommends that instruction in the techniques of Assessment Literacy should be made part of the professional development of mathematics teachers.

Keywords: assessment, formative assessments, summative assessments, assessment literacy, assessment of learning, assessment for learning, assessment as learning

Assessment Literacy in a Mathematics Classroom Introduction

Beginning with the 2017-2018 school year, the federal educational policy law, "Every Student Succeeds Act" will take full effect (Klein, 2016). This law will require states to submit accountability goals, plans, and interventions, with the purpose of reaching academic indicators based on state testing, English language proficiency, and high school graduation rates. States will have to test students in reading and mathematics in grades three through eight and once in high school. The high school tests must be local or nationally recognized tests, given with state permission and are required to adopt "challenging" academic standards (Klein, 2016). Schools will have to submit their plans and goals to their states, and those schools who are rated in the bottom 5 percent as well as high schools with high dropout rates, will need to come up with evidenced-based comprehensive plans to turnaround low performing schools (Klein, 2016).

State testing and accountability planning is changing the way in which students are taught and tested. In fact modern educators are now replacing the term "testing" with the term, "assessment". To fully understand the concept of assessment, one should begin with the definition of assessment. "Assessment is the process of gathering evidence of student learning to inform education-related decisions" (Assessment Literacy Defined, 2016, para. 1). According to Lorna Earl (2003), an educational author and spokesperson, "The predominant kind of assessment in schools is Assessment of Learning... whose purpose is summative, intended to certify learning and report to parents and students about students' progress… and relative position compared to other students" (p. 3). Marzano (2000) argued that this type of assessment and subsequent reporting as grades and scores has long been accepted in history. However, educational researchers are now

starting to criticize these traditional measurement theories and grades (as cited in Earl, 2003).

In response to the criticism of traditional testing, grade reporting, and assessment of learning, as well the call to help every student succeed, Stiggins coined a new term "Assessment Literacy" (as cited in Bayat & Rezaei, 2015, 2). Assessment Literacy defines new methods and standards which assessment literate educators must understand and practice if they wish their students to progress and become prepared to succeed in the digital age (Stiggins, n.d., 4:16). Assessment literate educators use assessment strategies in the classroom to promote and improve learning. They understand that the evidence gathered from assessments must inform both the teacher and the students. The teacher must be able to take the results of the assessment and let it influence future teaching decisions. The students must be able to understand the results of the assessment to determine where they are in their learning, where they need to be to meet the learning target, and how they are going to get there (Stiggins, 2015).

Assessment of Learning vs.

Assessment for Learning & Assessment as Learning

Many schools and educators are currently only using assessments of learning in their classrooms. Assessments of learning usually consist of summative assessments done at the end of a unit that provide students with a grade or score. These assessments confirm what students know and whether or not they have met learning targets. In addition, they often certify proficiency and help educators make decisions about students' future programs and placements. Assessments of learning provide evidence to parents,

teachers, school administrators, students, and other outside groups such as employers and educational institutions (Rethinking Classroom Assessment, 2006).

Assessments for learning, on the other hand, are done constantly by giving formative assessments throughout a unit. They are considered practice for students and are usually not assigned for a grade. They allow students to see their current level of understanding and receive feedback on their work, which in turn allows them an opportunity to grow. Assessments for learning help to identify "connections students are making, their prior knowledge, preconceptions, gaps, and learning styles" (Rethinking Classroom Assessment 2006, p.1). "Teachers use this information to structure and differentiate instruction and learning opportunities in order to reinforce and build on productive learning, and to challenge beliefs or ideas that are creating problems or inhibiting the next stage of learning" (Rethinking Classroom Assessment, 2006 p. 2). When teachers are conducting assessments for learning, they collect a wide range of data, in order to identify particular learning needs. The timing of "Assessment for learning" is critical. It must occur during the learning, not at the end of the learning (Earl, 2003, p 2). The record keeping involved in assessments for learning is not the traditional grade book. It consists of checklists, artifacts, and portfolios of student work (Earl, 2003, p 2).

"Assessments as learning" make learning a personal affair for each student. Students decide, sometimes with the help of the teacher or another student, about the important evidence of their learning, and its role in choosing their own personal goals, and choice of self corrections and adjustments to their learning (Earl, 2003).

Review of Literature

There are many educational and social groups, which are now devoting much time to providing leadership and resources to support the adoption of the principles of "Assessment Literacy" in American schools today. Such groups include: the National Task Force on Assessment Education and Assessment Literacy; the Assessment Training Institute of Portland, Oregon; the ETS (Educational Testing Service); the NCTE (National Council on the Teaching of English); jff (Jobs for the Future); the Core Collaborative; Teach, Learn, and Grow– the Education Blog, PNAS, the National Academy of Sciences, and the journal, Education Week. Because so many educational and social scholars support these techniques, it is important to present their findings.

According to Pearson's second edition of Classroom Assessment for Student Learning, there are five keys to effective classroom "Assessment for learning." They are: clear purpose, clear targets, sound design, effective communication, and student involvement (Arter J., Chappuis J., Chappuis, S., & Stiggins, R., 2012). This review of literature will discuss all five keys of effective assessments for learning in detail and provide examples of what they look like when present in a mathematics classroom.

The Clear Purpose of Assessment for Learning

The purpose of assessments is to provide answers to the questions of all groups involved in learning: the student, the teacher, the school administrators, and the policy makers (Stiggins, n.d.). Each group has its own questions and the many types of assessments help to answer their questions. Rick Stiggins (n.d.) who is the founder and CEO of the Assessment Training Institute and an advisor to the National Task Force on Assessment Education, explained that understanding is the key word to answering student

questions and that student questions and answers provide the information for all groups involved in assessment activities. Each type of assessment has its own purpose. In his video, "A New Vision in Assessment", Stiggins (n.d.) listed the following types of assessments: Summative Assessments, Formative Assessments, Interim Assessment, Benchmark Assessments, and Diagnostic Assessments. Student scores from these assessments provide answers for the purposes of evaluations, placements, diagnosis, and rankings. However, in order for any type of assessment scores to rise, it is the formative assessments that provide the link and key between the questions and the successful answers. Students must understand what they can do to improve their own work and ultimately their scores and grades. Teachers must be able to identify if students are learning and to provide them with help to reach their goals. Stiggins proposed the question, "Can assessments help our students to realize their dreams?". He answered "definitely". In his video (n.d.), he goes on to suggest that the use of Assessment Literacy techniques will help to achieve society's new directives, as outlined in the "Every Student Succeeds Act" of 2016. Stiggins proposed that effectively using formative assessments for learning will help "narrow achievement gaps, reduce dropout rates, help to achieve universal high school graduation, ensure that all students are ready for college or the workplace, and in other words produce lifelong learners" (n.d.). Stiggins advised that we have a new vision of local excellence in assessment, which contributes to a new school mission that "All become readers, writers, math problem solvers, prepared to succeed in a digital age" (n.d.). This is opposed to the old view that test scores were meant to sort people into categories.

Moving forward with a clear purpose, Stiggins (2015) suggested that all assessments must be balanced. He concluded that balancing assessments means that all levels from summative to formative are important, but the base is the most important. The base is made up of the classroom assessments that are given to students. Stiggins suggested that classroom assessments and decisions should drive all types of assessments forward. He also stated that classroom assessments must be working day to day to help all learners to achieve society's new mission (n.d). He suggested that we must create a "Culture of Confidence", by helping students to believe in their personal success (Stiggins, n.d.).

