Overview of SLO Process Work for the Division

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
Dept - (PSME) Astronomy	ASTR 10	Appraise the benefits to society of astronomical research concerning stars and stellar systems.				
		Appraise the benefits to society of astronomical research concerning stars and stellar systems.				
		Evaluate astronomical news items or theories about stellar astronomy based upon the scientific method.				
		Evaluate astronomical news items or theories about stellar astronomy based upon the scientific method.				
		Evaluate the impact on Earth's characteristics of the evolution of stars and stellar systems.				
		Evaluate the impact on Earth's characteristics of the evolution of stars and stellar systems.				
	ASTR 4	Appraise the benefits to society of planetary research and exploration.				
		Appraise the benefits to society of planetary research and exploration.				
		Compare and contrast the development of planetary systems and of the major panet types, including those factors that have led to Earth's unique characteristics.				
		Compare and contrast the development of planetary systems and of the major panet types, including those factors that have led to Earth's unique characteristics.				
		Evaluate astronomical news				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		items or theories concerning solar system astronomy based upon the scientific method.				
		Evaluate astronomical news items or theories concerning solar system astronomy based upon the scientific method.				
Dept - (PSME) Chemistry	CHEM 10	Develop problem solving techniques by applying the "Scientific Method" to chemical data.				
		Develop problem solving techniques by applying the "Scientific Method" to chemical data.				
		Evaluate the relationship between molecular structure and chemical properties of compounds.				
		Evaluate the relationship between molecular structure and chemical properties of compounds.				
	CHEM 12A	Apply principles of thermodynamics, kinetics, and equilibrium to organic reaction systems.				
		Apply principles of thermodynamics, kinetics, and equilibrium to organic reaction systems.				
		Construct molecular structure from spectroscopic data.				
		Construct molecular structure from spectroscopic data.				
		Generate logical stepwise reaction mechanisms.				
		Generate logical stepwise reaction mechanisms.				
		Predict the product of a chemical reaction.				
		Predict the product of a chemical				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		reaction.				
	CHEM 12B	Apply molecular orbital theory to predict the outcome of selected chemical reactions.				
		Apply molecular orbital theory to predict the outcome of selected chemical reactions.				
		Apply resonance theory to predict the major and minor products of chemical reactions.				
		Apply resonance theory to predict the major and minor products of chemical reactions.				
		Construct logical stepwise reaction mechanisms for increasingly complex chemical systems.				
		Construct logical stepwise reaction mechanisms for increasingly complex chemical systems.				
		Generate logical multi-step syntheses of increasingly complex molecules.				
		Generate logical multi-step syntheses of increasingly complex molecules.				
	CHEM 12C	Apply the principles of thermodynamics, kinetics, equilibrium to biologically important molecules.				
		Apply the principles of thermodynamics, kinetics, equilibrium to biologically important molecules.				
		Conduct sectroscopic analysis and identifiy structures of biologically important molecules.				
		Conduct sectroscopic analysis and identifiy structures of biologically important molecules.				
		Design logical syntheses and				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		structural modifications of biologically important molecules.				
		Design logical syntheses and structural modifications of biologically important molecules.				
		Generate stepwise reaction mechanisms of biologically important molecules.				
		Generate stepwise reaction mechanisms of biologically important molecules.				
	CHEM 1A	Apply the first law of thermodynamics to chemical reactions.				
		Apply the first law of thermodynamics to chemical reactions.				
		Construct balanced reaction equations and illustrate principles of stoichiometry.				
		Construct balanced reaction equations and illustrate principles of stoichiometry.				
		Identify and explain trends in the periodic table.				
		Identify and explain trends in the periodic table.				
	CHEM 1B	Apply principles of chemical equilibrium to chemical reactions.				
		Apply principles of chemical equilibrium to chemical reactions.				
		Apply the second and third laws of thermodynamics to chemical reactions.				
		Apply the second and third laws of thermodynamics to chemical reactions.				
		Demonstrate a knowledge of intermolecular forces.				
		Demonstrate a knowledge of	blah blah blah			

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		intermolecular forces.	blah blah blah			
		Evaluate the principles of molecular kinetics.				
		Evaluate the principles of molecular kinetics.				
	CHEM 1C	Apply the principles of equilibrium and thermodynamics to electrochemical systems.				
		Apply the principles of equilibrium and thermodynamics to electrochemical systems.				
		Apply the principles of transition metail chemistry to predict outcomes of chemical reactions and physical properties.				
		Apply the principles of transition metail chemistry to predict outcomes of chemical reactions and physical properties.				
		Evaluate isotopic decay pathways.				
		Evaluate isotopic decay pathways.				
	CHEM 30A	Apply acid-base chemical principles to biological processes.				
		Apply acid-base chemical principles to biological processes.				
		Predict the behavior of ideal gasses using Kinetic Molecular Theory.				
		Predict the behavior of ideal gasses using Kinetic Molecular Theory.				
		Solve stoichiometric problems by applying appropriate molar relationships.				
		Solve stoichiometric problems by applying appropriate molar relationships.				
	CHEM	Differentiate the general				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	30B	reactions of the principle organic functional groups.				
		Differentiate the general reactions of the principle organic functional groups.				
		Evaluate the major classes of biological compounds from a chemical perspective.				
		Evaluate the major classes of biological compounds from a chemical perspective.				
	CHEM 50	Assess the fundamental concepts of modern atomic and molecular theory.				
		Assess the fundamental concepts of modern atomic and molecular theory.				
		Demonstrate a fundamental understanding of mathematical concepts pertaining to chemical experimentation and calculations.				
		Demonstrate a fundamental understanding of mathematical concepts pertaining to chemical experimentation and calculations.				
		Evaluate the standard classes of chemical reactions.				
		Evaluate the standard classes of chemical reactions.				
Dept - (PSME) Engineering	ENGR 10	The student will be able to analyze, graph and develop a formula for a given data set.				
		The student will be able to analyze, graph and develop a formula for a given data set.				
		The student will be able to write technical documentation both written and orally.				
		The student will be able to write				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		technical documentation both written and orally.				
		The student will work collaboratively on an engineering team.				
		The student will work collaboratively on an engineering team.				
	ENGR 35	The student will be able to analyze two- and three-dimensional force systems on rigid bodies in static equilibrium using vector and scalar analysis methods.				
		The student will be able to analyze two- and three-dimensional force systems on rigid bodies in static equilibrium using vector and scalar analysis methods.				
	ENGR 37	The student will be able to analyze circuits containing resistive, capacitive, inductive passive elements, along with op-amps interconnected to voltage and current sources.				
		The student will be able to analyze circuits containing resistive, capacitive, inductive passive elements, along with op-amps interconnected to voltage and current sources.				
		The student will be able to use circuit laws and network theorems to solve DC steady state circuits, RC, RL, and RLC DC circuit transients and sinusoidal AC steady state circuits.				
		The student will be able to use circuit laws and network theorems to solve DC steady state circuits, RC, RL, and RLC DC circuit transients and				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		sinusoidal AC steady state circuits.				
Dept - (PSME) Geology	GEOL 10	Apply scientific methodology and geologic principles to analyze the impact of the Earth system on humanity, from specific natural hazards and the availability, use, and distribution of Earth resources.				
		Apply scientific methodology and geologic principles to analyze the impact of the Earth system on humanity, from specific natural hazards and the availability, use, and distribution of Earth resources.				
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.				
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	Question 1 (data from 12 students): Correct choice: 58 percent Almost-correct choice: 25 percent Incorrect choices: 17 percent Question 2 (data from 24 students): Correct choice: 96 percent Almost-correct choice: 4 percent Incorrect choices: 0 percent Question 3 (data from 19 students): Correct choice: 42 percent Almost-correct choice: 16 percent Incorrect choices: 42 percent Question 4 (data from 24	As this was the first SLO assessed by the department, the assessment data have been examined for a baseline of target success date. The first fact that is apparent in the data is that success percentages can vary greatly. In the case of Question 2, virtually the entire class recognized the correct alternative hypothesis. For the other questions, slightly more or less than half of the class chose the best answer, with most of the remaining students choosing the `almost correct' answer.  This raises a number of interesting questions regarding how student success on SLO tasks may arise. While the SLOs are designed to be represent important cognitive skills, it is always possible for `skill	

Unit Name	Course /Servic e ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Actio n
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	students): Correct choice: 42 percent Almost-correct choice 1: 42 percent Almost-correct choice 2: 16 percent Incorrect choice: 0 percent	acquisition' to be mimicked by `learning a story'. It is possible that in the case of some or all of these questions, the `story' behind how scientists figured out the relevant portion of the Earth system might have been more or less memorable for students. This could, in turn, depend on how the material was presented in class.	
