Confidence in Computational Problem-Solving Skills of First-Year Engineering Students

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Abstract
This work-in-progress paper describes a pilot program to assess student confidence and competency in computational problem solving to permit instructors to better understand and meet the needs of a diverse student skillset. We focused on measuring student perceptions of their computational problem solving skills and compared them to their performance. Previous studies at Michigan Technological University have indicated that students inflate their perceived level of expertise using spreadsheets. This work further explores student confidence and competence on several computational problem solving skills. To determine this, a short pre-assessment was given to students on the first day of their beginning First-Year Engineering course. This pre-assessment included topics that are important for using computational tools to solve problems. Following each question, students were asked to rate their confidence in their answer on a five-point Likert scale (1 = completely confident to 5 = not at all confident). The results from the pre-assessment were compared to similar questions (both skill and confidence questions) on the midterm and final exams. Additional post-assessment measures include performance on two lab practical exams, one using spreadsheets, the other using MATLAB. To determine if there is a difference in performance or confidence between groups, responses were compared by gender and concurrent math course group (Group 1: Calc 1/1+, Group 2: Calc II, or Group 3: Calc III).

Introduction
Many first-year engineering students enter their first engineering course with the perception that they “already know” the material or that the course material is not important. The reality could be different. Sometimes the students realize their knowledge in a subject or their confidence in an answer is lacking. This ability to recognize knowledge gaps is an important skill as a professional and a student and is the focus of this paper.

There are many studies in the confidence and self-efficacy of students where the focus has been on self-reporting confidence without a link to actual student performance. Self-efficacy is how a person’s belief in their capabilities impacts their ability to achieve a goal.1 In 2015, mathematical self-concept was studied with respect to how it differs between genders and how it affects pre-college and post-K-12 career choice decisions. Self-concept studies investigate how psychological processes relate to academic achievement and career choice.2 In particular, this longitudinal study looked at how different factors including the person, their environment, and math self-concept impact a student’s decision to pursue a STEM (Science, Technology, Engineering and Mathematics) career. Data from surveys were analyzed to determine math self-concept and compared with demographic data, high school GPA, outcome expectations (persistence, academic performance, career goals), and personal interests. Overall, the analysis showed that independent of STEM field, women self-reported less confidence in their math ability at a higher rate than men. Because of this lower self-concept, many women elect to pursue careers outside of STEM or change from a STEM major to a non-STEM degree even when past performance indicates that women’s math ability is high.
Self-efficacy has four components: “mastery experience, vicarious experience, social persuasion and emotional arousal.” A survey of 178 third year engineering students was completed to see if there was a correlation between these factors and academic performance. The researchers found that all factors correlated well with math achievement, but mastery experience correlated well with math and engineering achievement. Mastery experience refers to how a person judges their competence based on past performance (which can be a successful or poor performance). The researchers recommended that higher level math and engineering courses should have activities that create opportunities for students to use the skills and information from earlier courses. This would further reinforce the “mastery experience”.

Additional research has been completed on how Social Cognitive Career Theory (SCCT) can be used to predict persistence at a Hispanic Serving Institution (HSI). In this longitudinal study, students were surveyed in their first year with respect to self-efficacy and other factors, and then completed a second survey to evaluate persistence one year later. The study found that a high individual self-efficacy rating in year 1 indicated a higher probability of persisting in engineering. Furthermore, self-efficacy was found to be a precursor for interests in engineering.

Researchers at the University of Cincinnati investigated the correlation between ACT scores in English, Mathematics and Reading, along with the total score to performance in first-year engineering student performance (modeling class and Calc I). Cluster analyses were completed based on the students’ performance in Calc I (good, average and poor performance) and how that correlated with a first-year engineering modeling course. It was found that the better a student did in Calc I, the better they performed in the engineering class. The cluster with a poor performance in Calc I, had the largest spread of the data while the good and average performance clusters had lower standard deviations. The higher standard deviation could indicate that success in calculus does not predict success in engineering courses. Many of the students in the poor calculus performing cluster had higher grades in their engineering class. When looking at ACT scores, the trend continued. Those in the higher performing clusters not only had higher overall ACT scores, but they also had higher math, reading and English scores.