Other educational researchers have also added their own rationale and purposes for the use of assessments for learning. Lori Shepard, in her address "The Future of Assessment: Shaping Teaching and Learning" (2005), proposed that formative classroom assessments that are given immediately foster new learning. Shepard stated that formative assessments are effective when timed so that the information can be used. The National Council on the Teaching of English (NCTE) added that formative assessments fall into three types that all contribute to the learning cycle: "on the fly"- those that happen during a lesson; "planned for interaction"- those decided before instruction and "curriculum-embedded"- those that are found throughout a unit and gather data at significant points (Formative Assessment that Truly Informs Instruction, 2017). According to Lorna Earl (2003) the role of the teacher in assessment changes according to the purpose of the assessment. If the purpose of assessment is for learning then the teacher becomes a mentor, who provides feedback and support to each student. Furthermore, Earl stated that the teacher is also a guide when she gathers diagnostic information to lead the group

through the classwork (Earl, 2003). This view is opposed to the teacher roles of accountant, reporter, and program director, when the teacher engages in assessment of learning (Earl, 2003).

Clear Targets

Because formative assessments for learning are embedded into the lesson, there must be clear learning targets that the answers to these assessments address. The Exemplars K-12 Website, directed by Ross Brewer and Cornelius de Groot (n.d.) suggested that teachers must first select a task or several tasks for the students to do. They recommended the use of backward design to ensure the units and skills are aligned with local, state, and national standards (Brewer, R., De Groot, C., & Armitage, D., n.d.). This process of backwards design starts with teachers selecting standards that they will assess during a unit and then stating an essential question that addresses the big ideas of the unit. The question should be open-ended and used to engage and focus the students. Teachers should then design a culminating task to allow students to show their answer to the essential question. The task should be multi-faceted and address a wide range of knowledge, skills, and resources and offer opportunities for students to explain how they have used their skills. Next, teachers develop learning and teaching activities to be used throughout the course of the unit. Finally, teachers assess student products and performances (Brewer et al., n.d.). Therefore, backward design calls for the most important skills to be identified first and then the curriculum and assessments can be developed around those skills. Stiggins (n.d.) also explained that the teacher must provide clear examples and models of the end results as well as the process and steps to follow. The Exemplars website described the steps involved for problem solving for a

mathematics class. The clear target of course would be what type of problem the students should be able to solve. However, Exemplars K-12 outlined the following suggested steps one could take when using a formative assessment for learning to problem solve:

1. Read the problem.
2. Highlight the important information.
3. What do you know and need to find out?
4. Plan how to solve the problem: what skills are needed? What strategies can you use? What ideas will help you?
5. Solve the problem
6. Draw and write about your solution and how you solved the problem.
7. Check your answer.
8. Share a connection or observation about this problem.
9. Provide students with a rubric to evaluate their learning.
10. Teacher evaluate the learning with a rubric.

(Brewer et al., n.d).

Sound Design

Although the learner and his activities are the focus of designing assessments for learning, it is the teacher, who must plan the lessons and activities which allow the students to understand what they know, can do, and must do in order to demonstrate their understanding of concepts and improve in order to do their best work. An assessment literate teacher must understand the traits of quality formative and summative assessments. According to Stiggins (n.d.), quality educational assessments must have the following traits.

- Content validity – meaning that the assessment must measure the intended learning target
- Reliability- meaning that all forms of the same test are equivalent
- Fairness- all students regardless of their backgrounds have the same chance to show success
- Student Engagement and Motivation – meaning that the students are motivated to produce their best work
- Consequential Relevance – meaning that the time and effort of taking and scoring the assessment support better student learning

Furthermore, Stiggins (n.d.) described the elements of sound design of formative classroom assessments for learning. He asked the following questions of the teacher, "Which methods match the learning targets? What is an appropriate sample? Are the items, tasks, and scoring rubrics of high quality? Will the assessment yield information that students can use to improve? (Stiggins, n.d.).

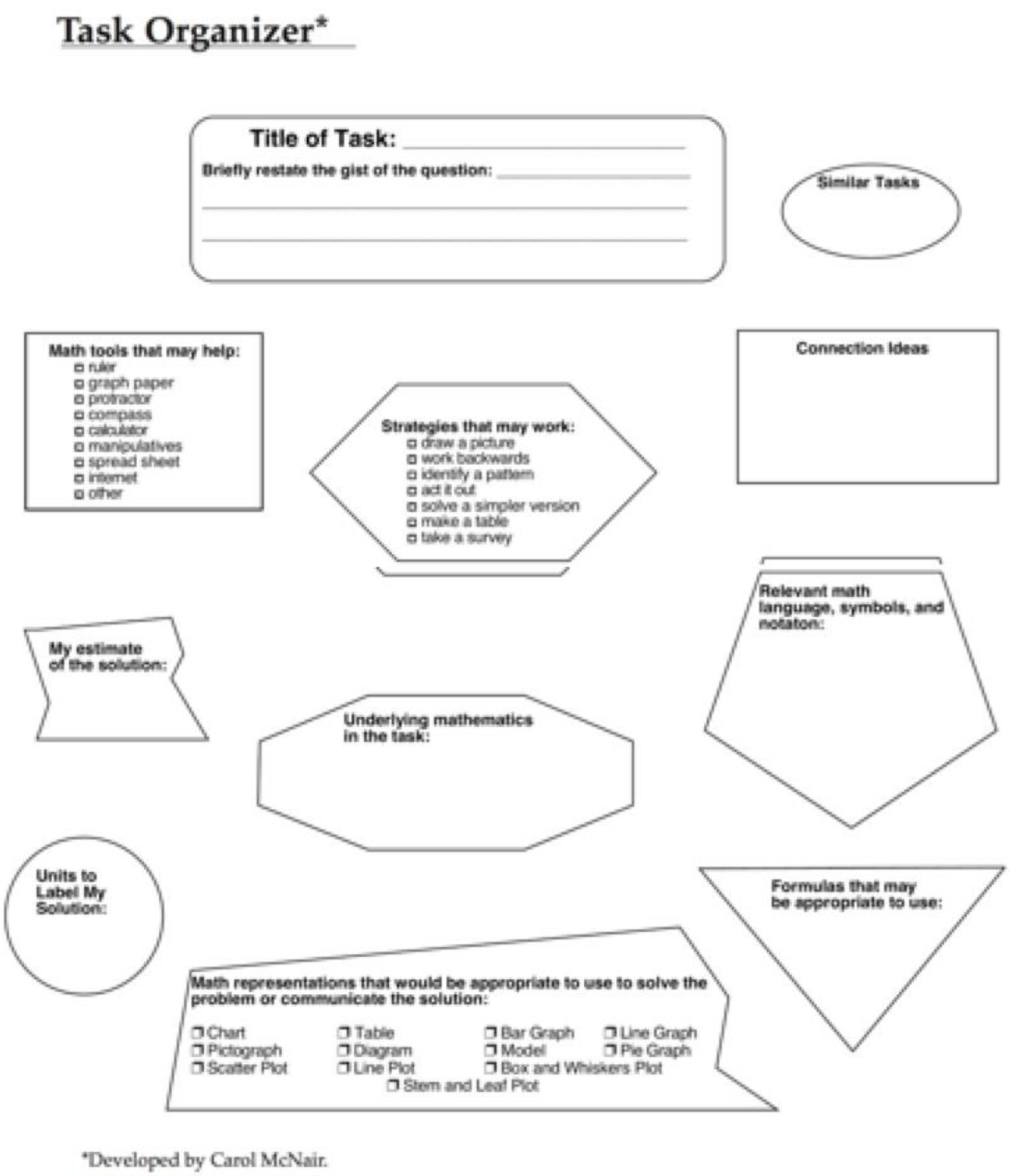
Black and William's (2004) suggested that teachers need professional development focused on teaching them formative assessment strategies (as cited in Shepard, 2005). The strategies that they highlighted included questioning techniques, feedback, sharing criteria, and techniques to elicit student self-assessment. From the article, "Formative Assessment that Truly Informs Instruction," the authors suggested training teachers to use the following tools to document their observations: taking of field notes in journals, computers, or on sticky notes; running records while listening to students read or explain their answers; checklists and observation guides to gather pre-