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'.	E1: It would be desirable to see more students select the correct answer. This is a case in which the students needed to have done some straightforward memorization, and less than half of them memorized the information correctly. Improving performance on this aspect of SLO 1 will probably involve finding ways to motivate the students to do a better job of the `memorization' part of their studying. E2: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. E3: Clearly, the subject of plate tectonics is sufficiently complicated and detailed that students stand a fair chance of not succeeding at SLO 1. It is probably worth examining how the lectures are structured and presented, and considering using newer pedagogical methods, such as those described under the category of `peer instruction'. Final, question 1: By choosing	This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	Student response data were tabulated for all three midterm exams (`E1', `E2', and `E3'), as well as for two questions on the final exam. On E1, a question about mineral cleavage was assessed. The students were asked to imagine a friend who suggests that minerals are made of atoms arranged in organized patterns. (This is, in fact, true.) They were further asked to imagine that they, the students, have proposed breaking a mineral to check for cleavage. (This is, in fact, a good test of the friend's hypothesis.) Question: What is a `fool you' mineral that lacks cleavage? This question requires the students to know enough about minerals and their cleavage to avoid an important pitfall that might arise when testing the friend's hypothesis. Student responses were about equally split between the correct choice (quartz, 39 percent), the `almost' response (pyroxene, which rarely displays its cleavage characteristics well, 31 percent, and the two bad answers (feldspar, mica, which both show distinct cleavage). The selected question from E2 asked the students to try and imagine examining layers of sedimentary rock in widely-separated areas. How might they determine whether the layers in the two areas are of the same age? 60 percent of the	the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. Final, question 2: It seemed clear from the 50-50 split between correct and incorrect answers that the students had not done a sufficient job of `keeping straight' the details about sedimentary structures, and/or they had not correctly visualized the problem. Possible ways of improving performance on this type of question might include giving them practice work of some sort, such as making drawings of sedimentary structures in tilted sequences of beds, and exchanging them with other students to analyze and interpret.	sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	students selected the best answer (finding index fossils), 32 percent chose the various bad answers, and only 6 percent chose the `almost' answer (finding fossils of organisms with hard skeletal parts). On E3, the tabulated question asked the students what *new* evidence revived the debate over continental drift, after the hypothesis had been rejected in the early 20th century? In this case, 71 percent of students selected one or the other of the bad answers. 16 percent selected the `almost' answer, and only 13 percent selected the correct answer (apparent polar-wander paths that did not match from continent to continent). The first tabulated question from the final exam asked the students to imagine examining an outcrop of igneous rock. What would constitute good evidence for an *intrusive* origin of the igneous rock? 64 percent of students selected the correct answer (an igneous dike cutting across other rocks), 31 percent selected one or the other of the bad answers (descriptions of sedimentary rocks), and only 5 percent selected the `almost' answer. The second tabulated question from the final exam asked the students to imagine examining a tilted sequence of sedimentary beds. What might indicate that the beds were overturned, if such were the case? Student	E1: It would be desirable to see more students select the correct answer. This is a case in which the students needed to have done some straightforward memorization, and less than half of them memorized the information correctly. Improving performance on this aspect of SLO 1 will probably involve finding ways to motivate the students to do a better job of the `memorization' part of their studying. E2: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. E3: Clearly, the subject of plate tectonics is sufficiently complicated and detailed that students stand a fair chance of not succeeding at SLO 1. It is probably worth examining how the lectures are structured and presented, and considering using newer pedagogical methods, such as those described under the category of `peer instruction'. Final, question 1: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. Final, question 2: It seemed clear from the 50-50 split between correct and incorrect answers that the students had not done a sufficient job of `keeping straight' the details	emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	responses were split evenly between the correct answer (downward-fining in a sandstone bed) and the three bad answers (descriptions of sedimentary structures in *upright* orientations).	about sedimentary structures, and/or they had not correctly visualized the problem. Possible ways of improving performance on this type of question might include giving them practice work of some sort, such as making drawings of sedimentary structures in tilted sequences of beds, and exchanging them with other students to analyze and interpret.	Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. Student response data were tabulated for all three midterm exams (`E1', `E2', and `E3'), as well as for two questions on the final exam. On E1, a question about mineral cleavage was assessed. The students were asked to imagine a friend who suggests that	E1: It would be desirable to see more students select the correct answer. This is a case in which the students needed to have done some straightforward memorization, and less than half of them memorized the information correctly. Improving performance on this aspect of SLO 1 will probably involve finding ways to motivate the students to do a better job of the `memorization' part of their studying. E2: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. E3: Clearly, the subject of plate tectonics is sufficiently complicated and detailed that students stand a fair chance of not succeeding at SLO 1. It is probably worth examining how the lectures are structured and presented, and considering using newer pedagogical methods, such as those described under the category of `peer instruction'. Final, question 1: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. Final, question 2: It seemed clear from the 50-50 split between correct and incorrect answers that the students had not done a sufficient job of `keeping straight' the details	implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	minerals are made of atoms arranged in organized patterns. (This is, in fact, true.) They were further asked to imagine that they, the students, have proposed breaking a mineral to check for cleavage. (This is, in fact, a good test of the friend's hypothesis.) Question: What is a `fool you' mineral that lacks cleavage? This question requires the students to know enough about minerals and their cleavage to avoid an important pitfall that might arise when testing the friend's hypothesis. Student responses were about equally split between the correct choice (quartz, 39 percent), the `almost' response (pyroxene, which rarely displays its cleavage characteristics well, 31 percent, and the two bad answers (feldspar, mica, which both show distinct cleavage). The selected question from E2 asked the students to try and imagine examining layers of sedimentary rock in widely-separated areas. How might they determine whether the layers in the two areas are of the same age? 60 percent of the students selected the best answer (finding index fossils), 32 percent chose the various bad answers, and only 6 percent chose the `almost' answer (finding fossils of organisms with hard skeletal parts). On E3, the tabulated question asked the students what *new* evidence revived the debate	about sedimentary structures, and/or they had not correctly visualized the problem. Possible ways of improving performance on this type of question might include giving them practice work of some sort, such as making drawings of sedimentary structures in tilted sequences of beds, and exchanging them with other students to analyze and interpret.	This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	over continental drift, after the hypothesis had been rejected in the early 20th century? In this case, 71 percent of students selected one or the other of the bad answers. 16 percent selected the `almost' answer, and only 13 percent selected the correct answer (apparent polar-wander paths that did not match from continent to continent). The first tabulated question from the final exam asked the students to imagine examining an outcrop of igneous rock. What would constitute good evidence for an *intrusive* origin of the igneous rock? 64 percent of students selected the correct answer (an igneous dike cutting across other rocks), 31 percent selected one or the other of the bad answers (descriptions of sedimentary rocks), and only 5 percent selected the `almost' answer. The second tabulated question from the final exam asked the students to imagine examining a tilted sequence of sedimentary beds. What might indicate that the beds were overturned, if such were the case? Student responses were split evenly between the correct answer (downward-fining in a sandstone bed) and the three bad answers (descriptions of sedimentary structures in *upright* orientations).	E1: It would be desirable to see more students select the correct answer. This is a case in which the students needed to have done some straightforward memorization, and less than half of them memorized the information correctly. Improving performance on this aspect of SLO 1 will probably involve finding ways to motivate the students to do a better job of the `memorization' part of their studying. E2: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. E3: Clearly, the subject of plate tectonics is sufficiently complicated and detailed that students stand a fair chance of not succeeding at SLO 1. It is probably worth examining how the lectures are structured and presented, and considering using newer pedagogical methods, such as those described under the category of `peer instruction'. Final, question 1: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. Final, question 2: It seemed clear from the 50-50 split between correct and incorrect answers that the students had not done a sufficient job of `keeping straight' the details	overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. Student response data were tabulated for all three midterm exams (`E1', `E2', and `E3'), as well as for two questions on the final exam. On E1, a question about mineral cleavage was assessed. The students were asked to imagine a friend who suggests that	about sedimentary structures, and/or they had not correctly visualized the problem. Possible ways of improving performance on this type of question might include giving them practice work of some sort, such as making drawings of sedimentary structures in tilted sequences of beds, and exchanging them with other students to analyze and interpret.	