Augmenting Grades with Competencies: Examples from the Surrey Portfolio Pathway Partnership

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Abstract  
This paper argues that schools should, in future, report student success not only through grading but also through the mapping of student competencies. It begins with a brief summary of the related changes taking place in several Canadian provinces, the problems they (and competency-based education in general) are responding to, and the nature of competency-based education (CBE) itself. After this background is established, we discuss a partnership program in which we developed, with the help of secondary students, a set of example artifacts that show some of the potential of competency-based education.

Keywords  
postsecondary admission; competency; postsecondary transition

How Did We Get Here?  
In the 1700s, there was no widely adopted grading system because relatively few people sought formal schooling (Sturgis, 2014). This began to shift when colleges started to consider competition an important part of their admissions processes. This practice then worked its way into the secondary and primary school systems and became the norm by the mid-1800s. The rapid expansion of public education in Canada and the United States only further entrenched this way of understanding achievement.
The use of letter or number grades to indicated levels of student achievement, referenced either to a peer group (norm referencing) or a standard (criterion referencing). These grades provided a number of important benefits to a 19th century education system in the midst of historic expansion. First, these grades provided a shared language of achievement. Large, complex systems need shared ways of communicating information in simple terms. Secondly, they provided a way to make straightforward distinctions between student achievement levels. This was, presumably, what made such a system interesting to college admissions officers in the first place. It is not difficult to see why, to this day, postsecondary institutions might prefer letter grading to essentially any other system (see Burns, 2018).

This simplicity is, of course, deceptive. Each Canadian province has its own reporting policies, which are interpreted by school boards, school administrators, and each classroom educator. Setting aside provincial, regional, and school-based variation, each teacher will still construct their classroom assessments differently and will leave their own imprint on their students’ grades. In a more technical sense, grades also risk incentivizing the wrong kind of behaviour. Kitchen et al. (2006), for example, argue that grades “can loom large under the traditional grading system as students struggle toward mastery, causing them to be reluctant to take the risks necessary to acquire such skills” (p. 270). Since true mastery of a skill requires a certain amount of failure, and since conventional grading punishes failure, students might thereby be discouraged from taking the risks true education requires. The system becomes more about teachers distributing “points among assignments and desired behaviors” (Sturgis, 2014, p. 10) and less about encouraging deeper mastery. From a systemic perspective, grades can also discourage students from pursuing certain careers or interests. If a student’s grades do not meet certain requirements, the student may change their future course of study, or even avoid enrolling in a program completely (Main & Ost, 2014). It is to address these shortcomings, among others, that British Columbia has been changing the way it articulates student achievement.

Changes in BC’s Education System

At the time of writing, British Columbia is completing the final stages of a decade of curricular reform—a large portion of which has been devoted to preparing students for an evolving, and often unpredictable, future. This future requires both that we emphasize the skills we are confident will be needed in the future—such as environmental impact, proficiency with emerging technologies, personal and social awareness and responsibility, and an understanding of Aboriginal perspectives—as well as skills needed for an unpredictable future, such as adaptability, a mentality of lifelong learning, and creative problem-solving skills (Davies et al., 2011).

One of the central features of this reform is that it is competency-driven, in the sense that the top-level organizing concepts of the curriculum are the new “Core Competencies” (British Columbia Ministry of Education, n.d.). These competencies are communication, creative thinking, critical thinking, positive personal and cultural identity, personal awareness and responsibility, and social responsibility. These broad headings are then manifested through “curricular competencies,” which are the learning outcomes of the new system. It is proficiency in these competencies, rather than achievement of high number or letter grades, that the reformed system seeks to encourage.