selected information of behaviors or interactions by making check marks or completing charts (n.d.).

The Exemplars K-12 Website listed three major types of teaching and learning activities that go into sound design of a lesson or assessment. There should be "Introductory activities... to pre- assess student knowledge; Instructional Activities… to provide opportunities for students to demonstrate their skills; Assessment Activities and the Culminating Activity to assess student products and performances" (Brewer et al., 2017). Furthermore, this site gave examples of classic teacher rubrics, which highlight the following: "Understanding- ...how well the student understands the problem; Strategies, Reasoning, and Procedures... Asks for evidence of appropriate mathematical reasoning and applications; Communication...focuses on student's own explanations of solutions... ; Level of Performance… what type of strategies and understandings students exhibit" (p 31-33.) Teachers were also encouraged to select "anchor papers" which are examples of previously scored work. From the Exemplar site, teachers were also given examples of task organizers for the math class. These are graphic organizers, which first ask students to state the task and then check off boxes that indicate the tools that are necessary to complete that task. For example, the list of tools could include a ruler, graph paper, protractor, etc. Next, students check off a strategy to use and demonstrate that strategy in the space provided. Possible strategies include: draw a picture, work backwards, or identify a pattern. Other boxes on the graphic organizer could elicit information such as an estimate of the solution, listing steps to solving the problem, or listing units or formulas needed. Teachers would need to pre-plan these organizers to give to students to help them to be actively involved in the work and to effectively

communicate their understandings (p.50). The following is an example of a plan of a task graphic organizer.

Figure 1



*Developed by Carol McNair.

Effective Communication

In order for the assessment to result in learning and improvement of skills, the results of the class work and formative assessments must be communicated from the student to the teacher and possibly to a peer or group of peers working together. The NCTE article suggested methods to facilitate student/teacher communication, including conversations, surveys, interviews, and conferences (Formative Assessment, n.d.). Furthermore, the teacher must promptly provide feedback to the student and plan and communicate effective strategies to help the student reach his or her goals. Students should track progress and share their successes with others. In D.R. Sadler's research paper titled "Formative Assessment and the Design of Instructional Systems", he stated that when anyone is trying to learn, feedback about their efforts must have three elements, "the desired goal, the evidence about their present position, and some understanding of a way to close the gap between the two" (as cited in Dyer, 2014, para. 2). Stiggins (n.d.) suggested that when students productively respond to results learning occurs. He gave examples of productive responses such as "I understand these results. I know what to do next. I'm OK. I choose to keep trying" (A New Vision Video). Sadler (1989) as cited by Shepard (2005) explained that "feedback is a critical element requiring teachers and students to have a clear vision of the skills to be learned, appraise current student progress, and make clear to students how to improve" (p. 5). Shepard went on to explain that in true formative assessments the questioning and follow-up takes places during class as teachers interact with students during the course of the lesson. Providing an exchange of questions and answers during a lesson is more time efficient than waiting.

Further compelling evidence supported the theory that classroom assessments guide both the students' judgments about what was important to learn and the students' self-perception of confidence to achieve (Shepard, 2005). Stiggins (n.d.) concluded that the emotional well being of students will help them to have control over their own academic well being. He proposed that a student's emotional reaction to results of assessments will determine what the student does next (A New Vision Video). Stiggins further suggested that what students think about assessments is more important than what adults think about them. If a student thinks of himself as slow – he will not take the steps necessary to succeed. Stiggins also proposed some questions which students may ask themselves, "Is the learning worth the energy I must expend to attain it? Is trying worth the risk that I might fail… again… in public?" Stiggins concluded that we must "Create a culture of confidence" for our students (New Vision Video, n,d,).

The type of feedback and the wording of the feedback were also important. Kluger and De Nisi (1996) concluded that depending on the actual feedback, student performance could improve or it could worsen (as cited in Shepard, 2005, p. 9). They concluded that in only one-third of their studies they saw feedback that yielded positive results. These positive examples focused on the important elements of the task or on giving specific guidance on how to improve. Only telling a student his score, grade, or proficiency category was not the type of feedback endorsed by the guidelines of Assessment Literacy. Shepard concluded that day-to-day uses of praise and feedback could shape students' confidence in their abilities as learners. If students are taught that ability can be increased by effort, they are more likely to keep going when faced with difficult academic challenges (Shepard, 2005). Shepard then described the sociocultural

theory of learning, which states that children develop cognitive abilities through social interaction. In various learning contexts, students model supports from adults, peers, and teachers to help them participate effectively in activities. Shepard defined the supporting of activities as scaffolding, where teachers created a classroom culture where students' learning is supported. Shepard (2005) concluded that the research on formative assessments works to support learning by helping students internalize the features of good work and by showing them how to improve their learning.

Student Involvement

The most important person in the learning process is the student himself. Lorna Earl contended that the student was the critical connector between the assessment and the learning process (Earl, 2003). Students who are active, engaged, and critical assessors, can make sense of information, relate it to prior knowledge, and then master the new skills being taught (Earl, 2003). Earl proposed that students posses self-motivation to be able to use their talents and knowledge to make important decisions about their own academic futures. Self-assessment techniques can help students to recognize when they don't understand something and need ways of deciding what to do next (Earl, 2003).

According to Stiggins in his video, A New Vision in Assessment, (n.d.) the 5th key to successful Assessment for Understanding is student involvement. The students need a clear vision of the intended learning, and then must be able to self-assess and set goals for themselves. Then, they must track their own progress, reflect on it, and share their learning progress with the teacher, parents, or peers (Stiggins, n.d.). Lori Shepard (2005) reminded her readers that conclusions from cognitive research support the theory of "meta-cognition" which stated that having students become self-aware improved

achievement. Shepard (2005) goes on to conclude that teaching students to self-assess increases both the quality of student projects and conceptual understanding. Dr. Paul Bloomberg, the Executive Director of the Core Collaborative, presented research from several groups, which supported the theory that self-assessment raised students' achievement significantly (Bloomberg, 2015). He concluded that confidence and self-efficacy played critical roles in self-assessment and goal setting. Rolheiser, Bower, and Stevahn (2000) reported that self-confidence influenced the learning goals set by students as well as the effort put forth to reach these goals (as cited in Bloomberg, 2015). These researchers believed that teachers must teach students how to realistically self-assess and set appropriate goals. Bloomberg suggested three processes of self- assessment: reflection, self-questioning, and feedback.