that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	minerals are made of atoms arranged in organized patterns. (This is, in fact, true.) They were further asked to imagine that they, the students, have proposed breaking a mineral to check for cleavage. (This is, in fact, a good test of the friend's hypothesis.) Question: What is a `fool you' mineral that lacks cleavage? This question requires the students to know enough about minerals and their cleavage to avoid an important pitfall that might arise when testing the friend's hypothesis. Student responses were about equally split between the correct choice (quartz, 39 percent), the `almost' response (pyroxene, which rarely displays its cleavage characteristics well, 31 percent, and the two bad answers (feldspar, mica, which both show distinct cleavage). The selected question from E2 asked the students to try and imagine examining layers of sedimentary rock in widely-separated areas. How might they determine whether the layers in the two areas are of the same age? 60 percent of the students selected the best answer (finding index fossils), 32 percent chose the various bad answers, and only 6 percent chose the `almost' answer (finding fossils of organisms with hard skeletal parts). On E3, the tabulated question asked the students what *new* evidence revived the debate	E1: It would be desirable to see more students select the correct answer. This is a case in which the students needed to have done some straightforward memorization, and less than half of them memorized the information correctly. Improving performance on this aspect of SLO 1 will probably involve finding ways to motivate the students to do a better job of the `memorization' part of their studying. E2: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. E3: Clearly, the subject of plate tectonics is sufficiently complicated and detailed that students stand a fair chance of not succeeding at SLO 1. It is probably worth examining how the lectures are structured and presented, and considering using newer pedagogical methods, such as those described under the category of `peer instruction'. Final, question 1: By choosing the correct answer 2-to-1 over the aggregate of both bad answers, students succeeded pretty well at SLO 1 in this case. Final, question 2: It seemed clear from the 50-50 split between correct and incorrect answers that the students had not done a sufficient job of `keeping straight' the details	instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	over continental drift, after the hypothesis had been rejected in the early 20th century? In this case, 71 percent of students selected one or the other of the bad answers. 16 percent selected the `almost' answer, and only 13 percent selected the correct answer (apparent polar-wander paths that did not match from continent to continent). The first tabulated question from the final exam asked the students to imagine examining an outcrop of igneous rock. What would constitute good evidence for an *intrusive* origin of the igneous rock? 64 percent of students selected the correct answer (an igneous dike cutting across other rocks), 31 percent selected one or the other of the bad answers (descriptions of sedimentary rocks), and only 5 percent selected the `almost' answer. The second tabulated question from the final exam asked the students to imagine examining a tilted sequence of sedimentary beds. What might indicate that the beds were overturned, if such were the case? Student responses were split evenly between the correct answer (downward-fining in a sandstone bed) and the three bad answers (descriptions of sedimentary structures in *upright* orientations).	about sedimentary structures, and/or they had not correctly visualized the problem. Possible ways of improving performance on this type of question might include giving them practice work of some sort, such as making drawings of sedimentary structures in tilted sequences of beds, and exchanging them with other students to analyze and interpret.	of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the	This is a generalized Action plan for Enhancement of student success in

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
			Questions from midterm exams and questions from final exam	Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. The Spring 2011 class that was selected for SLO 1 assessment was a 30-person night class. One question was selected from each of the four graded items in the course: The three midterm exams (`E1', `E2', and `E3'), and the final exam. On E1, students were asked what was the *early* evidence for organized atomic structure in crystals? The hypothesis that crystals have such an atomic	`almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	structure is a key part of an understanding of what terrestrial planets are made of, and in this question, students needed to distinguish between the *early* evidence, which suggests a hypothesis in the first place, and *later* evidence, which tests the hypothesis. 58 percent of student selected the correct choice (constancy of interfacial angles from crystal to crystal), 25 percent selected the `almost' choice (later evidence, such as from X-ray diffraction), and 17 percent of students selected one or another of the bad choices (other facts about minerals). On E2, the students were asked to imagine that they were discussing a desert landscape with a friend, such as that found in areas like Joshua Tree, where extremely large, rounded boulders are found. In the question, a friend suggests that the boulders were rounded by stream transport. What alternative hypothesis might be suggested? 95 percent of students gave the correct answer, than the boulders had been joint-bounded blocks whose corners and edges has been rounded off by chemical weathering while still buried under soil. On E3, students were asked to describe the new evidence that revived the hypothesis of continental drift, after it was dismissed in the early 20th century. Student responses were split (at 42 percent)	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	between the correct choice (apparent polar-wander paths that didn't match from continent to continent) and the two bad choices. 16 percent of students chose the `almost' answer (data related to purported rotation of continents). On the final exam, the question selected for assessment of SLO 1 was similar to one used for W2011. Students were asked to imagine examining beds of sedimentary rock in widely separated areas. How might they test the hypothesis that the beds were deposited at the same time? Student responses were evenly split (at 42 percent) between the correct choice (same fossils in the two areas) and an `almost' choice (same rock types in the two areas). 16 percent of students selected the other `almost' choice (volcanic ash in the sediment), and no students selected the bad choice (rocks are metamorphosed).	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. The Spring 2011 class that was selected for SLO 1 assessment was a 30-person night class. One question was selected from each of the four graded items in the course: The three midterm exams (`E1', `E2', and `E3'), and the final exam. On E1, students were asked	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	what was the *early* evidence for organized atomic structure in crystals? The hypothesis that crystals have such an atomic structure is a key part of an understanding of what terrestrial planets are made of, and in this question, students needed to distinguish between the *early* evidence, which suggests a hypothesis in the first place, and *later* evidence, which tests the hypothesis. 58 percent of student selected the correct choice (constancy of interfacial angles from crystal to crystal), 25 percent selected the `almost' choice (later evidence, such as from X-ray diffraction), and 17 percent of students selected one or another of the bad choices (other facts about minerals). On E2, the students were asked to imagine that they were discussing a desert landscape with a friend, such as that found in areas like Joshua Tree, where extremely large, rounded boulders are found. In the question, a friend suggests that the boulders were rounded by stream transport. What alternative hypothesis might be suggested? 95 percent of students gave the correct answer, than the boulders had been joint-bounded blocks whose corners and edges has been rounded off by chemical weathering while still buried under soil. On E3, students were asked to describe the new evidence that revived the hypothesis of	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	continental drift, after it was dismissed in the early 20th century. Student responses were split (at 42 percent) between the correct choice (apparent polar-wander paths that didn't match from continent to continent) and the two bad choices. 16 percent of students chose the `almost' answer (data related to purported rotation of continents). On the final exam, the question selected for assessment of SLO 1 was similar to one used for W2011. Students were asked to imagine examining beds of sedimentary rock in widely separated areas. How might they test the hypothesis that the beds were deposited at the same time? Student responses were evenly split (at 42 percent) between the correct choice (same fossils in the two areas) and an `almost' choice (same rock types in the two areas). 16 percent of students selected the other `almost' choice (volcanic ash in the sediment), and no students selected the bad choice (rocks are metamorphosed).	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. The Spring 2011 class that was selected for SLO 1 assessment was a 30-person night class. One question was selected from each of the four graded items in the course: The three midterm exams (`E1', `E2', and `E3'), and the final exam. On E1, students were asked	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	what was the *early* evidence for organized atomic structure in crystals? The hypothesis that crystals have such an atomic structure is a key part of an understanding of what terrestrial planets are made of, and in this question, students needed to distinguish between the *early* evidence, which suggests a hypothesis in the first place, and *later* evidence, which tests the hypothesis. 58 percent of student selected the correct choice (constancy of interfacial angles from crystal to crystal), 25 percent selected the `almost' choice (later evidence, such as from X-ray diffraction), and 17 percent of students selected one or another of the bad choices (other facts about minerals). On E2, the students were asked to imagine that they were discussing a desert landscape with a friend, such as that found in areas like Joshua Tree, where extremely large, rounded boulders are found. In the question, a friend suggests that the boulders were rounded by stream transport. What alternative hypothesis might be suggested? 