A study was completed where the researchers investigated how the effect of math level for engineering students impacted their graduation rate. The results showed that the better students performed in Calc I, the higher their graduation rate was with a degree in engineering. At the University of Kwazulu-Natal, it was found that math performance was a better predictor of the academic success than other first-year courses (accounting, economics and management courses). The study found that increasing math scores and performance, resulted in an increase of 16% in the overall successful completion of first-year courses.

Several studies related to student confidence and self-efficacy have been completed at Michigan Tech. The university has a common first-year engineering program, where students enrolled in Calc I or higher take a two course sequence (ENG1101, Engineering Analysis and Problem Solving, followed by ENG1102, Engineering Design and Modeling). The focus of the program is for students to gain the fundamental engineering skills in problem solving, technical communication and modeling (3D and numerical), along with a basic proficiency in using modern software packages. In 2007-2009, data were collected on student surveys at the beginning of ENG1101 regarding their perceived proficiency in using spreadsheets. Almost half
of the students felt that they were proficient prior to entering the first-year program. After the spreadsheet topics were covered in class, students took a 20 minute lab practical where they completed basic calculations and created graphs on a spreadsheet. It was found that the women students predicted their skill level much better than the male students. In fact, the women who initially reported themselves as “proficient” not only predicted their high performance, but they out-performed the male students who had ranked themselves as “proficient”. This study found that women were more able to assess their expertise based on past activities than the male students. The study also showed that most of the students who ranked themselves as proficient were.  

Additional work completed at Michigan Tech in 2015 investigated the impact of math level and performance. It was found that Calc I students had lower performance on almost all course metrics when compared to students in higher math levels. Additionally, how students prepared for class impacted their overall course performance. For example, students who watched a pre-lesson video and completed a short on-line quiz, overall out-performed students who did not.  

Methods

For this study, students from Michigan Tech’s first-year engineering course, ENG1101, completed a pre- and post-assessment to determine their competence and confidence in several computational problem solving skills. Students who did not have a complete data set for all testing parameters were dropped from the study. As previous research has indicated, the largest performance differences were between students enrolled in the calculus courses. This analysis only includes students enrolled in either Calc I/I+, Calc II, or Calc III. Calc I is a 4-credit course and Calc I+ is an equivalent 5-credit course that meets an extra hour per week. Our sample was taken from ten of the fifteen sections of ENG1101 (N = 474) and is approximately 26% female (N=124), 74% male (N=350) and is predominantly comprised of Calc I/I+ students (N=291, 61.4%) although there is a significant population of Calc II (N=138, 29.1%) and Calc III (N=45, 9.5%) students.

The pre-assessment included one question on each of the following topics: 1) units in equations, 2) mathematical order of operations, 3) absolute and relative addressing in a spreadsheet, and 4) analyzing four lines of a generic sequential code. Following each question, students rated their confidence in their answer on a 5-point Likert scale (1 = not at all confident to 5 = completely confident).

Similar questions but with increased difficulty were assessed on the midterm and final exams. Three questions on the midterm exam were: 1) unit conversions, 2) units in equations, and 3) absolute and relative addressing in a spreadsheet. The final exam had two questions on: 1) mathematical order of operations and 2) analyzing four lines of a generic sequential code. A complete listing of all the competency questions are in the Appendix.

When analyzing the data, students in ENG1101 were divided into groups based on their gender and concurrent math course. The math groups included: Group 1: Calc I/I+, Group 2: Calc II, and Group 3: Calc III. Responses were compared based on gender and math group to determine if there is a difference in performance or confidence within the groups. Pre- and post-assessment data were first evaluated separately to determine initial and final skill and confidence levels in
our sample student population (N=521). These results were then evaluated by looking at gender and math group. In addition, a paired comparison was completed to determine individual changes in skill and confidence levels from pre- to post-assessment. Finally an ANOVA was performed with a Bonferroni posthoc test to determine the changes according to math group. Additionally, student performance was analyzed to determine the computational competency in Excel spreadsheets and basic MATLAB programming through two lab practicals.