Pauline Zdonek, in her article at SmartBlog Education (2014), "Helping Students Self-Assess", shared her method of teaching students to self-reflect on a mathematics quiz. She gave the students a chart (a quiz reflection form) for each problem they got wrong. The students needed to rewrite the problem from the quiz (examining the problem), correctly solve the problem (learn to perform the skill correctly), and then state what they did wrong (analyze the problem) (as quoted in Dyer, 2014). Another study by Brookhart, Andolia, Zusa, and Furman (2004) noted several methods of self-reflection, which were used successfully in the mathematics classroom. These authors gave a weekly tool for self-reflection. Some examples included logs, graphs, and reflection sheets (Dyer, 2014).

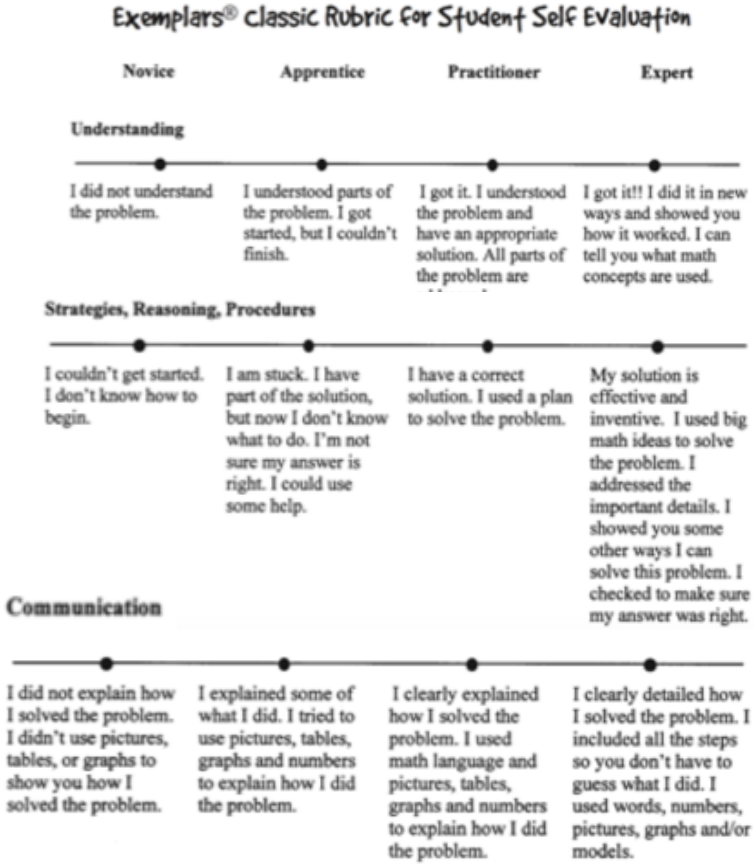
The Exemplars K-12 "Getting started Guide for Math and Science" suggested using a math journal for self-assessment (Brewer et al, n.d.). The students write in a

notebook to answer open-ended questions using numbers, symbols, and words. The students then read and share their journals with a partner, the whole class, or the teacher. Below are some examples of these open-ended questions:

> "Why was this problem easy? Would this problem be easier today than yesterday? Why? What did I do to solve this problem? Are numbers important in solving this problem? Why? Did graphs help me to solve the problem? Why?" (Brewer et al., n.d. p 23)

Armitage (2017), an Exemplars' consultant, developed a rubric (Figure 2) for student self-evaluation. The student chooses a level for three pieces of criteria: Understanding; Strategies, Reasoning, Procedures; and Communication.

Figure 2



Exemplars® classic Rubric for Student Self Evaluation

	Novice	Apprentice	Practitioner	Expert
Understanding	I did not understand the problem.	I understood parts of the problem. I got started, but I couldn't finish.	I got it. I understood the problem and have an appropriate solution. All parts of the problem are	I got it!! I did it in new ways and showed you how it worked. I can tell you what math concepts are used.
Strategies, Reasoning, Procedures	I couldn't get started. I don't know how to begin.	I am stuck. I have part of the solution, but now I don't know what to do. I'm not sure my answer is right. I could use some help.	I have a correct solution. I used a plan to solve the problem.	My solution is effective and inventive. I used big math ideas to solve the problem. I addressed the important details. I showed you some other ways I can solve this problem. I checked to make sure my answer was right.
Communication	I did not explain how I solved the problem. I didn't use pictures, tables, or graphs to show you how I solved the problem.	I explained some of what I did. I tried to use pictures, tables, graphs and numbers to explain how I did the problem.	I clearly explained how I solved the problem. I used math language and pictures, tables, graphs and numbers to explain how I did the problem.	I clearly detailed how I solved the problem. I included all the steps so you don't have to guess what I did. I used words, numbers, pictures, graphs and/or models.

(Brewer et al., n.d. p. 38).

Bloomberg (2015) also suggested the use of color-coding the rubric to demonstrate understanding. He suggested stoplight colors and images. The students choose green = I can do this, yellow= I'm getting there, and red= I need help (p. 2). These can be very simple exit tickets or other feedback to show to the student himself, teacher, and peers to indicate the present level of understanding.

White and Frederickson (2000) demonstrated the importance of engaging students' prior knowledge to support the understanding of new learning to enable the transfer of knowledge (as cited in Shepard, 2005). Shepard also postulated that assessment processes connected directly to questions such as where am I now and where do I want to go? Figure 3 portrays the Exemplars K-12 KWL chart for assessing prior knowledge.

Figure 3

KWL chart pg. 52

What I **Know**	What I **Want** to Know	What I **Learned**

(Brewer et al., n.d., p, 52).

Finally, after allowing students to self-assess and collecting samples of their work, the teacher organizes the student samples and assesses the student needs. Figure 4

on the next page is an example of a teacher's rubric used to organize student assessments, provided by the Exemplars K-12 website on pg. 49.

Figure 4

Exemplars Level	Problem Solving	Reasoning and Proof	Communication	Connections	Representations
Novice					
Apprentice					
Practitioner					
Expert					

Comments:

Grade Level

Student's Name: _____ Date: _____

(Brewer et al., n.d., p 49).

According to O'Connell and Vandas (2016) in "The Art of Teaching Feedback," "when teachers solicit and analyze feedback, instruction and student learning can dramatically improve" (p.1). O'Connell and Vandas (2016) also concluded that "student-to-student communication in the classroom trump teacher communication to students" (p. 1.). In most classes there is only one teacher and many students. Unless the teacher has worked before class to provide individualized feedback, the students need to utilize others to receive timely feedback. Assessment Literate teachers are now relying on classroom peers to provide feedback through "Peer assessment." According to Brooke and Andrade (2013) "peer assessment is simply a matter of students giving informed feedback to one another on an assignment" (p.1). They go on to say that peer assessment happens during the learning process and then using the "works-in-progress" feedback students can revise their work. Brooke and Andrade mapped out a schedule for teachers when utilizing peer assessment. They listed the following steps:

1- Teacher groups the students into small peer feedback groups
2- Teacher models effective peer feedback for students
3- Students receive a checklist or document that reminds them how to deliver effective peer feedback.
4- Teacher clarifies the assignment for the students.
5- Teacher actively monitors the progress of the peer feedback groups.
6- Teacher monitors the quality of the feedback.
7- Peer feedback is checked for reliability. (p.1).