95 percent of students gave the correct answer, than the boulders had been joint-bounded blocks whose corners and edges has been rounded off by chemical weathering while still buried under soil. On E3, students were asked to describe the new evidence that revived the hypothesis of	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	continental drift, after it was dismissed in the early 20th century. Student responses were split (at 42 percent) between the correct choice (apparent polar-wander paths that didn't match from continent to continent) and the two bad choices. 16 percent of students chose the `almost' answer (data related to purported rotation of continents). On the final exam, the question selected for assessment of SLO 1 was similar to one used for W2011. Students were asked to imagine examining beds of sedimentary rock in widely separated areas. How might they test the hypothesis that the beds were deposited at the same time? Student responses were evenly split (at 42 percent) between the correct choice (same fossils in the two areas) and an `almost' choice (same rock types in the two areas). 16 percent of students selected the other `almost' choice (volcanic ash in the sediment), and no students selected the bad choice (rocks are metamorphosed).	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. The Spring 2011 class that was selected for SLO 1 assessment was a 30-person night class. One question was selected from each of the four graded items in the course: The three midterm exams (\`E1', \`E2', and \`E3'), and the final exam. On E1, students were asked	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the \`almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like \`clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	what was the *early* evidence for organized atomic structure in crystals? The hypothesis that crystals have such an atomic structure is a key part of an understanding of what terrestrial planets are made of, and in this question, students needed to distinguish between the *early* evidence, which suggests a hypothesis in the first place, and *later* evidence, which tests the hypothesis. 58 percent of student selected the correct choice (constancy of interfacial angles from crystal to crystal), 25 percent selected the `almost' choice (later evidence, such as from X-ray diffraction), and 17 percent of students selected one or another of the bad choices (other facts about minerals). On E2, the students were asked to imagine that they were discussing a desert landscape with a friend, such as that found in areas like Joshua Tree, where extremely large, rounded boulders are found. In the question, a friend suggests that the boulders were rounded by stream transport. What alternative hypothesis might be suggested? 95 percent of students gave the correct answer, than the boulders had been joint-bounded blocks whose corners and edges has been rounded off by chemical weathering while still buried under soil. On E3, students were asked to describe the new evidence that revived the hypothesis of	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	continental drift, after it was dismissed in the early 20th century. Student responses were split (at 42 percent) between the correct choice (apparent polar-wander paths that didn't match from continent to continent) and the two bad choices. 16 percent of students chose the `almost' answer (data related to purported rotation of continents). On the final exam, the question selected for assessment of SLO 1 was similar to one used for W2011. Students were asked to imagine examining beds of sedimentary rock in widely separated areas. How might they test the hypothesis that the beds were deposited at the same time? Student responses were evenly split (at 42 percent) between the correct choice (same fossils in the two areas) and an `almost' choice (same rock types in the two areas). 16 percent of students selected the other `almost' choice (volcanic ash in the sediment), and no students selected the bad choice (rocks are metamorphosed).	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. The Spring 2011 class that was selected for SLO 1 assessment was a 30-person night class. One question was selected from each of the four graded items in the course: The three midterm exams (`E1', `E2', and `E3'), and the final exam. On E1, students were asked	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	what was the *early* evidence for organized atomic structure in crystals? The hypothesis that crystals have such an atomic structure is a key part of an understanding of what terrestrial planets are made of, and in this question, students needed to distinguish between the *early* evidence, which suggests a hypothesis in the first place, and *later* evidence, which tests the hypothesis. 58 percent of student selected the correct choice (constancy of interfacial angles from crystal to crystal), 25 percent selected the `almost' choice (later evidence, such as from X-ray diffraction), and 17 percent of students selected one or another of the bad choices (other facts about minerals). On E2, the students were asked to imagine that they were discussing a desert landscape with a friend, such as that found in areas like Joshua Tree, where extremely large, rounded boulders are found. In the question, a friend suggests that the boulders were rounded by stream transport. What alternative hypothesis might be suggested? 95 percent of students gave the correct answer, than the boulders had been joint-bounded blocks whose corners and edges has been rounded off by chemical weathering while still buried under soil. On E3, students were asked to describe the new evidence that revived the hypothesis of	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	continental drift, after it was dismissed in the early 20th century. Student responses were split (at 42 percent) between the correct choice (apparent polar-wander paths that didn't match from continent to continent) and the two bad choices. 16 percent of students chose the `almost' answer (data related to purported rotation of continents). On the final exam, the question selected for assessment of SLO 1 was similar to one used for W2011. Students were asked to imagine examining beds of sedimentary rock in widely separated areas. How might they test the hypothesis that the beds were deposited at the same time? Student responses were evenly split (at 42 percent) between the correct choice (same fossils in the two areas) and an `almost' choice (same rock types in the two areas). 16 percent of students selected the other `almost' choice (volcanic ash in the sediment), and no students selected the bad choice (rocks are metamorphosed).	E1: Overall, students performed well on this question, selecting the correct choice by a more than 2-to-1 margin over the `almost' choice, and by a more than 3-to-1 margin over the aggregate of the bad choices. E2: Students overwhelmingly recalled the correct story that really explains the existence of large, rounded rock masses in desert areas. E3: As in Winter 2011, student success on SLO 1, in the topic area of plate tectonics, was not especially good. This may reflect the general complexity of the topic. Concepts such as paleomagnetism and apparent polar-wander paths are quite complex. It may be necessary to devote more time in lecture to these topics, and/or to do more hands-on exercises in lab, as well as possibly employing peer-instruction techniques, in which students would help each other clarify and reinforce their understanding. Final: The split between *fossil correlation* and correlation of lithologies suggests that the students might not have understood the importance of the principle of fossil succession. It may be worth clarifying this point in the lecture, and/or the peer-instruction techniques suggested above, for E3.	of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The	The question used in this assessment required the students to envision testing a hypothesis. They are presented	Enhancement / Action: This is a generalized

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
			Questions from midterm exams and questions from final exam	Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as image files in the `Related Documents'. For the question used in this assessment, about half of the students selected the correct answer, and about half selected incorrect answers.	with the hypothesis that a particular rock sample is a metamorphic rock called *schist*, which forms when pre-existing rock (typically shale or mudstone) is exposed to high heat and pressure in the roots of a developing mountain range. What observable characteristics should the sample show, if it is in fact schist? It should show a foliation defined by aligned mica crystals.	Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the overall pool of

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as image files in the \`Related Documents'. For the question used in this assessment, about half of the students selected the correct answer, and about half selected incorrect answers.	The question used in this assessment required the students to envision testing a hypothesis. They are presented with the hypothesis that a particular rock sample is a metamorphic rock called *schist*, which forms when pre-existing rock (typically shale or mudstone) is exposed to high heat and pressure in the roots of a developing mountain range. What observable characteristics should the sample show, if it is in fact schist? It should show a foliation defined by aligned mica crystals.	assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult \`memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be \`kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests that additional

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as image files in the `Related Documents'. For the question used in this assessment, about half of the students selected the correct answer, and about half selected incorrect answers.	The question used in this assessment required the students to envision testing a hypothesis. They are presented with the hypothesis that a particular rock sample is a metamorphic rock called *schist*, which forms when pre-existing rock (typically shale or mudstone) is exposed to high heat and pressure in the roots of a developing mountain range. What observable characteristics should the sample show, if it is in fact schist? It should show a foliation defined by aligned mica crystals.	pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-instruction methods