Similar priorities can be seen in Nova Scotia, where the Nova Scotia School Board Association outlines its approach in Shaping a New Vision for Public Education in Nova Scotia. There they state that the competencies their students will need are “creativity, innovation, and
entrepreneurship, critical thinking, collaboration, communication, character, cultural and ethical citizenship, computer and digital technologies” (Nova Scotia School Board Association, 2014, p. 3). New Brunswick follows a similar path, where the “21st Century School initiative has recently begun and has as objectives to define, promote and focus upon 21st-century skills; create innovative learning environments; and to provide ubiquitous access to technology in classrooms” (Ananiadou & Claro, 2009, p. 12). Québec’s approach “encompasses nine cross-curricular competencies in four categories” (Ercikan & Oliveri, 2016, p. 23) that reflect a number of 21st-century skills and competencies. These four categories of competencies are: personal and social competencies (adopts effective work methods, uses information and communications technologies); intellectual competencies (uses information, solves problems, exercises critical judgment, uses creativity); and communication-related competency (communicates appropriately)” (Ercikan & Oliveri, 2016, p. 23). The goal, in each of the provincial contexts noted, is to shift students away from linear progression of conventional grades and towards a more fluid and dynamic progression in pursuit of proficient competency.

**Competency-Based Education**

Competency-based education (CBE) revolves around the mastery of competencies. Under a CBE system, one of the key conceptual shifts is that the intended outcomes (competencies) are not necessarily linked to a single discrete course—instead, many competencies can be developed in different disciplines from the ones from which they “originate” (Bristow & Patrick, 2014; Gervais, 2016). To illustrate this, we can use the example of public speaking. While a competency pertaining to public speaking might originally sit in the curriculum of an English course, it can be demonstrated through a number of other experiences, such as through a presentation in Psychology or a debate in Social Studies. This openness may also apply to experiences outside of the classroom—such as that same student working as a camp leader (and thus building a portfolio of successful public speaking experiences).

Within CBE models, students are the drivers of their own learning (Broderson et al., 2017; Gervais, 2016; Patrick & Sturgis, 2013; Phillips & Schneider, 2016). They are encouraged to explore areas they find interesting or are passionate about, and to acquire and demonstrate their skills within those areas. CBE often places less emphasis on time constraints, “recognize[ing] that not everyone learns at the same time or pace” (Gervais, 2016, p. 99). Students move on to more challenging competencies once they have mastered previous ones, and graduate from courses when they have mastered the competencies within them.

CBE utilizes both formative and summative assessments (Gervais, 2016). Formative assessments measure learning up until a certain point, allowing students to gauge where they are, while summative assessments are “final” assessments summing up students’ achievements, determining whether or not they can move on to the next level of development in that area. The central summative goal of assessment within CBE is the certification of competencies. Because of this, assessments in CBE will often take the form of “badging” systems, wherein competencies are certified, recorded, and collected. While teachers may set particular competency goals for given assignments, a more open planning process might also be employed. CBE, at its most innovative, encourages students to explore the cross-curricular competencies they can gain through various projects.

Portfolios have proven to be a powerful tool in the assessment of competencies. They afford students opportunities to reassess their work and continuously improve with frequent self-
reflection and teacher feedback (Hattie & Timperley, 2007; Hill & Barber, 2014; Schuwirth & Ash, 2013). They can also provide a record of evidence for their teachers’ certification of their various competencies. That record could be drawn upon in future applications to the workforce or postsecondary institutions (see Burns, 2018).

Orienting an education system to competencies can open avenues for non-traditional students to succeed. At-risk students, for example, can benefit from CBE because it “increases the likelihood of graduation for students at risk of dropping or aging out by offering an alternative, self-paced system of instruction for reaching graduation” (Tomasello & Brand, 2016, p. 1). For these students, grades can be a major barrier to their academic success. Factors such family life, mental and physical health, financial matters, and the like, can have a devastating impact on a students’ grades, making those grades of limited value in articulating authentic student achievement (Guskey, 2006; Lash, 2016). CBE allows each competency to stand on its own, and therefore represents a more strength-based approach.

Despite the benefits of CBE, there are limitations that create barriers for implementation. One such limitation is the lack of a “common definition of proficiency,” in other words, a lack of standardization. Because of this, a major barrier in implementing CBE is that its assessment models are often not yet recognized by postsecondary admission systems. Portfolios, for example, are generally not used for university admission in British Columbia (outside of a few limited examples, such as schools of design). This kind of standardization would of course require substantial investment, and it is in part for this reason that CBE systems are also challenged by the need for additional funding and resources (Broderson et al., 2017; Lacey & Murray, 2015; Magnusson & Frank, 2014). CBE, insofar as it alters the traditional curricular model, also necessitates a substantial amount of professional development for educators.