Pre-Assessment Results
For each question on the pre-assessment, students were asked to rate their confidence in their answer. Responses were delineated by confidence level (confident (4 or 5) and not confident (1, 2, or 3)) and correctness. As shown in Figure 1, the majority of students correctly answered the units in equations question (95% correct), however only 73% were confident in their correct answer. For the order of operations question, 88% of students answered this correctly with 79% confident in their correct answers. On the other hand, most students did not answer the spreadsheet question or sequential programming question correctly (14% and 40% respectively) and the majority of the students were not confident in their responses (90% and 82% respectively). While most students did a good job evaluating their correctness (high percentage of students that were confident and correct or high percent of students that were incorrect and not confident), there were a number of students that lack confidence in their correct answer. More than 20% of students were in the correct, not confident category for the units in equations and sequential programming questions.

To determine if there is a difference in correctness and/or confidence, student responses by gender were examined. A comparison of the pre-assessment responses from men and women, shown in Table 1, indicated that while there was not a significant difference in the percent of correct answers (p=0.640), the women were not as confident in their correct answers as the men (p=0.039). Responses for each question are shown in Figures 2 for the men and women. In all questions the percent correct and not confident is higher for the women than the men except for
the spreadsheet question where men and women had nearly equal performance and confidence. This difference in confidence is especially pronounced in the sequential programming question (p=0.026 for the difference in correct/confident, p=0.038 for the difference in correct/not confident).

Table 1. Pre-assessment comparison of correctness and confidence by gender

<table>
<thead>
<tr>
<th>Category</th>
<th>Male avg (std dev)</th>
<th>Female avg (std dev)</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Percent correct</td>
<td>59.8 (18.8)</td>
<td>59.0 (18.3)</td>
<td>0.640</td>
</tr>
<tr>
<td>Correct, confident</td>
<td>43.0 (20.0)</td>
<td>38.8 (19.5)</td>
<td>0.039*</td>
</tr>
<tr>
<td>Correct, not confident</td>
<td>16.8 (18.8)</td>
<td>20.2 (20.0)</td>
<td>0.085</td>
</tr>
<tr>
<td>Incorrect, confident</td>
<td>5.3 (10.8)</td>
<td>5.3 (11.6)</td>
<td>0.920</td>
</tr>
<tr>
<td>Incorrect, not confident</td>
<td>34.9 (18.4)</td>
<td>35.9 (18.7)</td>
<td>0.620</td>
</tr>
</tbody>
</table>

*p<0.05 ** p<0.01

Figure 2. Pre-Assessment Questions of First-Year Engineering Students' Confidence by Gender (male: n = 350; female: n=124)

Student responses on the pre-assessment were also examined by concurrent math course. A one-way ANOVA test indicated that there was no difference in the number correct across math levels (p=0.223). In fact the only difference in the pre-assessment results by math group was that Calc I/+ students were less likely than Calc II students to be confident about their correct answer on the order of operation questions (p=0.008).
Post-Assessment Results and Comparisons: Gender

Students were asked similar questions as in the pre-assessment, but with increasing difficulty, on the midterm and final exam. Post-assessment student responses were grouped into categories based on the correctness of their response as well as their confidence as shown in Figure 3. (For ease of comparison, pre-assessment responses previously shown in Figure 1 are also included in Figure 3.) On the post-assessment, most students correctly answered the questions on spreadsheets (97% correct, 86% were confident in their correct answer), order of operations (88% correct, 73% confident), and sequential programming (95% correct, 81% confident). Fewer students were able to correctly answer the unit conversion question (72% correct) and the units in equations question (68% correct). The units in equations question was substantially harder than the pre-assessment and in a subject matter that was most likely unfamiliar to the student. The pre-assessment question asked students to determine the units of force, given $f=ma$; while the post-assessment question used the drag force equation. There was not a comparable unit conversion question on the pre-assessment. As expected, students were not as confident in their answers for these two questions on the post-assessment (50% and 48% not confident respectively) with a $p=0.000$ significance when comparing the units in equation pre- and post-assessment question.