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as image files in the `Related Documents'. For the question used in this assessment, about half of the students selected the correct answer, and about half selected incorrect answers.	The question used in this assessment required the students to envision testing a hypothesis. They are presented with the hypothesis that a particular rock sample is a metamorphic rock called *schist*, which forms when pre-existing rock (typically shale or mudstone) is exposed to high heat and pressure in the roots of a developing mountain range. What observable characteristics should the sample show, if it is in fact schist? It should show a foliation defined by aligned mica crystals.	can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask of our students. Thus,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Apply the principles of scientific methodology to evaluate hypotheses on how the earth works as an integrated system.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as image files in the \`Related Documents'. For the question used in this assessment, about half of the students selected the correct answer, and about half selected incorrect answers.	The question used in this assessment required the students to envision testing a hypothesis. They are presented with the hypothesis that a particular rock sample is a metamorphic rock called *schist*, which forms when pre-existing rock (typically shale or mudstone) is exposed to high heat and pressure in the roots of a developing mountain range. What observable characteristics should the sample show, if it is in fact schist? It should show a foliation defined by aligned mica crystals.	it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like \`clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For SLO 2 in Fall 2011, one question was selected from each of the three midterm exams (\`E1', \`E2', and \`E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were examining some ancient rocks,	E1: Although correct responses outnumbered bad responses by nearly 2-to-1, the percentage of correct responses could be higher. It is possible that students simply hadn't memorized enough facts about chemical weathering, or that they had trouble visualizing the environment at the Earth's surface changing through geologic time. Possible pedagogical responses might include changing the way this material is presented in lecture, or using a clicker question to emphasize this point, if the logistical and cost-to-students issues surrounding clickers can be fully settled. E2: Student success was fairly good on this question, although it would be desirable to improve the percentage of students choosing \`mass extinctions'. This is a case where the students probably needed to simply have the relevant facts memorized better. The fact that the geological time scale is divided on the basis of events in the history of life, particularly mass extinctions, is probably less amenable to peer-instruction methods and critical-thinking exercises, compared to other aspects of SLO 2. This may be a case where students need better training in how to memorize relevant information. In-class training or homework training, such as by making study cards of the sort the instructor used in college, might be a worthwhile form of \`in-class	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	and those rocks have undergone intense chemical weathering. What would best describe the environment in which this weathering occurred? 56 percent of students chose the correct response (an environment with a lot of water), 10 percent chose the `almost' response (a wet, but *cold* environment), and 34 percent chose one or the other of the bad responses (dry environments). On E2, students were asked about changes in the Earth system in this way: What events marked the boundaries between the Paleozoic and Mesozoic Eras, and between the Mesozoic and Cenozoic Eras? 61 percent of students selected the correct response (mass extinctions), 13 percent selected the `almost' response (mass extinctions, with one of the extinction dates wrong), and 26 percent selected one or the other of the bad responses (evolution of various traits that did not lead to mass extinctions). On E3, students were asked to choose what sort of data would best provide evidence for the changing relative positions of continents (i.e. continental drift) through time? 34 percent of students chose the correct answer (ancient, non-tilted lava flows in Antarctica, with horizontal paleomagnetic fields in them), 16 percent of students chose the `almost' answer (same, but with steeply-inclined	study skills training'. E3: As has been noticed in the assessment of SLO 1, questions related to plate tectonics tend to have the lowest success rates in SLO 2 as well. This may be a case in which students generally have more difficulty understanding the many details of paleomagnetism and plate-tectonic theory than the instructor does. Plate tectonics, especially as it intersects with the various SLOs, may require special attention, either in the form of revised lectures, more lecture time, covering it earlier in the quarter, and/or the use of new pedagogical techniques, such as those that involve peer-instruction techniques. Final, first question assessed: Student success was quite good on SLO 2, at nearly 80 percent correct. This is a case where they seemed to remember the details of the `Cambrian' explosion of life forms with hard skeletal parts, and its importance for the geological record. Although this is a `success story' for SLO 2, it may be worth asking `what made the students remember *this* part of the story better than, say the information about mass extinctions from the E2 question? Final, second question assessed: Student success on this question was quite good, with correct responses outnumbering the others by	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	fields), and 50 precent chose one or the other of the bad answers (various pieces of evidence for paleomagnetic reversals). On the final exam, the first question selected for assessment of SLO 2 concerned the fossil record. Students were asked why Precambrian rocks do not show much of a fossil record? 79 percent of students chose the correct response (organisms had not yet evolved hard skeletal parts), 3 percent chose the `almost' response (there were no more organisms with had skeletal parts, which is factually incorrect), and 18 percent chose one or the other of the two bad responses (non-factual claims about climate and sedimentation). The second question chosen from the final exam concerned ice ages. What was some of the original evidence for an ice age? 74 percent of students selected the correct choice (moraines far from present-day glaciers), 25 percent selected one or the other of the bad choices (factually incorrect accounts), and only 1 percent selected the`almost' choice (volcanic landforms that erupted through ice).	nearly 3 to 1.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For SLO 2 in Fall 2011, one question was selected from each of the three midterm exams (\`E1', \`E2', and \`E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were examining some ancient rocks,	E1: Although correct responses outnumbered bad responses by nearly 2-to-1, the percentage of correct responses could be higher. It is possible that students simply hadn't memorized enough facts about chemical weathering, or that they had trouble visualizing the environment at the Earth's surface changing through geologic time. Possible pedagogical responses might include changing the way this material is presented in lecture, or using a clicker question to emphasize this point, if the logistical and cost-to-students issues surrounding clickers can be fully settled. E2: Student success was fairly good on this question, although it would be desirable to improve the percentage of students choosing \`mass extinctions'. This is a case where the students probably needed to simply have the relevant facts memorized better. The fact that the geological time scale is divided on the basis of events in the history of life, particularly mass extinctions, is probably less amenable to peer-instruction methods and critical-thinking exercises, compared to other aspects of SLO 2. This may be a case where students need better training in how to memorize relevant information. In-class training or homework training, such as by making study cards of the sort the instructor used in college, might be a worthwhile form of \`in-class	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	and those rocks have undergone intense chemical weathering. What would best describe the environment in which this weathering occurred? 56 percent of students chose the correct response (an environment with a lot of water), 10 percent chose the `almost' response (a wet, but *cold* environment), and 34 percent chose one or the other of the bad responses (dry environments). On E2, students were asked about changes in the Earth system in this way: What events marked the boundaries between the Paleozoic and Mesozoic Eras, and between the Mesozoic and Cenozoic Eras? 61 percent of students selected the correct response (mass extinctions), 13 percent selected the `almost' response (mass extinctions, with one of the extinction dates wrong), and 26 percent selected one or the other of the bad responses (evolution of various traits that did not lead to mass extinctions). On E3, students were asked to choose what sort of data would best provide evidence for the changing relative positions of continents (i.e. continental drift) through time? 34 percent of students chose the correct answer (ancient, non-tilted lava flows in Antarctica, with horizontal paleomagnetic fields in them), 16 percent of students chose the `almost' answer (same, but with steeply-inclined	study skills training'. E3: As has been noticed in the assessment of SLO 1, questions related to plate tectonics tend to have the lowest success rates in SLO 2 as well. This may be a case in which students generally have more difficulty understanding the many details of paleomagnetism and plate-tectonic theory than the instructor does. Plate tectonics, especially as it intersects with the various SLOs, may require special attention, either in the form of revised lectures, more lecture time, covering it earlier in the quarter, and/or the use of new pedagogical techniques, such as those that involve peer-instruction techniques. Final, first question assessed: Student success was quite good on SLO 2, at nearly 80 percent correct. This is a case where they seemed to remember the details of the `Cambrian' explosion of life forms with hard skeletal parts, and its importance for the geological record. Although this is a `success story' for SLO 2, it may be worth asking `what made the students remember *this* part of the story better than, say the information about mass extinctions from the E2 question? Final, second question assessed: Student success on this question was quite good, with correct responses outnumbering the others by	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	fields), and 50 precent chose one or the other of the bad answers (various pieces of evidence for paleomagnetic reversals). On the final exam, the first question selected for assessment of SLO 2 concerned the fossil record. Students were asked why Precambrian rocks do not show much of a fossil record? 79 percent of students chose the correct response (organisms had not yet evolved hard skeletal parts), 3 percent chose the `almost' response (there were no more organisms with had skeletal parts, which is factually incorrect), and 18 percent chose one or the other of the two bad responses (non-factual claims about climate and sedimentation). The second question chosen from the final exam concerned ice ages. What was some of the original evidence for an ice age? 74 percent of students selected the correct choice (moraines far from present-day glaciers), 25 percent selected one or the other of the bad choices (factually incorrect accounts), and only 1 percent selected the`almost' choice (volcanic landforms that erupted through ice).	nearly 3 to 1.