The Surrey Portfolio Pathway Partnership

To summarize the preceding discussion, competency-based education responds to important limitations in conventional educational systems by shifting the focus of the curriculum and assessment away from the “grades only” approach and towards a more flexible one. While several Canadian provinces are moving towards increased CBE, a perceived lack of standardization and professional development (as well as hesitation among universities to recognize competency portfolios) has slowed the change process.

As we discuss elsewhere (see Burns, 2018), a significant component of the reform process is the extent to which universities can take seriously the competencies high school teachers might, in the future, certify. To understand how this might work, and to prepare our universities for a future in which grades are not the only achievement indicator our future students arrive with, we have initiated a series of projects now referred to as the Surrey Portfolio Pathway Partnership (S3P). The centrepiece of this research was the partnership we established with Surrey Schools. This partnership allowed us to recruit a group of six students and run an admission simulation.

We began by receiving special permission from our university senate to admit six students based on the recommendation of the primary investigator and the students’ having completed Grade 12. The normal requirement they meet certain grade thresholds was, in other words, waived. The research group did not, and do not, know the students’ final grades.

We told the students we wanted to understand what their grade 12 work could tell us if we looked beyond their grades to their competencies. To this end, we asked them, what would you show us to prove you are ready for university? Over the following months, as the students
completed their Grade 12 year, we collected about 40 assignments in all. These assignments were then compared to the learning outcomes in some of our university’s most popular first-year courses. The result was hundreds of connections indicating these students were already developing the competencies we would teach them in their future undergraduate studies.

We did not intend to collect a statistically significant sample, nor did we intend to use the sample as representative of any particular population. Our objective was to explore the ways in which we could map competencies/outcomes from many courses onto assignments provided as part of a competency portfolio. In addition to mapping the ways in which our admission system could make use of student work in this way, we also sought to celebrate some of the fascinating work being done by these students both inside and out of school. It was our intention for this document to provide illustrative examples both of the quality of work students created, and also the ways in which that work can communicate important multidisciplinary information about their competencies.

Preliminary Discussion

In Figures 1-10, artifacts collected through S3P are linked to learning outcomes from first- and second-year Kwantlen Polytechnic University courses to demonstrate competency linkages. While it is our intent to use this analysis to start a larger discussion, two preliminary observations are worth making:

1. **Portfolio artifacts can show cross-curricular achievement.**

   The different colours used in these maps represent various academic areas within Kwantlen Polytechnic University. When viewing the maps, it is clear that many single assignments, regardless of their subject area, are applicable at least in part to multiple other areas. This weaving of specific knowledge and broad competencies allows students to apply and articulate their learning across a range of contexts.

2. **Out-of-class learning experiences can, in principle, be assessed in much the same way as are in-class experiences.**

   We have showcased several experiences that occurred outside of the classroom. These include: participation on a panel about the future of education; a volunteer experience at a summer camp for youth with Autism Spectrum Disorder; an original song and music video made to express thoughts about their Aboriginal roots; and a poetry book a student wrote in their spare time. These examples are used to highlight the information that can be drawn from the many experiences that students took initiative to participate in outside of the classroom. They also show how these experiences can be assessed.

   Finally, please note that these linkages do not represent a comprehensive list of KPU learning outcome links possible. Instead, the map aims to show the breadth of competencies identified within student artifacts.
References


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Here, a student reflects on their experience of speaking at an interdisciplinary conference.