Students need to be taught how to give feedback. They also need to be given models, charts, or checklists to record their feedback. Brooke and Andrade provided a model (Figure 5), entitled the "Ladder of Feedback", based on the words of Perkins (2003).

Figure 5

(Perkins, 2003 as cited in Brooke & Andrade, 2013, p. 2).

According to O'Connell and Vandas (2016), 80% of daily feedback students receive is from peers, and 80% of the time the feedback is inaccurate. Students should be taught how to give, receive, and reflect upon this feedback. They suggested the use of

feedback exchange frames in which students are taught the necessary language to provide feedback. Table 1 lists potential exchange frames that students may wish to learn.

Table 1

Giving	Receiving
I noticed that	I appreciate you noticing that ....
I wondered about	I hadn't thought about that ...
I was confused by	I heard you say _____ confused you.
I suggest that	Based on your suggestion, I will ....
Have you thought about....	Thank you, what would you do?
You might consider...	I'm not sure what that looks like, tell me more

(O'Connell & Vandas, 2006, p. 2).

According to Dyer (2014), research on the self-regulation of learning, which included both self-assessment and self-monitoring, supported the conclusion that students who engaged in these activities were more likely to have a sense of empowerment and autonomy in their learning. She quoted a study published by the *British Journal of Educational Psychology* (1996), which monitored an eight-month program conducted by 25 primary school teachers, who implemented self-assessment strategies in their classrooms. They concluded that when students were provided with regular opportunities to use self-assessment techniques, they were more likely to believe that they could impact their own learning. They were less likely to attribute success or failure to other reasons (as cited in Dyer, 2014). Dyer (2014) also referenced another study conducted in 2004 by Brookhart, Andolia, Zusa, and Furman called "Minute Math: An action research study of student self-assessment". In this study students were provided with self-monitoring tools including logs, graphs, and reflection sheets. After analyzing their reflection sheets, it was noted that when students became more autonomous, they could accurately predict

their own success on upcoming exams. Overall, students indicated that they enjoyed the self-assessment process, which helped them to acknowledge the value of their own studying to improve their performance on assessments (as cited in Dyer, 2014).

Conclusion and Summary

In conclusion, the research supported the conclusion that the incorporation of the techniques of "Assessment Literacy" into classroom instruction resulted in the improvement of student learning and contributed to a sense of self-ownership of learning and enjoyment in the process. There is a present critical need to change the negative climate created by the era of high-stakes testing, which has been shown to have negatively impacted teaching and learning, and resulted in increased dropout rates by minority students (Madaus and Clarke, 2001). One strategy to implement this change is to provide professional development for teachers in the area of Assessment Literacy. Teacher professional development programs are now needed to teach techniques and strategies to help all students succeed.

Assessment Literacy advocates that assessment for learning is its most important objective To ensure that formative assessments can help all students to become readers, writers, math problem solvers, and to succeed in the digital age, schools must ensure that formative assessments are developed and administered for clear purposes and reach clear learning targets. They must be soundly designed and embedded in lessons, which allow and teach effective communication skills and engage and support student involvement in the learning process and in their future academic decisions.

Study of Assessment Literacy in a Mathematics Classroom

The purpose of this study was to determine the effects for students in a Geometry B level mathematics class at the high school level, when the learning was differentiated to correspond to the techniques of "Assessment Literacy".

Significance of the Study

This study is significant because it may help teachers of mathematics to improve their instruction and increase student progress toward mastering the learning targets by implementing the techniques of assessment literacy.

Method of the Study

Assessment literacy techniques were applied in a low-level Geometry class during the 2015-2016 school year at Lake Park High School in Roselle, Illinois. The class consisted of mostly juniors and seniors. These students had previously completed a year of pre-algebra and a year of double period algebra. Each day the students came to class and student-friendly learning targets were written on the front board. The teacher referred to them at the start of class so students were aware of the goals for that particular day. In addition, the teacher asked students to take out their goal progress sheet and complete a self-assessment. Figure 6 is an example is located below. Students were instructed to read the daily goal and rate themselves in the column labeled "Rating 1" with the appropriate smiley face for the goal. The teacher then proceeded with the lesson and notes for the day. After the lesson, students rated themselves based on the daily goal again. This time students recorded their rating in the column labeled "Rating 2". When the class finished the unit of study, students rated themselves one more time in the column labeled "Rating

3". The teacher encouraged students to look at the progress they made from the beginning so that students could gain confidence before the unit test. Also, the teacher stressed that any low ratings should guide the topics that students study when preparing for the unit test. Any daily goals that were marked with a frown face or neutral face in the "Rating 3" column should be studied, practiced, and mastered before the unit test to have a better chance of success.

Figure 6

***GEOMETRY**
UNIT 3

NAME_____

Goal Progress:

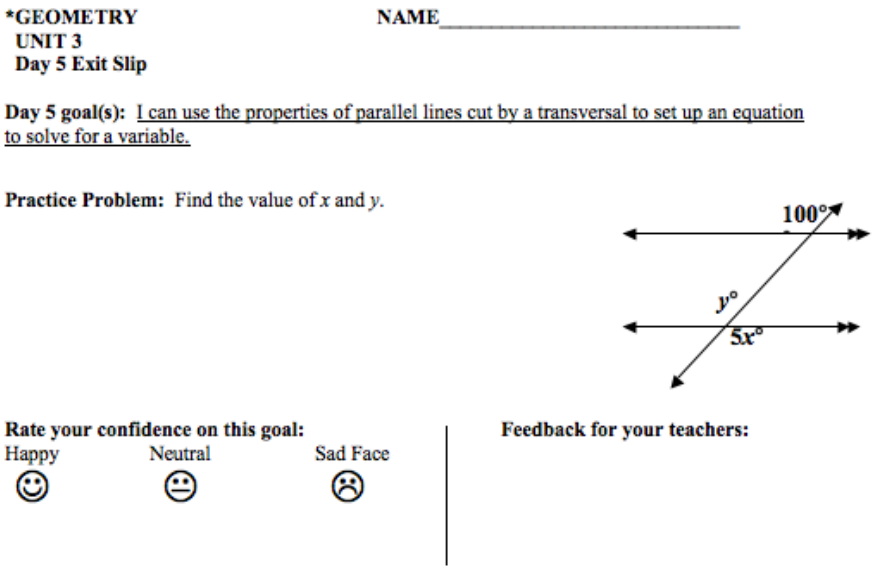
Rate yourself on each goal using a happy, neutral, or sad face.

DAY	DAILY GOALS	RATING 1	RATING 2	RATING 3
1	I can determine if two lines are parallel, perpendicular, neither, or the same line by calculating the slopes of the lines.			
1.5	I can determine if two lines are parallel, perpendicular, neither, or the same line from the equations of the lines.			
2	I can find the measure of an angle using the properties of parallel lines cut by a transversal.			
3	I can find the measure of an angle using the properties of parallel lines cut by a transversal.			
4	I can use the properties of parallel lines cut by a transversal to set up an equation to solve for a variable.			
5	I can use the properties of parallel lines cut by a transversal to set up an equation to solve for a variable.			
6	I can prove when two lines are parallel based on the information given.			
7	I can use the theorems about perpendicular lines to set up an equation to solve for a variable.			
8	I can use the theorems about perpendicular lines to set up an equation to solve for a variable.			