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For SLO 2 in Fall 2011, one question was selected from each of the three midterm exams (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were examining some ancient rocks,	E1: Although correct responses outnumbered bad responses by nearly 2-to-1, the percentage of correct responses could be higher. It is possible that students simply hadn't memorized enough facts about chemical weathering, or that they had trouble visualizing the environment at the Earth's surface changing through geologic time. Possible pedagogical responses might include changing the way this material is presented in lecture, or using a clicker question to emphasize this point, if the logistical and cost-to-students issues surrounding clickers can be fully settled. E2: Student success was fairly good on this question, although it would be desirable to improve the percentage of students choosing `mass extinctions'. This is a case where the students probably needed to simply have the relevant facts memorized better. The fact that the geological time scale is divided on the basis of events in the history of life, particularly mass extinctions, is probably less amenable to peer-instruction methods and critical-thinking exercises, compared to other aspects of SLO 2. This may be a case where students need better training in how to memorize relevant information. In-class training or homework training, such as by making study cards of the sort the instructor used in college, might be a worthwhile form of `in-class	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	and those rocks have undergone intense chemical weathering. What would best describe the environment in which this weathering occurred? 56 percent of students chose the correct response (an environment with a lot of water), 10 percent chose the `almost' response (a wet, but *cold* environment), and 34 percent chose one or the other of the bad responses (dry environments). On E2, students were asked about changes in the Earth system in this way: What events marked the boundaries between the Paleozoic and Mesozoic Eras, and between the Mesozoic and Cenozoic Eras? 61 percent of students selected the correct response (mass extinctions), 13 percent selected the `almost' response (mass extinctions, with one of the extinction dates wrong), and 26 percent selected one or the other of the bad responses (evolution of various traits that did not lead to mass extinctions). On E3, students were asked to choose what sort of data would best provide evidence for the changing relative positions of continents (i.e. continental drift) through time? 34 percent of students chose the correct answer (ancient, non-tilted lava flows in Antarctica, with horizontal paleomagnetic fields in them), 16 percent of students chose the `almost' answer (same, but with steeply-inclined	study skills training'. E3: As has been noticed in the assessment of SLO 1, questions related to plate tectonics tend to have the lowest success rates in SLO 2 as well. This may be a case in which students generally have more difficulty understanding the many details of paleomagnetism and plate-tectonic theory than the instructor does. Plate tectonics, especially as it intersects with the various SLOs, may require special attention, either in the form of revised lectures, more lecture time, covering it earlier in the quarter, and/or the use of new pedagogical techniques, such as those that involve peer-instruction techniques. Final, first question assessed: Student success was quite good on SLO 2, at nearly 80 percent correct. This is a case where they seemed to remember the details of the `Cambrian' explosion of life forms with hard skeletal parts, and its importance for the geological record. Although this is a `success story' for SLO 2, it may be worth asking `what made the students remember *this* part of the story better than, say the information about mass extinctions from the E2 question? Final, second question assessed: Student success on this question was quite good, with correct responses outnumbering the others by	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	fields), and 50 precent chose one or the other of the bad answers (various pieces of evidence for paleomagnetic reversals). On the final exam, the first question selected for assessment of SLO 2 concerned the fossil record. Students were asked why Precambrian rocks do not show much of a fossil record? 79 percent of students chose the correct response (organisms had not yet evolved hard skeletal parts), 3 percent chose the `almost' response (there were no more organisms with had skeletal parts, which is factually incorrect), and 18 percent chose one or the other of the two bad responses (non-factual claims about climate and sedimentation). The second question chosen from the final exam concerned ice ages. What was some of the original evidence for an ice age? 74 percent of students selected the correct choice (moraines far from present-day glaciers), 25 percent selected one or the other of the bad choices (factually incorrect accounts), and only 1 percent selected the`almost' choice (volcanic landforms that erupted through ice).	nearly 3 to 1.	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For SLO 2 in Fall 2011, one question was selected from each of the three midterm exams (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were examining some ancient rocks,	E1: Although correct responses outnumbered bad responses by nearly 2-to-1, the percentage of correct responses could be higher. It is possible that students simply hadn't memorized enough facts about chemical weathering, or that they had trouble visualizing the environment at the Earth's surface changing through geologic time. Possible pedagogical responses might include changing the way this material is presented in lecture, or using a clicker question to emphasize this point, if the logistical and cost-to-students issues surrounding clickers can be fully settled. E2: Student success was fairly good on this question, although it would be desirable to improve the percentage of students choosing `mass extinctions'. This is a case where the students probably needed to simply have the relevant facts memorized better. The fact that the geological time scale is divided on the basis of events in the history of life, particularly mass extinctions, is probably less amenable to peer-instruction methods and critical-thinking exercises, compared to other aspects of SLO 2. This may be a case where students need better training in how to memorize relevant information. In-class training or homework training, such as by making study cards of the sort the instructor used in college, might be a worthwhile form of `in-class	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	and those rocks have undergone intense chemical weathering. What would best describe the environment in which this weathering occurred? 56 percent of students chose the correct response (an environment with a lot of water), 10 percent chose the `almost' response (a wet, but *cold* environment), and 34 percent chose one or the other of the bad responses (dry environments). On E2, students were asked about changes in the Earth system in this way: What events marked the boundaries between the Paleozoic and Mesozoic Eras, and between the Mesozoic and Cenozoic Eras? 61 percent of students selected the correct response (mass extinctions), 13 percent selected the `almost' response (mass extinctions, with one of the extinction dates wrong), and 26 percent selected one or the other of the bad responses (evolution of various traits that did not lead to mass extinctions). On E3, students were asked to choose what sort of data would best provide evidence for the changing relative positions of continents (i.e. continental drift) through time? 34 percent of students chose the correct answer (ancient, non-tilted lava flows in Antarctica, with horizontal paleomagnetic fields in them), 16 percent of students chose the `almost' answer (same, but with steeply-inclined	study skills training'. E3: As has been noticed in the assessment of SLO 1, questions related to plate tectonics tend to have the lowest success rates in SLO 2 as well. This may be a case in which students generally have more difficulty understanding the many details of paleomagnetism and plate-tectonic theory than the instructor does. Plate tectonics, especially as it intersects with the various SLOs, may require special attention, either in the form of revised lectures, more lecture time, covering it earlier in the quarter, and/or the use of new pedagogical techniques, such as those that involve peer-instruction techniques. Final, first question assessed: Student success was quite good on SLO 2, at nearly 80 percent correct. This is a case where they seemed to remember the details of the `Cambrian' explosion of life forms with hard skeletal parts, and its importance for the geological record. Although this is a `success story' for SLO 2, it may be worth asking `what made the students remember *this* part of the story better than, say the information about mass extinctions from the E2 question? Final, second question assessed: Student success on this question was quite good, with correct responses outnumbering the others by	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	fields), and 50 precent chose one or the other of the bad answers (various pieces of evidence for paleomagnetic reversals). On the final exam, the first question selected for assessment of SLO 2 concerned the fossil record. Students were asked why Precambrian rocks do not show much of a fossil record? 79 percent of students chose the correct response (organisms had not yet evolved hard skeletal parts), 3 percent chose the `almost' response (there were no more organisms with had skeletal parts, which is factually incorrect), and 18 percent chose one or the other of the two bad responses (non-factual claims about climate and sedimentation). The second question chosen from the final exam concerned ice ages. What was some of the original evidence for an ice age? 74 percent of students selected the correct choice (moraines far from present-day glaciers), 25 percent selected one or the other of the bad choices (factually incorrect accounts), and only 1 percent selected the`almost' choice (volcanic landforms that erupted through ice).	nearly 3 to 1.	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Servic e ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Actio n