I partnered with the KEPI Institute and the Surrey School district to discuss the new curriculum changes. At the event, I explained that grades alone do not represent the entirety of a student’s capability. Unfortunately, often extracurricular activities and experiential learning is not always perceived as having equal value as traditional classroom education. In reality, teamwork, resilience, and adaptability are just as important as educational qualifications. For instance, in the workplace, adaptability and hard work, which are not taught in textbooks, are characteristics that employers value. In addition, we discussed the significance of students being able to authentically communicate their needs and concerns. Many students have diverse needs and learning styles. Being flexible and catering to their needs is an important aspect of the new curriculum, which is also related to students articulating their own competencies. Sometimes when students evaluate their own work, they may be overly critical. Although, when a teacher looks at their work, they may bring to light valuable characteristics that a student did not previously recognize. In the same sense, teachers’ connection with their students influence how likely the student is to learn. For example in Grade 10, our Social Studies final was the Olympics. Our teacher would ask us a question and we would bring him the answer on a paper after doing an athletic task (ex. catching a football, kicking a soccer ball, etc.). Through interactive approaches in education, students create an emotional connection, making it more memorable. Thus, they are more willing to apply their learning in real life.
During high-school I became really open minded on which career path I wanted to pursue in the future. The career path that was the best fit for my personality was a Police Officer because I always want to give back in various ways such as volunteering my time at summer camps, retirement homes and many more. One of the paths of volunteerism as a Camp Leader of a Summer Camp specially organized for young youth with Autism Spectrum Disorder really spoke out to me and gave me a better understanding of life in many different perspectives.

Autism, or autism spectrum disorder refers to a range of conditions characterized by challenges with social skills. Repetitive behaviors, speech and nonverbal communication, as well as by unique strengths and differences.

As a camp-leader my role at the summer camp was to create a safe environment by bonding with young youth who suffer from ASD, lead a variety of small and large group activities each week including crafts, nature walks, swimming, archery, hiking and team building and identify and response to camper behavior issues. Also, to be a positive role model by including everyone and spreading positivity.

Over the few weeks of interacting with the youth they were able to think critically, understand their surroundings and grow into their own ASD. After being able to witness those impactful movements I came to a realization that summer camps for children with autism aids in creating social skills and improves their behavior. Also, the importance of awareness of ASD is a main key because children with ASD should not be left out of activities just because they have differing social skills and intellectual abilities. Autism awareness is important for so many reasons, and it is important to understand that ASD does not require a cure and shouldn’t be singled out.

In conclusion, throughout the camp I had a great experience because it was my first time dealing with health issues such as ASD. This experience helped me learn more about autism throughout the child’s engagement towards the camp. It is time to stop pointing out the differences among people and accept everyone for who they are.
N’we Jinan Artists:
"HIDE & SEEK"

Theresa, along with a group of aboriginal students from the Surrey School District, wrote and performed a song about their heritage.

In the reflection video, Theresa says of the experience:

“We came up with the title, it was for people who are hiding from their culture, like their ancestors or whoever, their grandmas and grandpas, they say ‘that’s not important in your life’, but that’s part of who you are. So the ‘seeking’ was to go out and find the multiple pieces that were left… so we could look at them and go; this is my culture, this is who I am, this is part of me... it’s finding ourselves.”

“The closer you look, the more that you see the wisdom of elders comes back to me. Once taken from home, but now we are free, we won’t forget where we’re meant to be.”
(N’we Jinan Artists)
This student created a poetry book, in which they finalized 12 of the poems they have written in recent years. Here, we share 2 examples from the book.

### Table of great fables

Words n’ stuff, mindful cuffs, bluffs and over ducks of invisible swinging fists of justice, Just us with our funny lies we actually buy into Through and through, it’s like a fluke, Almost a case for a lawsuit, or a kick in the head with a steel toed boot.

Time to scoot off this topic, it tends to flick like bricks at forest sticks, Sticks to the ground for a foundation where we’re all just too impatient to see the rough ground,

Ugly brown dead grass, broken glass, Almost like you would need to take a class to get that type of harassment towards the past.

Truth is ruthless like natures wolves, Making a kill to fulfill its daily need Truth is what feeds and bleeds through our funny lies, let’s cut ties and say goodbye to the great enterprises and enjoy the demise of false items that hold no meaning, I mean it’s just stuff but you act like it’s your greatest pair of handcuffs, Once you lose everything you’re free to do anything Bling and bring your own meaning to the great fables.

### Broken Morals

History s no longer written by the victor, now the undertaker, the faker, more haste, more waste, less taste, no faith, more hesitant debates that are fake. Only here for the rates, fates on the line, people have become so blind. We twist our minds & combine and refine the line where it sits and fits for our needs.

Where others read, I sit and philosophize off of nicotine and caffeine and beam off of the reality that sits around our absurd sounds, it’s all around. You can see it off of the many frowns that echo around the room when ones right… Right? What’s right, our collective minds all rhyming with the timing.

