

Evaluation of Student Learning, 2005-2006

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Student Learning Outcome #1

Students in the following classes will learn to use technical word processing software: MA-019, MA-108, MA-110. In particular:

- ✓80% of students completing MA-019 will produce a paper using technical word processing software.
- ✓100% of students in MA-108 and MA-110 will produce a paper using technical word processing software.
- ✓20% of students in MA-108 and MA-110 will use technical word processing software for an assignment without being required to do so.

Student Work

Data in the form of papers written by students using technical word processing software have been collected in the following courses:

MA 108, Spring 2005—Mathematical Analysis, MA 19, Fall 2005—Multivariable Calculus, MA 110, Spring 2006—Modern Algebra

Samples of papers from MA 110 are shown below

Student #1	Student #2	Student #3
<p>Homework 12 - Extra Credit, Chapter 7, 22, 24</p> <p>22. Suppose that G is a group with more than one element and G has no proper, nontrivial subgroups. Prove that G is prime. (Do not assume that the order of G is finite.)</p> <p>Since we cannot assume that the order of G is finite, there are two cases that we need to examine concerning the order of G:</p> <p>Case 1: $G = \infty$ (the order of G is infinite)</p> <p>Case 2: $G = n$ (the order of G is finite)</p> <p>By examining Case 2, we let $x \in G$, where $x \neq e$ (because we know there is more than one element in G, so we are choosing an $x \in G$ such that $x \neq e$). Therefore, $\langle x \rangle = \{e, x, x^2, \dots\}$ (the order of x is finite).</p> <p>Let's first examine $\langle x \rangle = \{e\}$. This would mean for some $e \in G$, we know that $\langle x \rangle = \{e\}$ is a subgroup of G because of Theorem 2.4. In addition, we also know that $\langle x \rangle = G$ because x has order n, making it impossible to generate all of G, and is therefore a proper subgroup of G.</p> <p>Then by looking at $\langle x \rangle$ under Case 2, when we pick an element in G, such as x^2, we know that $\langle x^2 \rangle = \{e, x^2, x^4, \dots\}$ is a subgroup of G by Theorem 2.4. However, $\langle x^2 \rangle = G$ because when looking at the powers of x^2, x is not generated, which is an element in G, so $\langle x^2 \rangle = \{e, x^2, x^4, \dots\}$ is a proper subgroup of G.</p> <p>By examining $\langle x \rangle$ and $\langle x^2 \rangle$ of Case 2, the Lemma: If $G = \infty$, then there exists a proper subgroup of G, which eliminates Case 2, leaving us with Case 1, or that $G = \infty$.</p> <p>We now want to show G is prime, so let's suppose $G = pq$, where $p \neq 1$ and $q \neq 1$ (making p not prime). Let $x \in G$, $x \neq e$. So $\langle x \rangle = \{e, x, x^2, \dots, x^{pq-1}\}$. If $\langle x \rangle = \{e\}$ then $\langle x \rangle = G$ because either p elements or q elements will be generated, which is not the p elements in G. Thus, $\langle x \rangle = G$ is a proper subgroup of G.</p> <p>If $\langle x \rangle = \{e, x, x^2, \dots, x^{p-1}\}$ then $\langle x \rangle$ generates p elements and therefore $\langle x \rangle = G$, so G is cyclic of order p. However, if you choose an element of G, such as x^2, we can see that $\langle x^2 \rangle = \{e, x^2, x^4, \dots, x^{p-2}\} \neq G$. Therefore, $\langle x^2 \rangle = G$ because $\langle x^2 \rangle$ generates q elements, which is not all of G, and is thus a proper subgroup of G.</p> <p>Therefore, a group, G, with more than one element that has a non-prime order implies that G has a proper subgroup.</p> <p>And by the contrapositive, we can see that if G does not have a proper subgroup then the order of G is prime, which is what we wanted to show.</p>	<p>7.22 Suppose that G is a group with more than one element and G has no proper, nontrivial subgroups. Prove that the order of G is prime. (Do not assume that the order of G is finite.)