The underlined daily goals above are the topics that you will see on your mastery test.

In addition to the goal progress sheet, the teacher used formative assessments in the form of daily exit slips. At the conclusion of the lesson, students were handed an exit slip with the daily learning goal(s) listed, a practice problem, a space to rate their understanding of the daily learning target, and a section for feedback for the teacher. A sample exit slip is shown in Figure 8 below.

Figure 7



***GEOMETRY** **NAME**_____
UNIT 3
Day 5 Exit Slip

Day 5 goal(s): I can use the properties of parallel lines cut by a transversal to set up an equation to solve for a variable.

Practice Problem: Find the value of x and y.

Rate your confidence on this goal:
Happy Neutral Sad Face

Feedback for your teachers:

Students turned the exit slips into the teacher daily. The teacher checked answers on the exit slip and took the results of the answers and ratings as well as the feedback into account when planning the next day's lesson. Students who struggled with the practice problem were often paired with a student who was confident on the daily learning goal at the beginning of class the next day. The stronger student was instructed to coach the struggling student through his or her mistakes by giving them feedback. The coach was instructed to give feedback on what the student did strongly, where the student made mistakes, and how the student could fix these mistakes. Once the struggling student

understood the mistake, he or she was required to redo the practice problem. The teacher received comments in the feedback section such as “Can you slow down?”, “I need more practice”, “I’ve got this!”, and “Can you move my seat to the front?”. The teacher was able to differentiate her lesson to the next day to accommodate the needs of students at different levels. Confident students were often given the option to help a struggling student to start class or to work on an extension problem. Extension problems were based off the previous day’s learning targets but required the student to think deeper about those targets, combine that knowledge with a previous topic, or apply the target to a real-world application. The teacher regularly discussed the rating section of the exit slips with students. She talked about what students could do if they had a sad or neutral face for a rating. The class discussed that sad or neutral faces would require the students to practice more or come in to get help from the teacher outside of class time. The teacher encouraged students to try to improve their ratings so they could gain confidence before the unit test.

Design of the Study

The teacher administered a pre-test at the beginning of the school year that consisted of 14 multiple-choice questions that targeted the daily learning goals (See Appendix A). The teacher gave the same test at the end of the semester as a post-test (See Appendix B). She compared the pre- and post-test scores to determine student growth during the semester. Furthermore, the teacher compared the growth of two different classes. The first class was taught during the first semester of the 2014-2015 school year and assessment literacy techniques such as the goal progress forms and exit slips were not used. The second class was taught during the first semester of the 2015-2016 school year

and included the assessment literacy techniques previously described in the methods section of this paper.

Results and Analysis of the Data

In the 2014-2015 Geometry class, assessment literacy techniques were not used. In the 2015-2016 school year, the assessment literacy techniques described above were applied. The 2014-2015 class averaged a 59% on the pre-test and increased their average to a 75% on the post-test. On the other hand, the 2015-2016 class started with a 53% average on the pre-test. This score showed that these students had less prior knowledge than the 2014-2015 class when beginning the Geometry curriculum. The 2015-2016 class increased their class average to 83%. This data shows that the students in 2014-2015 Geometry group only increased their test scores by 16% where as the students in 2015-2016 Geometry increased their test scores by 29%. Both groups of students were taught the same curriculum by the same teacher. The only difference between the groups was the addition of assessment literacy techniques such as daily learning goals, formative assessments, self-assessment, and feedback from both the student and peers in the 2015-2016 class. The tables on the next page show the scores and growth of individual students in each of the two classes.

Table 2

Geometry B First Semester 2014/2015 Data Taught without Assessment Literacy			
Student	**Pre-test Score**	**Post-Test Score**	**Percentage Growth**
Student 1	64%	71%	7%
Student 2	71%	86%	15%
Student 3	57%	71%	14%
Student 4	29%	64%	35%
Student 5	29%	71%	42%
Student 6	64%	71%	7%
Student 7	64%	57%	-7%
Student 8	43%	71%	28%
Student 9	93%	86%	-7%
Student 10	50%	100%	50%
Student 11	93%	86%	-7%
Student 12	64%	93%	29%
Student 13	50%	43%	-7%
Class Averages	**59%**	**75%**	**16%**

Table 3

Geometry B First Semester 2015/2016 Data Taught with Assessment Literacy			
Student	**Pre-test Score**	**Post-Test Score**	**Percentage Growth**
Student 1	36%	71%	35%
Student 2	50%	93%	43%
Student 3	79%	93%	14%
Student 4	79%	100%	21%
Student 5	36%	71%	35%
Student 6	71%	93%	22%
Student 7	57%	86%	29%
Student 8	29%	64%	35%
Student 9	50%	93%	43%
Student 10	57%	57%	0%
Student 11	29%	79%	50%
Student 12	64%	86%	22%
Class Averages	**53%**	**82%**	**29%**

On the following page, Tables 4 and 5 display an item analysis of each question that shows the number of students who chose the correct answer on both the pre- and the post-test. There is also a difference column that exhibits how many more students got the question right on the post-test versus the pre-test. Following the item analysis, Table 6 lists each question number on the pre and post-test and the learning target that corresponds to each question. In the 2014-2015 school year, on average 1.857 more students marked the correct answer on each post-test item in comparison to the pre-test. In the 2015-2016 school year, on average 3.5 more students marked the correct answer on each post-test item in comparison to the pre-test. These averages show that the class who received an assessment literacy filled curriculum in the 2015-2016 school year was able to have almost double the amount of students answer each item correctly on the post-test than the pre-test. When analyzing each individual item, the results show growth from the 2014-2015 class to the 2015-2016 class on nine out of fifteen questions. The specific questions that did not show growth are problems one, six, seven, nine, and twelve. The researcher believes these problems may not have shown growth since the majority of students answered them correctly on the pre-test. These questions can be seen in the appendix. The students had some previous knowledge of each of these questions and may have been able to eliminate multiple-choice answers that did not make sense. Students could have made an educated guess without doing the actual math or going through the thought process that was required to calculate the answer. For example, item one on the pre- and post-test gave the student the entire length of $\overline{AC}$ is 10. The student was also shown that $\overline{AB} = 2$. Students could have looked at the diagram and reasoned that $\overline{BC}$ was

shorter than 10 and longer than 2. The only reasonable answer choice listed was 8, which happened to be the correct answer.