For all questions except those on units, students had a higher percentage of correct answers on the post-assessment than the pre-assessment. Students showed gains in their overall correct answers with confidence and correct answers with less confidence. There was a decrease in the incorrect and not confident responses. Statistically significant gains ($p<0.000$) in correctness and confidence were observed in the spreadsheet question and the sequential programming question.
with the sequential programming question also seeing significant decreases in the number of correct but not confident answers (p<0.000). The order of operations question showed a shift in confidence. While there was not a significant change in the percent of students with a correct answer, the number of students who were confident in their answer decreased from the pre- to post-assessment (p=0.05).

Next, post-assessment student responses were analyzed by gender to determine if there is a difference in correctness and/or confidence. As shown in Table 2, the women have a lower percentage of correct answers. Additionally, the women were less confident in their correct answers than men (p=0.011). The post-assessment results for each question are shown in Figure 4 for the male students and Figure 5 for the female students. The number of women responses that were both correct and confident is statistically lower (p<0.05) for all questions except the question on units in equations. In general, the women have a larger percent of students in the correct but not confident category than the men (statistically significant for the questions on order of operations and sequential programming, p<0.05)). The exception to this is the question on unit conversions where the women have a much larger percent of incorrect and not confident students (p=0.002).

Table 2. Post-assessment comparison of correctness and confidence by gender

<table>
<thead>
<tr>
<th>Category</th>
<th>Male avg (std dev)</th>
<th>Female avg (std dev)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent correct</td>
<td>85.0 (16.2)</td>
<td>80.6 (18.3)</td>
<td>0.012*</td>
</tr>
<tr>
<td>Correct, confident</td>
<td>68.1 (22.9)</td>
<td>58.1 (27.3)</td>
<td>0.000**</td>
</tr>
<tr>
<td>Correct, not confident</td>
<td>17.0 (19.6)</td>
<td>22.6 (24.2)</td>
<td>0.011*</td>
</tr>
<tr>
<td>Incorrect, confident</td>
<td>4.7 (9.5)</td>
<td>4.4 (8.3)</td>
<td>0.731</td>
</tr>
<tr>
<td>Incorrect, not confident</td>
<td>10.2 (13.9)</td>
<td>15.0 (16.1)</td>
<td>0.002**</td>
</tr>
</tbody>
</table>

*p<0.05  ** p<0.01
Other measures of computational competency measured in the course include two lab practicals, one using Excel, the other using MATLAB; midterm exam multiple choice (MC) questions; and final exam multiple choice questions. The grades earned in each of these are shown in Table 3 by gender. In general, the women had slightly higher scores on the lab practicals than the men.
although these differences were not statistically significant. However, the women had lower grades on the midterm than the men (p=0.009). This result was unexpected and further investigation may be required.

<table>
<thead>
<tr>
<th>Table 3. Comparison of course grades by gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
</tr>
<tr>
<td>Excel Lab Practical</td>
</tr>
<tr>
<td>MATLAB Lab Practical</td>
</tr>
<tr>
<td>Midterm MC</td>
</tr>
<tr>
<td>Final Exam MC</td>
</tr>
</tbody>
</table>