</p> <p>Let $H = \langle x \rangle$ where $x \in G$, $x \neq e$. Since there is no proper subgroup of G, then $H = G$ since there is no proper subgroup of G. Since there is no group H where H divides G except when $H = \{e, x\}$. Therefore G is the only divisor of G, and G is prime. If G is infinite, let $x \in G$ where $x \neq e$. Then $\langle x \rangle = \{e, x, x^2, \dots\}$ is a subgroup of G. If $\langle x \rangle = G$, then G is cyclic of order n, which is a contradiction. In words the element x generates a proper subgroup of G, which cannot exist by the definition of G. If $\langle x \rangle = \{e, x\}$, then $\langle x^2 \rangle = G$, because the element x^2 is not in the group generated by $\langle x \rangle$, which is a contradiction to the definition of G. Therefore G must be a finite group. Therefore G is prime.</p> <p>7.24 Let G be a group of order 25. Prove that G is cyclic or $G^2 = e$ for all $g \in G$. In other words, show G is not cyclic implies $G^2 = e$, $\langle x \rangle = G$ for all $g \in G$. Possible orders for $\langle x \rangle$ include 1, 5, 25. G is not cyclic implies $\langle x \rangle = \{e, x, x^2, \dots, x^{24}\}$. Therefore $\langle x \rangle = G$. If $\langle x \rangle = G$, then G is cyclic of order 25. If $\langle x \rangle = \{e, x, x^2, \dots, x^{4}\}$, then $\langle x^5 \rangle = \{e, x^5, x^{10}, \dots, x^{20}\}$. This set of elements is a subgroup of G. If $\langle x^5 \rangle = G$, then G is cyclic of order 5. If $\langle x^5 \rangle = \{e, x^5, x^{10}, \dots, x^{20}\}$, then $\langle x^5 \rangle$ is a proper subgroup of G. The contrapositive has been shown. Thus, if G is a group with more than one element and G has no proper, nontrivial subgroups, then G is prime.</p> <p>24. Let G be a group of order 25. Prove that G is cyclic or $G^2 = e$ for all $g \in G$.</p> <p>Suppose that G is not cyclic. Then there does not exist a G that generates the group G. The order of the elements in G must divide 25, but cannot equal 25 because G is not cyclic. Hence, $G = 1$ or 5. If $G = 1$, then $G = \{e\}$ and $G^2 = e$. And if $G = 5$, then $G^2 = e$. And we can conclude that if G is not cyclic, $G^2 = e$ for all $g \in G$. Therefore, if G is a group of order 25, then G is cyclic or $G^2 = e$ for all $g \in G$.</p>	<p>22. Suppose that G is a group with more than one element and G has no proper, nontrivial subgroups. Prove that G is prime. (Do not assume that the order of G is finite.)</p> <p>Prove the contrapositive by supposing that G is not prime. Then we then 2 possible cases that result from this supposition.</p> <p>Case 1: $G = \infty$.</p> <p>Let $x \in G$, $x \neq e$. Either $\langle x \rangle = \{e, x, x^2, \dots\}$ or $\langle x \rangle = \{e, x, x^2, \dots, x^{n-1}\}$, where n is the order of x. Then G has a nontrivial proper subgroup.</p> <p>If $\langle x \rangle = \{e, x, x^2, \dots, x^{n-1}\}$, then G has a nontrivial proper subgroup. If $\langle x \rangle = \{e, x, x^2, \dots, x^{n-1}\}$, then G has a nontrivial proper subgroup.</p> <p>Case 2: $G = pq$.</p> <p>Let $x \in G$, $x \neq e$. Either $\langle x \rangle = \{e, x, x^2, \dots, x^{pq-1}\}$ or $\langle x \rangle = \{e, x, x^2, \dots, x^{p-1}\}$ or $\langle x \rangle = \{e, x, x^2, \dots, x^{q-1}\}$. Then we see $\langle x \rangle = G$ since $\langle x \rangle = G$ since $p < pq$ and $q < pq$.</p> <p>If $\langle x \rangle = \{e, x, x^2, \dots, x^{p-1}\}$, then $\langle x^q \rangle = \{e, x^q, x^{2q}, \dots, x^{(p-1)q}\}$. Then we see $\langle x^q \rangle = G$ since $\langle x^q \rangle = G$ since $p < pq$ and $q < pq$.</p> <p>If $\langle x \rangle = \{e, x, x^2, \dots, x^{q-1}\}$, then $\langle x^p \rangle = \{e, x^p, x^{2p}, \dots, x^{(q-1)p}\}$. Then we see $\langle x^p \rangle = G$ since $\langle x^p \rangle = G$ since $p < pq$ and $q < pq$.</p> <p>The contrapositive has been shown. Thus, if G is a group with more than one element and G has no proper, nontrivial subgroups, then G is prime.</p> <p>24. Let G be a group of order 25. Prove that G is cyclic or $G^2 = e$ for all $g \in G$.</p>