All finding a lie to live.
Vygotsky

Early Life

Lev Vygotsky was born November 17, 1896 in Orsha during the Russian Empire. There isn’t much about his childhood but, Vygotsky’s father was banker and his mother was a teacher. Although his mother ended up staying home and taking care of his 7 siblings. Lev went to Moscow State University which he received a degree for Law from and studied a variety of subjects such as, sociology, linguistics, psychology, and philosophy. He studied psychology at the Institute of Psychology, but during his absence due to his acute tuberculosis relapse, caused his leg to be incapacitated and had to leave work for a year. Later on Lev started researching topics on language, attention, and memory. Sadly due to his illness, Lev passed away June 11th, 1934.

Theory

One of Vygotsky’s theories was based on the Social Development of a child. Similar to Piaget’s theory, Lev Vygotsky believes social interaction plays a major role in the growth of a child’s cognitive development. As a child, you’re curious about everything around you, wondering what’s going on around them. The social learning takes place where you reach out and connect with other people which leads into cognitive development. After that part of Vygotsky’s theory, according to him there are 3 stages of language that plays important role. Social, egocentric, & inner speech. Language helps us dictate how we look at things and process certain information.

According to Lev Vygotsky, during the zone of proximal development a child needs instruction and guidance from the MKO (skilled & knowledgeable person; adult) for sensitive information to help with it’s cognitive growth.

Theory based on Reality

In Vygotsky’s theory he talks about the way a child develops by learning from their environment. The way a child is brought up can have a number of effects depending on their environment. If a child is raised in an abusive childhood then its likely that the child will grow up and be abusive to others the reason why they do it is they learn from their parents so they think its right to do it to others. If a child is raised where the parents are loving and care for the child, they would most likely treat others the way they were brought up. If you look at a friend and look at how they act, you can get a rough image of how they were raised.

*Identify an issue, generate a question and explain the significance of locally, regionally or globally focused researchable questions*

*Recognize the complexity of current issues and their potential solutions*

*Articulate individual world view, personal beliefs and values in relation to family, community and culture*

*Apply principles of unity, coherence, and emphasis in academic writing*

*Describe dimensions and factors of mental health and well-being*

*Use critical thinking skills through discussion and analysis of psychological issues*

*Analyze the ways everyday practices and images socially construct reality, knowledge, and identities; and how they reflect, reproduce or transform the social order*

*Construct arguments in oral and written communication*
Short Story Comparison

Authors Alice Munro and Joyce Carol Oates and their stories “The Children Stay” and “Life after High School” both portray the standard social norms and the effect it has on people, delivering both positives and negatives of the controversy. There are a vast number of theoretical reasons as to why people follow these boundaries as well as symbolic and meaningful representations of those ideas through the text of these two passages. Within the text, the foundation of the stories revolve around an underlying statement that explicitly implies that we as people obey the unwritten rule which states that we must abide by the limitations and conventions that society writes out for us with an ink physically invisible to the eye, yet mentally carved within our subconsciousness.

If we choose to ignore the two stories, the question can be answered with less of a biased opinion than it would be answered if we depended upon the stories. Generally, we obey the social norms and accept its boundaries for three reasons. The first reason is fear. We are scared of being categorized as “different” and looked down upon. We fear to step out of line and be exposed in our natural state, whatever that state may be. We are scared to draw unguided attention towards ourselves. We resist and avoid being seen as anything different than how we want others to perceive us. In this day and age, it is easy for others to form a perspective of us solely based on one little thing. It could be our sexuality, hobby, sense of humor, and so on. The second reason is the risk factor. We do not want to risk anything if the consequence can possibly extend out of our control. To explain further, if someone wished to divorce their spouse but did not want to risk their future, their reputation, and the sudden change of others’ opinion of them, they would have to risk being judged for doing such a thing because the expectation for marriage is that they “live happily ever after”. Risk is hyped up to be such a big thing in one’s life nowadays even though in order to go on living our life to the best we can live it is by taking risks itself. We avoid risks with the mindset that risks will jeopardize our future and we will not be able to grow into what we aspire to be. Ironic is it not? Because a life without risk, is a life without growth. The third reason for our abiding, is that we choose to play it safe. Not only do we evade risks and surrender to our fears, but we go beyond that and do things with the purpose to avoid any misconceptions that we deem different. We are just afraid of people thinking we are different. It has come to a point where we are so afraid being judged and seen as something we may refrain from being that we forget to realize that everyone has their own opinions, and that no one knows you better than you know yourself.