*p<0.05 ** p<0.01

Post-Assessment Results and Comparisons: Math Group
Figure 6 shows the breakdown of correct responses and confidence for the post-assessment questions by math group. Within each math group the breakdown of male and female students was similar to the overall data with the exception of the Calc III group which was 80% male, 20% female. In general, the students in the Calc I/I+ group had a lower percentage of correct answers and were more likely to be less confident in their correct responses. Confidence and correct answers increase with increasing math group with the exception of the spreadsheet question, and the sequential programming question where Calc II had the highest percentage of correct answers. Overall, students enrolled in Calc II or Calc III had a higher percentage of correct answers than those in Cal I/I+ (p=0.000).
Figure 6. Confidence in Post-Assessment Questions of Students in Various Math Courses
The unit questions in the post-assessment were statistically different between math groups. Calc I/I+ students had a lower percentage of confident/correct responses as compared to Calc II and Calc III. For the unit conversion answers, Calc I/I+ were lower than Calc II (p =0.001) and for the units in equations problem, they were lower than Calc II (p=0.000) and Calc III (p=0.000). Conversely, there is an increase in the number of incorrect/not confident answers for Calc I/I+ as compared to Calc II (p=0.001) and Calc III (p=0.001). In addition, there were differences in confidence in the sequential programming problem. The Calc I/I+ students showed a reduction in correct/confident responses as compared to Calc II (p=0.002). Calc III, on the other hand, showed an increase in the incorrect/not confident responses as compared to Calc II (p=0.030).

Table 4 shows the differences between the three comparison groups with a negative number indicating the first group listed has a lower value than the comparison group. For example, the CalcI/I+ group answered on average 8.1% fewer assessment questions correctly than the Calc II group and 10.0% less than the Calc III group. These differences are statistically significant (p=0.000). Comparing Calc II and Calc III indicates that there is not a statistically significant difference in the overall percentage of correct answers or the confidence in those students. There are differences when looking at the Calc I/I+ group and these two groups. Calc I/I+ students have a lower percentage of correct answers and, conversely, a higher percentage of incorrect/not confident answers.

Table 4. Comparison of number of correct answers and their confidence by math group

<table>
<thead>
<tr>
<th>Category</th>
<th>Calc I/I+ and Calc II Δ avg ± std error (p)</th>
<th>Calc I/I+ and Calc III Δ avg ± std error (p)</th>
<th>Calc II and Calc III Δ avg ± std error (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent correct</td>
<td>-8.1 ± 1.7 (0.000)**</td>
<td>-10.0 ± 2.6 (0.000)**</td>
<td>-2.0 ± 2.8 (1.000)</td>
</tr>
<tr>
<td>Correct, confident</td>
<td>-12.9 ± 2.4 (0.000)**</td>
<td>-14.8 ± 3.8 (0.000)**</td>
<td>-1.9 ± 4.1 (1.000)</td>
</tr>
<tr>
<td>Correct, not confident</td>
<td>4.8 ± 2.2 (0.077)</td>
<td>4.8 ± 3.3 (0.460)</td>
<td>-0.04 ± 3.6 (1.000)</td>
</tr>
<tr>
<td>Incorrect, confident</td>
<td>1.9 ± 0.9 (0.142)</td>
<td>2.2 ± 1.5 (0.378)</td>
<td>0.04 ± 1.6 (1.000)</td>
</tr>
<tr>
<td>Incorrect, not confident</td>
<td>6.2 ± 1.5 (0.000)**</td>
<td>7.8 ± 2.3 (0.002)**</td>
<td>1.6 ± 2.4 (1.000)</td>
</tr>
</tbody>
</table>

*p<0.05 ** p<0.01

Comparing the performance on the lab practicals and exams, the Calc I/I+ group scored significantly lower on all metrics as compared to both Calc II and Calc III. There are differences between the Calc II and Calc III groups, however none of these are statistically significant.
Table 5. Comparison of course grades by math group