Interpretation

The papers from MA 110 demonstrate that students mastered the software sufficiently to produce a paper. However, the quality of the papers was decidedly mixed.

Students were required to use the software on the assignment evaluated here, but 1 of the 5 students in the course used the software on a later assignment for which it was not required (our goal was to have 20% of students in the course use it when not required, so we've met that goal).

Lack of accessibility of technical word processing software was an obstacle to students' learning to use it. The professor of MA 110 implemented her plan to introduce students to more accessible software (freeware, widely used in the academic communities of mathematics and computer science). The software was more difficult for students to install on their computers and required them to spend more time learning to use it than the software used in previous semesters. Consequently, more time (in and outside of class) was needed by students and professor to enable students to use the software. Students did report that in spite of the initial challenges, they preferred having the software on their own computers.

Using the Results and Next Steps

While these pieces of student work demonstrate one particular student learning outcome that our department hoped for, we continue to discuss how to include assessment of our broader goals for student writing in our evaluation of the technical word processing goal.

Toward that end, one faculty member circulated (within the department) a draft of a rubric that could help us take a more detailed look at the work students are producing with technical word processing software (this rubric is available on the department's program review web page). To make use of such a rubric, we need further departmental discussion about the student learning outcomes it would measure. As we considered when to have such a conversation, it became evident that we do not have consensus as a department about the value of pursuing the goal of having our students learn to use technical word processing software.

Moreover, the technical difficulties of installing and learning to use the freeware mentioned above have left us uncertain about whether our students are well-served by its use.

Those faculty who do value the goal may simply decide to make it a goal for the courses they teach, without making it a goal for all of our majors. Those faculty may decide to collaborate with each other on the assessment of that goal, and may find ways to collaborate across courses, but these ideas need further discussion. All the faculty who share this goal will be away for parts of 2006-07, so we will postpone further discussion until 2007-08.

Student Learning Outcome #2

100% of Liberal Studies students taking the CSET exam will pass the subject area exam in mathematics

Data

As of May 2006 CSET scores are available for 8 of the 9 Westmont Liberal studies graduates continuing into the Westmont Elementary program. 100% of students passed in each year

	2004-5	2005-06
Mathematics	4.00	3.875

Interpretation

The scores of Westmont Liberal Studies graduates leave very little room for improvement. The data clearly indicate that the current configuration of the MA160/MA165 series is serving the Liberal Studies majors well.

Using the Results and Next Steps

The scores do not indicate the need for any changes in the current program. Rather, any proposed changes should be carefully monitored to insure that there is not a negative impact.

We will continue to monitor the CSET mathematics scores of Liberal Studies students to insure that the current quality is maintained.