Now, taking Joyce Carol Oates’s story “Life after High School” into consideration, it not only answers the question as to why we abide by these norms, but as well as what the consequences come to be when we either oppress or circumvent these limitations. These expectations affected the protagonist, Zachary Graff the most. He was burdened by the social norm that stated he had to have a certain fixed sexuality. He spent his life struggling to reform into the boundaries in which society would accept him in. He forced himself into doing things with the determination of not only convincing others he was “normal”, but convincing himself as well. Behaviors such as, pressuring himself into loving the prettiest girl in high school, driving a car that is a symbol of masculinity itself, and begging the girl to marry him; all so that he can rid himself of any part that tethered him to his indifference from the rest. Although Zachary was being oppressed by this standard, He pursued to try find a way around it, in his own way. But, the scheme was not without its consequences. However, doing those things to mask his true self, were things against his preference. He begged Sunny to marry him with the hope that the title of marriage would cast sunlight over the “sinful” side of him.
Continued:

Due to his religion forbidding such a way of life, Zachary was religiously ashamed of himself, as explained in the text. “Zachary confided in Tobias that he prayed every morning of his life - immediately upon waking up he scrambled out of bed, knelt, hid his face in his hands, and prayed for his sinful soul, sinful thoughts, deeds, and desires”. In the quoted text, Zachary shows that his conscious is conflicted; conflicted not just with his beliefs and actions, but precisely, the difference between them. Yet unfortunately, his efforts to circumvent the predicament was not enough. He soon became overwhelmed by society’s expectation and once again, became oppressed. After Sunny rejected him, Zachary felt as if the only doorway out had been slammed shut before his hopeful eyes. He then resorted to open another doorway when he asked Tobias to go away with him. After being rejected by Tobias as well, Zachary’s mind took shelter in a place where he believed that if no one else could accept him for who he was or was trying to be, neither could he. Zachary surrendered and admitted defeat to the arrogance of conventions in the social world.

Similarly to the first story, author Alice Munro’s “The Children Stay” explains a protagonist, Pauline, who deals with her own dilemma of reforming to external expectations. Although married, raising two kids, Pauline was not entirely content with her life. She felt restricted from pursuing her dreams and herself as an independent woman. Provoking this constraint, were her kids, husband, responsibilities, and most importantly, social standards. Pauline was very excited for the play she was yet to perform in. Although she was not getting paid for it, it was the idea that she was doing something she loved for once, that gave her happiness. She wanted something more for her life but would not speak of it due to social expectations beating down on her. She was burdened by the expectation that married couples are supposed to “live happily ever after”. While being subdued, she kept her kids happy, her husband happy, but had to trade with her own happiness. There’s always consequences to oppression. If she stayed oppressed the entire time, she would have spent her whole life miserable. On the other hand, when she choose to do something about it and not be suppressed, there were still consequences to follow. Subconsciously, Pauline was looking for an escape from the burdening, and later on she had found it, she had found Jeffrey. Jeffrey enabled Pauline to escape her burden and evade the limitations that had held her down for most of her life. However, when Pauline left her husband and kids for Jeffrey and her new life, she had hurt her husband and abandoned her kids at a time they probably needed her most. In cases like this, it all comes down to someone’s sense of values and how they to choose to weigh them.

Ultimately, we all abide by and live within certain limitations and conventions. But it is up to us to decide whether or not we want to break away from the restraints holding us down with chains that thieve us of our free will. We need to learn to accept ourselves and each other for who we are and what we do. In the world today we are so caught up in the fear of being judged or perceived as different from the rest of us, that we forget to judge ourselves, to live our own life, full of risks. When we choose not to take risks and abide by certain conventions, we are choosing to stay put and play it safe, but if we take risks, and move forward, we grow. Therefore, we can either choose to live our lives entirely in fear, or take a risk, and make fear your friend. For what is life, if not lived without a little risk?
Here, a student created a diagram of a brain, which they then created a digitized map with. Each part of the brain is clickable, moving the page to a separate page describing the function of that part of the brain.