<table>
<thead>
<tr>
<th>Category</th>
<th>Calc I/I+ and Calc II (\Delta) avg ± std error ((p))</th>
<th>Calc I/I+ and Calc III (\Delta) avg ± std error ((p))</th>
<th>Calc II and Calc III (\Delta) avg ± std error ((p))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excel Lab Practical</td>
<td>-2.6 ± 1.0 ((0.024)^\ast)</td>
<td>-2.1 ± 1.5 ((0.491))</td>
<td>0.5 ± 1.6 ((1.000))</td>
</tr>
<tr>
<td>MATLAB Lab Practical</td>
<td>-4.9 ± 1.8 ((0.17)^\ast)</td>
<td>-9.7 ± 2.7 ((0.001)^\ast)</td>
<td>-4.8 ± 2.9 ((0.303))</td>
</tr>
<tr>
<td>Midterm MC</td>
<td>-5.1 ± 1.0 ((0.000)^\ast)</td>
<td>-8.7 ± 1.6 ((0.000)^\ast)</td>
<td>-3.6 ± 1.7 ((0.111))</td>
</tr>
<tr>
<td>Final Exam MC</td>
<td>-8.1 ± 1.1 ((0.000)^\ast)</td>
<td>-6.3 ± 1.7 ((0.000)^\ast)</td>
<td>1.8 ± 1.8 ((0.910))</td>
</tr>
</tbody>
</table>

\*p<0.05 ** p<0.01

Discussion
While the pilot study results indicate a change in confidence and correct responses, there are a few items to consider. First of all, it is very difficult to draw concrete conclusions with only a single pre/post-question for each topic. This is especially challenging when the question difficulty increases between the pre- and post-assessment, as was the case with the units in equations question. While the purpose of the survey is to give instructors a quick, baseline competency level for students in their classroom, this could be improved by including a greater number of questions and ensuring the pre- and post-assessment questions are of similar difficulty.

The survey also addressed student confidence in these topics using a simple 5-item Likert scale. There are other scales that measure confidence or self-efficacy in engineering (e.g., LAESE\(^{12}\), Loo and Choy\(^3\)). Since we were interested in topical confidence, we did not use these scales; however, we may consider incorporating some aspects of these or similar metrics in the future.

Currently, we have in-class activities, individual and team homework assignments, and individual assessments. In general, it was observed that as students work through the course material, both their confidence and competence increased. This is part of “the mastery experience” described by Bandura.\(^1\) When students are confident in a given skill, they may perceive activities as busy work. On the other hand, faculty perceive them as meaningful skill building activities. By better understanding our students’ incoming skill set and confidence, we can tailor in-class activities and homework for individual class sections. In future work, we will investigate which aspects of the course have the greatest impact on student confidence and competence.

Conclusions
Overall, students performed well on the pre-assessment questions on units in equations and order of operations and had difficulty with questions on spreadsheets and sequential programming. While the men and women had a similar percentage of correct responses, the women had lower
confidence in their correct answers. This trend of lower confidence in women persisted in the post-assessment. With regard to performance, both genders improved from pre- to post-assessment, but women had a statistically significant lower percentage of correct answers on this metric. The largest pre- to post-assessment gains in performance were observed for spreadsheets and sequential programming. There was no significant change for percent correct on the order of operations question and a decline in the percentage of correct responses on the units in equations question. This may be due to increased problem difficulty and less familiarity between the pre- and post-assessments (F=ma versus the drag force equation). Differences in confidence and performance were found between math groups as well. Within the Calc I/I+ group, there was a higher percentage of students that were less confident in their correct answers than the other two math groups. In general, performance increased with increasing math group.

By identifying the areas where students lack competency and/or confidence, activities can be developed to increase these skills. In addition, this assessment method identifies areas where students already possess both confidence and competency and further course development is not needed in these areas. This allows instructors to focus on building skills and the course where they are deficient. This customization of material will also increase the number of students that demonstrate competency (or mastery) of a given skill. Our future work will focus on determining which aspects of the course most improve student competence and confidence in computational problem solving.

References


Appendix A: Pre-Assessment and Post-Assessment Questions

The following questions were given in the Pre-Assessment:

1. You are given the equation: \( F = m \cdot a \), where \( m \) = mass, kg; \( a \) = acceleration, m/s\(^2\). What are the units of force, \( F \)?
   a. kg
   b. m/s\(^2\)
   c. kg\( \cdot \)m
   d. kg/s\(^2\)
   e. kg\( \cdot \)m/s\(^2\)
   f. kg/s\(^2\)/m

2. Complete the following calculation:
   \( 6 \cdot 5 + 2^3 / 2 \)
   a. No answer
   b. 26
   c. 32.8
   d. 33
   e. 34
   f. 41
   g. 46.9

3. In the Excel spreadsheet shown on the right, you need to calculate the power requirement for three different vehicles. What should be entered into cell B7 so that the formula can be copied down to B22 and over the corresponding rows of columns C and D so that the calculations are performed properly?