Table 4

Geometry B First Semester 2014/2015 Item Analysis of Pre and Post-Test Taught without Assessment Literacy			
Question	**# of Students with correct answer on Pre-test**	**# of Students with correct answer on Post-test**	**Difference**
# 1	9	13	4
# 2	7	11	4
# 3	9	12	3
# 4	7	8	1
# 5	8	10	2
# 6	8	11	3
# 7	3	9	6
# 8	8	9	1
# 9	9	3	6
#10	9	11	2
# 11	7	11	4
#12	10	12	2
#13	10	9	-1
# 14	4	5	1
Average	**7.714**	**9.571**	**1.857**

Table 5

Geometry B First Semester 2015/2016 Item Analysis of Pre and Post-Test Taught with Assessment Literacy			
Question	**# of Students with correct answer on Pre-test**	**# of Students with correct answer on Post-test**	**Difference**
# 1	9	12	3
# 2	10	11	1
# 3	7	11	4
# 4	6	8	2
# 5	8	12	4
# 6	8	10	2
# 7	5	8	3
# 8	3	10	7
# 9	7	8	1
#10	4	11	7
# 11	5	10	7
#12	9	8	-1
#13	6	11	5
# 14	2	8	6
Average	**6.357**	**9.857**	**3.5**

Table 6

Question	**Student Friendly Learning Targets**
# 1	Given the length of a line segment, I can solve for a missing piece of that line segment.
# 2	Given two congruent segments, I know the segments are equal in length.
# 3	I can use the Law of Syllogism to draw a conclusion from a pair of statements.
# 4	I know that vertical angles are congruent. I know that complementary angles add to 90 degrees.
# 5	I can classify pairs of angles that are formed by two parallel lines crossed by a transversal.
# 6	I can determine if two lines are parallel, perpendicular, neither, or same line from the equations of the lines.
# 7	Given two points, I can find the slope.
# 8	I can compare slopes to determine whether two lines are parallel, perpendicular, or neither.
# 9	I can determine if two lines are parallel, perpendicular, neither, or same line by calculating the slopes of the lines.
# 10	Given a triangle, I know "If sides, then angles".
# 11	Given two congruent triangles, I know CPCTC. I know all three angles in a triangle add to 180 degrees.
# 12	Given two similar triangles, I can set up a proportion to solve for a missing side.
# 13	Given two points, I can use the midpoint formula to find the midpoint.
# 14	Given two points, I can use the distance formula to calculate distance.

Conclusions

The results demonstrated that the students who were exposed to a curriculum involving assessment literacy were able to show more growth from the pre-test to the post-test than those students who received the same curriculum without assessment literacy. This study showed that assessment literacy techniques in a mathematics classroom were a benefit to student learning. When daily learning targets were presented

to students at the beginning of class and were stated in student friendly language, students easily comprehended what they were expected to understand at the end of class. Self-reflection sheets helped students to track their progress, gain confidence, and realize when there was room for improvement. Daily formative assessments allowed students to practice the daily learning goals in a "safe" environment. These assessments allow students to make mistakes and learn from them before they took a quiz or test that affected their grade. In addition, formative assessments provided feedback to the teacher. The student work, reflection, and feedback from formative assessments may help the teacher to differentiate the lesson the next day based on individual student need. In conclusion, assessment literacy techniques are a necessity in today's mathematics classrooms. Mathematics is often a subject that causes stress and anxiety to students. Assessment literacy allows students to track their own progress, which makes mathematics an approachable subject. To implement these learning techniques, teachers will need more professional development on the topic of assessment literacy so there can be improvement in teaching and learning in mathematics classrooms in the future.

Recommendations

In the future, the researcher in this study would like to incorporate more opportunities for peer-assessment into her classroom. Peer-assessment allows personalized feedback to be given to each student in a timely manner. She plans to implement this by creating a peer-feedback form to go along with her exit slips so that students can identify each other's mistakes and learn from them. The peer feedback form will be given to students the day after they complete an exit slip. They will use the peer feedback form to critique a classmate's work on the exit slip. The top half of the form

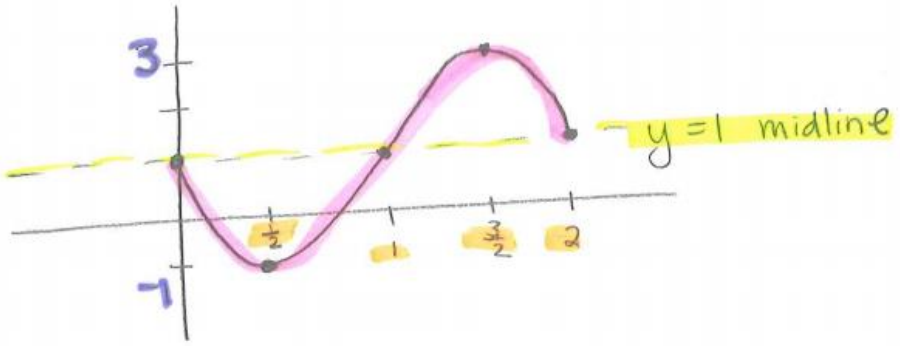
will consist of an identical copy of the exit slip that students completed. However, this exit slip will have the complete solution to the problem. The bottom half of the form will have blank lines where students can fill in success criteria. Success criteria are all the components that a teacher would be looking for if she was checking the problem. The class together will discuss what the success criteria looks like for the problem. This discussion will serve as a review of the vocabulary. Once the success criteria is determined, the students will fill in each component that will lead to success on the blank lines. Those components are what each student will receive feedback about. Students can easily circle the smiley face or the frown face to indicate whether the student has successfully fulfilled that piece of criteria. Then students can elaborate on the blank lines below to give more feedback about what exactly the student did well, what they need to improve upon, and exactly how they can improve. An example of a completed Precalculus peer-feedback form is shown on the next page . This form would be helpful when teaching students to graph trigonometric functions. The form (Figure 8) is color-coded to show where each piece of success criteria appears on the graph in the answer key.

Figure 8

***PRECALCULUS** **Answer Key & Peer Feedback Form**
7.4 Day 11 Exit Slip

Day 11 goal: I can graph a sine and cosine function.

Practice Problem: **Graph** $y = -2\sin(\pi x)+1$.



Rate your confidence on this goal:

Happy ☺ Neutral 😐 Sad Face ☹

Feedback for your teachers:

Success Criteria: for Student #1's Work
Worked checked by: Ginny Doran

Circle One

1. midline ☺ ☹
2. shape of graph ☺ ☹
3. period / tick marks ☺ ☹
4. amplitude ☺ ☹

Comments:

Great job on midline, shape, & period! For amplitude make sure you count 2 up + down from the midline. It looks like you counted from the origin.

The researcher would also like to continue to educate other teachers on implementing assessment literacy in their classrooms. She is already part of the assessment literacy team at Lake Park High School. This team works together to educate their fellow colleagues on assessment literacy. So far they have trained two cohorts and meet with them frequently throughout the school year to check in and discuss their progress. The researcher would like to expand beyond her school to other schools and universities. She would like to educate teachers on the benefits of assessment literacy in all types of classrooms at all grade levels. She hopes to begin by presenting her findings at an NCTM (National Council of Teachers of Mathematics) or ICTM (Illinois Council of Teachers of Mathematics) conference in the near future. Hopefully, by spreading the word about assessment literacy, we can continue to improve teaching, learning, and student achievement.

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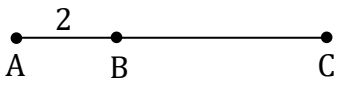
Appendix

Geometry B **Name**_____
First Semester Pre/Post-Test
Form A

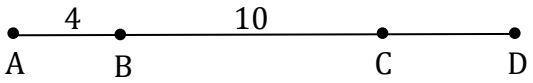
1. Given $AC = 10$. Find BC.