Below are examples of some of the parts.

**Thalamus**

The Thalamus is involved in sensory and motor signal relay and the regulation of consciousness and sleep.

**Hypothalamus**

Located at the base of the brain it signals the body’s hormonal system to release various hormones.
Sin and Cos Law Quiz

The first page of a three-page math quiz.

From 11 Name:

Quiz: Practice w/ sine law & cos law finding the right angle.

Show all your work.

1. Use sin law to solve for the side.
   \[ \sin 32^\circ \times 13 = \sin 75^\circ \]
   \[ x = \frac{\sin 75^\circ}{\sin 32^\circ} \times 13 = 7.1 \]

2. Use sin law to solve for the angle.
   \[ \sin A = \frac{\sin 39^\circ}{46} \]
   \[ \sin A = 0.933... \]
   \[ A = 69^\circ \]

3. Use the cos law to find the side.
   \[ a^2 = b^2 + c^2 - 2bc \cos A \]
   \[ a^2 = (9.5^2 + 11.9^2 - 2(9.5)(11.9) \cos 63^\circ) \]
   \[ a = 11.2 \text{ cm} \]

4. Use the cos law to find the angle.
   \[ a^2 = b^2 + c^2 - 2bc \cos A \]
   \[ (90.5^2 - 95.5^2 - 110.0^2) \]
   \[ a^2 = 13030 \]
   \[ \cos A = 0.620... \]
   \[ A = 51.6^\circ \]

FIGURE 8

Sin and Cos Law Quiz

MATH 1102
Precalculus
Algebra

Use standard mathematical notation and terminology correctly.

Organize information, draw diagrams, or construct tables and graphs to make meaning from descriptions, data, or relationships.

Demonstrate competence and flexibility in moving amongst multiple representations (verbal, graphical, and symbolic) of a problem or concept.

Select appropriate concepts and techniques to solve a problem.

Interpret and use function notation with ease.

Use mathematical notation and terminology correctly, showing an appreciation for the need for precision and correct syntax.

Understand and apply the concepts of trigonometry.

Understand and apply the concepts of algebra.

Solve algebraic equations and inequalities using appropriate methods.
Reflections and Inverse Quiz

The first page of a three-page math quiz.

1) The graph of \( y = f(x) \) is shown below.

a) Draw the graph for \( y = f^3(x) \)

b) Draw the graph for \( y = -f(-x) \)

b) For the equation \( y = 3x - 1 \), what would the new equation be if it undergoes a reflection in the \( y \) axis?

\[
y = 3x - 1 \quad \rightarrow \quad y = 3(-x) - 1
\]

\[
y = -3x - 1
\]

c) For the equation \( y^2 - 2y + 3x - 1 \), what would the equation be if it undergoes a reflection in the \( x \) and \( y \) axis?

\[
\begin{align*}
y^2 - 2y + 3x &= 1 \\
(-y)^2 - 2(-y) + 3(x) &= 1 \\
y^2 + 2y - 3x &= 1
\end{align*}
\]

d) Find the equation of the inverse for \( y = (x+2)^2 - 1 \)

\[
x = (y+2)^2 - 1
\]

\[
\sqrt{x+1} = \sqrt{y+2}
\]

\[
x+1 = y+2
\]

\[
x = y
\]
Earth Science Package

Here, the student created an earth science package which contained:

- A diagram of the earth's core
- Vocabulary worksheets
- A worksheet on plate boundary types
- A graph representing the arrival times of earthquake waves
- A quiz on plate tectonics

Describe broadly the sequence of events leading to the formation of Earth, the composition of Earth and its internal (layered) structure.

Explain plate tectonic theory background, including the type and intensity of geological events occurring at converging, diverging and transforming plate boundaries.

Outline why earthquakes occur, how seismic waves travel, and the scales used to measure the size of earthquakes.

Explain why and how tectonic forces can lead to lithostatic stress, rock deformation, folds and faults.

Describe common depositional and erosional landforms derived from surface processes.