Note: Power Requirement = (Net Resistive Force) \( \times \) (Velocity)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Net Resistive force (N)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Vehicle 1</td>
<td>Vehicle 2</td>
</tr>
<tr>
<td>3</td>
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<td>257</td>
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<td>4</td>
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<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Velocity (m/s)</td>
<td>Vehicle 1</td>
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<tr>
<td>8</td>
<td></td>
<td>0</td>
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<tr>
<td>9</td>
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a. =$B$3*$A$7
b. =$B$3*A7
c. =$B3*A$7
d. =$B3*$A7
e. =B3*A7
f. None
4. Determine the value of “Y” after the following lines of code have been executed:
   \[ \begin{align*}
   X &= 7 \\
   X &= X + 1 \\
   Y &= 4 \\
   Y &= X \times 3
   \end{align*} \]
   a. 4  
   b. 21  
   c. 24  
   d. 32  
   e. These lines of code cannot be executed  
   f. Some of the variables are not defined

The following questions were given in the Post-Assessment (Midterm Exam):

1. This spreadsheet was used to convert Australian dollars to other currencies. A formula was used in cell C6 to convert 100 Australian dollars to euros. It was then filled down to C10. What was the formula stored in cell C6?
   \[
   \begin{array}{|c|c|c|}
   \hline
   \text{Currency} & \text{Exchange Rate} & \text{Amount} \\
   \hline
   \text{European Union, euro} & 0.3573 & 35.73 \\
   \text{New Zealand, dollar} & 1.2612 & 126.12 \\
   \text{South Africa, rand} & 4.7705 & 477.05 \\
   \text{UK, pound} & 0.8638 & 86.38 \\
   \text{USA, dollar} & 0.7488 & 74.88 \\
   \hline
   \end{array}
   \]
   A. \$B3*B6  
   B. \$B3*B6  
   C. =B3*$B$6  
   D. =B3*B$6

2. After completing maintenance work on a city water storage tank, it is required that the tank be disinfected with 200 mg/L of chlorine. The volume of water in the tank is approximately 100 gallons (gal). What is the water volume in liters, L?
   \[ 1 \text{ lbm} = 453492 \text{ mg} \quad 1 \text{ L} = 0.264172 \text{ gal} \]
   A. 400 L  
   B. 37.85 L  
   C. 1,514 L  
   D. 6,060 L
3. When objects move through a fluid, their velocity is reduced by drag. The drag coefficient, $C_D$, indicates how the object resists the flow. Given the following equation, what are the units on $C_D$?

$$F_D = \frac{1}{2} C_D \cdot \rho \cdot A \cdot v^2$$

Where:
- $F_D$ = Drag force, N (kg⋅m/s²)
- $\rho$ = fluid density, kg/m³
- $A$ = cross-sectional area of the object in the fluid, m²
- $v$ = fluid or object velocity, m/s

A. Unitless (dimensionless)
B. kg⋅m/s⁴
C. m/s²
D. m⁴/s⁴

The following questions were given in the Post-Assessment (Final Exam):

1. Which of the following MATLAB calculations would result in the value 1?
   A. $3^2/(3*3)$
   B. $6/2*3$
   C. $1+4/5$
   D. $(1+2)+3/(1+2)+3$
   E. None of the above

2. What is stored in variable R after the following MATLAB program finishes executing?
   A. 4
   B. 5
   C. 6
   D. 20
   E. 21
   F. An error will occur

```matlab
R = 5;
S = 4;
R = R*S;
R = R + 1;
```