A. 8
B. 10
C. 12
D. 20

2. Given: $\overline{AB} \cong \overline{CD}$. Find BD.

A. 4
B. 10
C. 14
D. 18



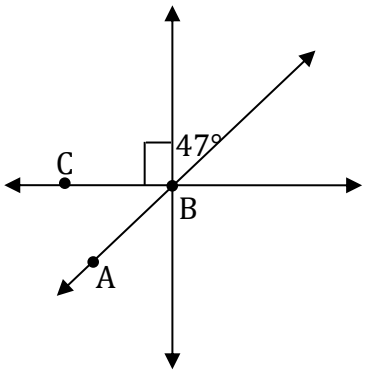
3. Use the Law of Syllogism to draw a conclusion from the following statements:

If Tony does not wake up, then he cannot go to work.
If Tony cannot go to work, then he will not get paid.

A. If Tony does not wake up, then he will not get paid.
B. Tony will get paid.
C. If Tony wakes up, then he will get paid.
D. If Tony does not go to work, then he will get paid.

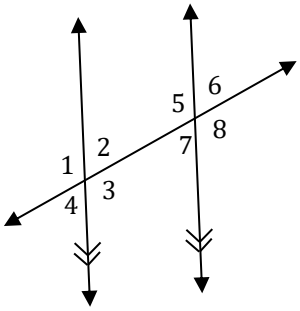
4. Find the measure of $\angle ABC$.

A. 43°
B. 47°
C. 90°

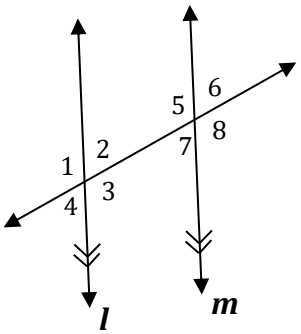


D. 133°

5. Which of the following can be used to classify $\angle 1$ and $\angle 8$ as an angle pair?
   A. Alternate Interior Angles
   B. Alternate Exterior Angles
   C. Corresponding Angles
   D. Vertical Angles



6. If $m\angle 4 = 25°$, determine the measure of $\angle 7$ if lines *l* and *m* are parallel.
   A. 25°
   B. 65°
   C. 115°
   D. 155°



7. Find the slope of the line containing the points (1, 7) and (3, 4).

   A. $-\frac{3}{2}$

B. $-\frac{3}{4}$

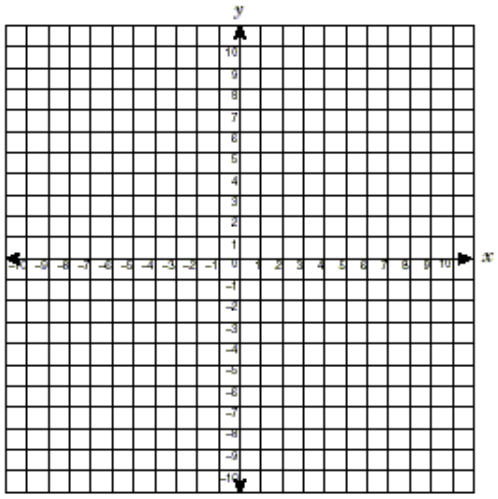
C. $\frac{2}{3}$

D. $\frac{11}{4}$

8. Are the lines $y = 3x - 4$ and $y = -\frac{1}{3}x + 4$ parallel, perpendicular, neither or the same line?
   A. Parallel
   B. Perpendicular
   C. Neither
   D. Same line

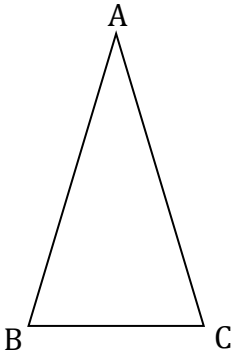
9. Find the slopes of $\overline{AB}$ and $\overline{CD}$. Which of the following conclusions are true about the two lines?

   A = (4, -3) and B = (1, -7)
   C = (6, -7) and D = (9, -3)



   A. $\overline{AB}$ and $\overline{CD}$ are parallel.
   B. $\overline{AB}$ and $\overline{CD}$ are perpendicular.
   C. $\overline{AB}$ and $\overline{CD}$ intersect at one point.
   D. There is not enough information.

10. Given ΔABC, find the value of ***x*** if $\overline{AB} \cong \overline{AC}$, $m\angle B = (2x + 22)^\circ$, and $m\angle C = (5x - 8)^\circ$.

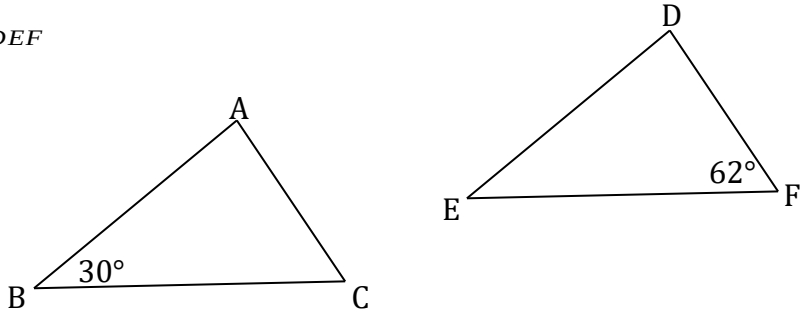


   A. 2
   B. 10
   C. 23.7
   D. 42

11. Given: $\triangle ABC \cong \triangle DEF$

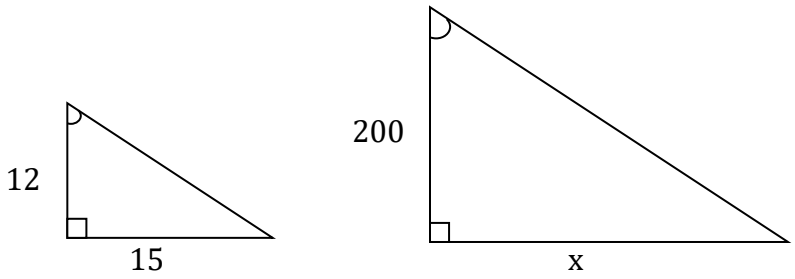
Find: $m\angle A$

A. 32°
B. 88°
C. 92°
D. 268°



12. The triangles below are similar. Find the value of x.

A. 0.9 ft
B. 160 ft
C. 188 ft
D. 250 ft



13. Use the formula $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ to find the midpoint $\overline{AB}$.

A = (2, 3) and B = (8, 11)

A. (5, 7)
B. (3, 4)
C. (2.5, 6.5)
D. (10, 14)

14. Use the formula below to find the distance between $(-2,5)$ and $(3,-7)$.

$$d=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

A. 12
B. 13
C. 119
D. 169

Governors State UNIVERSITY

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To:	Dr. Dianna Galante and Virginia Doran
From:	Institutional Review Board – Governors State University –
	Larry Maucieri, PhD, ABPP-CN, Board Member
CC:	Fatmah Tommalieh
Date:	October 2, 2017
Re:	Formative assessment with self-assessment
Project Number:	17-08-06

We are pleased to inform you that your proposal has been approved by the GSU Institutional Review Board. Please be advised that the protocol will expire on October 2, 2018, one year after the date of approval.

At the end of the year, if your research is completed, please inform the IRB in writing of the closing date by using the IRB Annual Review form, which can be found at www.govst.edu/irb. If you intend to collect data using human subjects after that date, the proposal must be renewed by the IRB. If you make any substantive changes in your research protocol before that date, you must inform the IRB and have the new protocol approved.

Please include the exact title of your project and the assigned IRB number in any correspondence about this project.

Best wishes for success with your research.