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For SLO 2 in Fall 2011, one question was selected from each of the three midterm exams (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were examining some ancient rocks,	E1: Although correct responses outnumbered bad responses by nearly 2-to-1, the percentage of correct responses could be higher. It is possible that students simply hadn't memorized enough facts about chemical weathering, or that they had trouble visualizing the environment at the Earth's surface changing through geologic time. Possible pedagogical responses might include changing the way this material is presented in lecture, or using a clicker question to emphasize this point, if the logistical and cost-to-students issues surrounding clickers can be fully settled. E2: Student success was fairly good on this question, although it would be desirable to improve the percentage of students choosing `mass extinctions'. This is a case where the students probably needed to simply have the relevant facts memorized better. The fact that the geological time scale is divided on the basis of events in the history of life, particularly mass extinctions, is probably less amenable to peer-instruction methods and critical-thinking exercises, compared to other aspects of SLO 2. This may be a case where students need better training in how to memorize relevant information. In-class training or homework training, such as by making study cards of the sort the instructor used in college, might be a worthwhile form of `in-class	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	and those rocks have undergone intense chemical weathering. What would best describe the environment in which this weathering occurred? 56 percent of students chose the correct response (an environment with a lot of water), 10 percent chose the `almost' response (a wet, but *cold* environment), and 34 percent chose one or the other of the bad responses (dry environments). On E2, students were asked about changes in the Earth system in this way: What events marked the boundaries between the Paleozoic and Mesozoic Eras, and between the Mesozoic and Cenozoic Eras? 61 percent of students selected the correct response (mass extinctions), 13 percent selected the `almost' response (mass extinctions, with one of the extinction dates wrong), and 26 percent selected one or the other of the bad responses (evolution of various traits that did not lead to mass extinctions). On E3, students were asked to choose what sort of data would best provide evidence for the changing relative positions of continents (i.e. continental drift) through time? 34 percent of students chose the correct answer (ancient, non-tilted lava flows in Antarctica, with horizontal paleomagnetic fields in them), 16 percent of students chose the `almost' answer (same, but with steeply-inclined	study skills training'. E3: As has been noticed in the assessment of SLO 1, questions related to plate tectonics tend to have the lowest success rates in SLO 2 as well. This may be a case in which students generally have more difficulty understanding the many details of paleomagnetism and plate-tectonic theory than the instructor does. Plate tectonics, especially as it intersects with the various SLOs, may require special attention, either in the form of revised lectures, more lecture time, covering it earlier in the quarter, and/or the use of new pedagogical techniques, such as those that involve peer-instruction techniques. Final, first question assessed: Student success was quite good on SLO 2, at nearly 80 percent correct. This is a case where they seemed to remember the details of the `Cambrian' explosion of life forms with hard skeletal parts, and its importance for the geological record. Although this is a `success story' for SLO 2, it may be worth asking `what made the students remember *this* part of the story better than, say the information about mass extinctions from the E2 question? Final, second question assessed: Student success on this question was quite good, with correct responses outnumbering the others by	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	fields), and 50 precent chose one or the other of the bad answers (various pieces of evidence for paleomagnetic reversals). On the final exam, the first question selected for assessment of SLO 2 concerned the fossil record. Students were asked why Precambrian rocks do not show much of a fossil record? 79 percent of students chose the correct response (organisms had not yet evolved hard skeletal parts), 3 percent chose the `almost' response (there were no more organisms with had skeletal parts, which is factually incorrect), and 18 percent chose one or the other of the two bad responses (non-factual claims about climate and sedimentation). The second question chosen from the final exam concerned ice ages. What was some of the original evidence for an ice age? 74 percent of students selected the correct choice (moraines far from present-day glaciers), 25 percent selected one or the other of the bad choices (factually incorrect accounts), and only 1 percent selected the`almost' choice (volcanic landforms that erupted through ice).	nearly 3 to 1.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc?	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in

Unit Name	Course /Servic e ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of	retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too	the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83	dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, \`E2', and one from the third exam, \`E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like \`clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the \`almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the \`almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	E2, first question: In this case, students did not generally do a good job of recognizing \`upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other \`reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of \`hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called \`concealed stratification' or \`lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, \`E2', and one from the third exam, \`E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	E2, first question: In this case, students did not generally do a good job of recognizing \`upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other \`reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of \`hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called \`concealed stratification' or \`lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of \`peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as \`think-pair-share' exercises, and the use of Personal Response System (\`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, \`E2', and one from the third exam, \`E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the \`almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the \`almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	E2, first question: In this case, students did not generally do a good job of recognizing \`upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other \`reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of \`hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called \`concealed stratification' or \`lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the \`almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the \`almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Spring 2012, questions were chosen from the midterm exams (2 from the second exam, `E2', and one from the third exam, `E3'), and from the final exam. The class assessed in Spring 2012 was a night class. On E2, the first question	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	assessed involved looking at some drawings of tilted rock layers, and using the sedimentary structures in those layers to decide which drawing showed a set of overturned rock layers. The percentages of correct answers chosen (47 percent) and incorrect answers chosen (53 percent) were similar. E2, second question: Students were asked to imagine that they were measuring and describing the thicknesses and compositions of a stack of sedimentary beds. Given that they are able to see the exposed edges of these layers, what happened to the layers after deposition? This tests students on their understanding of Steno's third principle, a key tool in using data to track and predict changes in the Earth system. 78 percent of students chose the correct response (erosion), 13 percent chose the `almost' response (tilting), and 9 percent chose one or the other of the bad responses (metamorphism, folding). On E3, students were asked to imagine that they have seen gneiss (a metamorphic rock) in the Alps. Where did the deformation that they observe in the rock form? 60 percent chose the correct answer (in the mid to lower crust), 9 percent chose the `almost' answer (in the upper crust), and 31 percent chose one or the other of the bad answers (in the inner or outer	E2, first question: In this case, students did not generally do a good job of recognizing `upside-down' sedimentary structures. They had been presented with examples of this sort of thing in class, but did not seem to have retained the point of the examples as well as might be desired. As with many of the other `reflections and analyses' in the first cycle of SLO 1 and 2 assessments, it might be concluded that a greater degree of `hands-on' involvement with the material, through problem-solving exercises, might improve student performance on this SLO. E2, second question: Student success on this question was good, with correct responses outnumbering incorrect ones by nearly 4 to 1. The point in question here, Steno's third principle (sometimes called `concealed stratification' or `lateral continuity'), was given particular emphasis by the instructor during lecture. This raises - but does not prove - the possibility that it is possible to increase student success in a particular measure of an SLO simply through careful emphasis of that topic in class. E3: A large fraction of the students chose answers that were wide of the mark, and which reflected a misunderstanding of where (in the Earth) different types of deformation occur, and the fact that the iron from the core does	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	core). Final, first question assessed: As in Fall 2011 and Winter 2012, students were asked why Precambrian rocks do not show much of a fossil record. 83 percent of students chose the correct answer (organisms had not yet evolved hard skeletal parts), 4 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, which gets Earth history backward), and 13 percent chose one or the other of the bad answers (non-factual accounts of climate and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 63 percent of students selected the correct choice (moraines far from present-day glaciers), no one selected the `almost' choice (volcanic landforms that erupted through ice), and 37 percent selected one or the other of the bad choices (non-factual scenarios).	not get exposed at the surface. The material on types of deformation probably needs to be presented in a different way, along with a re-emphasis of the point (made at the beginning of the quarter) that the core is too dense for any of it to be exposed at the Earth's surface. Final, first question: The success rate were quite high for this assessment of SLO 2, at nearly 85 percent. This part of the story of the evolutionary history of life on Earth seems to be a reasonably straightforward thing for students to understand and to recall. Final, second question: Success was high, at over 60 percent, but a significant fraction of the class (slightly over a third) chose one of the factually incorrect scenarios given as answer choices. This raises the question of how completely the subject was covered in the reading and lectures, relative to other parts of the topic of glaciation. Previous quarters (e.g. Winter 2012) did better on this assessment of SLO 2, so clearly it is possible for students to succeed at higher rates in this area.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students	being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory	Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought.  Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose	portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities, have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (\`E1', \`E2', and \`E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the \`story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of \`peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as \`think-pair-share' exercises, and the use of Personal Response System (\`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or \`stratovolcano'), 10 percent chose the \`almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the \`leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the \`leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the \`almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected \`a', \`b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more \`bad' responses, and in most cases, an \`almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one \`almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the \`correct', \`almost', and \`bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as \`N=75'.  The results of the tabulation(s) can be seen as a PDF file in the \`Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (\`E1', \`E2', and \`E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or \`stratovolcano'), 10 percent chose the \`almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the \`leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the \`leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the \`almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the \`story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	parts of the \`parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult \`memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be \`kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a `baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or \`stratovolcano'), 10 percent chose the \`almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the \`leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the \`leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the \`almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	Enhancement / Action: This is a generalized Action plan for Enhancement of student success in the Student Learning Outcomes for Geology 10. It is based on SLOAC results for one year of SLO 1 (2010-2011) and one year of SLO 2 (2011-2012). Averaged over two school years and both SLOs, a broad pattern exists for student performance on a typical 4-item multiple-choice question from an in-class exam: About 60 percent of the students choose the correct response, with the remainder of the chosen responses distributed pretty evenly between the three incorrect choices. This performance level thus represents a \`baseline' from which improvements can be sought. Examples of low and high success rates on SLO-assessment embedded questions can be drawn from a number of different

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	parts of the `parameter space' represented by the overall pool of assessed questions. In some cases, students will succeed at an SLO by remembering key facts or data that they need in order to assess a hypothesis or track or predict some change in the Earth system. In other cases, the key facts are remembered less well, resulting in a lower success rate on the SLO. To the extent that this is correlated with subject matter, the most difficult `memory challenges' occur in the most complex subjects covered in Geology 10, particularly the subject of plate tectonics. This suggests that where the material involves a large number of details that have to be `kept straight', additional pedagogical emphasis is needed. Students in Geology 10 face other challenges as well, such as interpreting visual cues from drawings, or

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	This SLO was assessed by tabulating the multiple-choice responses that the students selected on their tests. (The Parscore system made it possible to count how many students selected `a', `b', etc? for any given question.) For each test question used in the SLO assessment, there is a correct response, one or more `bad' responses, and in most cases, an `almost correct' response. Each question had four choices, total - one correct, two or three bad choices, and in most cases, one `almost correct' choice.  Each test question that was chosen for SLO assessment was evaluated in the following way: The percentage of students choosing the `correct', `almost', and `bad' choices were reported as a percentage of total responses. The total number of tests used in the assessment was also recorded. For example, if 75 tests were used, this was reported as `N=75'.  The results of the tabulation(s) can be seen as a PDF file in the `Related Documents'. For the assessment of SLO 2 in Winter 2011, one question was selected from each midterm exam (`E1', `E2', and `E3'), and two questions were selected from the final exam. On E1, the students were asked to imagine that they were exploring the Goat Rocks, a real	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	visualizing scenarios described to them in words. This suggests that additional pedagogical emphasis may be needed for all forms of visualization and visual pattern recognition. Specific pedagogical actions can be undertaken to try and increase success rates on SLOs. The most attractive set of new teaching methods falls under the heading of `peer instruction'. Pioneered by instructors like Eric Mazur, a physics professor at Harvard, they involve students attempting to answer conceptual questions about the material, and then attempting to explain their answers to each other. Peer-instruction methods can take many forms, such as `think-pair-share' exercises, and the use of Personal Response System (`clickers'). Research by instructors like Mazur at Harvard, and a number of instructors in Geology and Astronomy at several universities,

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	place in Washington state. This group of small mountains are the remnants of an extinct, eroded volcano, made of alternating layers of ash and lava. What type of volcano was the Goat Rocks at an earlier time in Earth history? 62 percent of students chose the correct response (a composite volcano, or `stratovolcano'), 10 percent chose the `almost' response (a shield volcano), and 28 percent chose one or the other of the bad responses (cinder cone, rhyolite dome, both of which are relatively small). On E2, students were asked about the significance of the `leftovers' of weathering. By choosing the correct response, they could demonstrate their understanding of how rocks and Earth materials change through time. 62 percent of students chose the correct response (the `leftovers' are the ingredients of sedimentary rocks), 32 percent chose one or the other of the bad responses (various factually incorrect statements), and 6 percent chose the `almost' response. E3: The re-arrangement of the positions of the continents through time is one of the most important changes in the Earth system that can be tracked with data. In the selected question from E3, students were asked to identify a piece of evidence that had been used by Alfred Wegener when he first proposed the existence of the	E1: Students succeeded at SLO 2 at a high level, over 60 percent, although this number could conceivably be improved. It is possible that those students who got the question wrong might have had difficulty *visualizing* the landscape being very different in the past. They might also have failed to pick up on the key clue - that the alternating layers of ash and lava are what made the old edifice a composite volcano. E2: Student success was reasonably high - about 2-to-1 in favor of the correct response over the aggregate of the bad ones - but it might be higher, if students had more experience working with the concept of the rock cycle. E3: Student success was good for this particular assessment of SLO 2, with the percentage of correct choices greatly outnumbering the percentages for any of the other choices. It seemed in this case that students remembered well the `story' of how Wegener first proposed continental drift. Final, first question: Students succeeded at a high level on SLO 2 in this case, with correct responses very greatly outnumbering incorrect ones. However, it might be possible to increase the success rate in this aspect of SLO 2. This would involve finding a way to make students remember this facts about the history of life on Earth	have demonstrated (through research and data) that peer-instruction methods can significantly enhance student understanding of material. The Geology department has already done research on these methods, and has made preliminary efforts to experiment with them. For example, in-class experiments have been done in Geology 10 to try and use the PSME Division's set of clickers in class. Thus far, these experiments have mostly involved trying to work out the *logistical* details of implementing systems like those used at other schools. Given the fact that De Anza College does not have graduate teaching assistants or other resources, such as a 4-year school might have, the implementation of peer-instruction methods can be difficult. Additionally, whereas a 4-year school might easily be able to ask its students to buy in-

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Use data and observations to track and predict changes in the Earth system resulting from dynamic Earth Processes.	Questions from midterm exams and questions from final exam	supercontinent Pangea. 66 percent of students chose the correct answer (Paleozoic orogens divided across the Atlantic), 18 percent chose the `almost' answer (pre-Paleozoic orogens divided across the Pacific), and 16 percent chose one or another of the bad answers (various non-factual accounts). Final exam, first question: As was done for SLO 2 in Fall 2011, students were asked why Precambrian rocks don't show much of a fossil record. 69 percent of students chose the correct answer (organisms hadn't yet evolved hard skeletal parts), 9 percent chose the `almost' answer (there were no more organisms with hard skeletal parts, a choice which gets Earth history backward), and 22 percent chose one or the other of the bad answers (non-factual accounts of erosion and sedimentation). Final exam, second question: Students were asked to describe some of the original evidence for an ice age. 78 percent of students selected the correct choice (moraines far from present-day glaciers), 9 percent selected the `almost' choice (volcanic landforms that erupted through ice), and 13 percent selected one or the other of the bad choices (non-factual scenarios).	better, or making it easier to understand those facts. One suggestion might be to incorporate more exercises involving paleontology and fossils into the class, either as think-pair-share exercises in the lecture hall, or in the laboratory portion of the class. Final, second question: The success rate was fairly high for this assessment of SLO 2. In order to try and improve the success rate, it would probably be necessary for students to have read, heard, or researched an even more detailed account of the Earth's glacial history and how this history was elucidated.	class tools like clickers, this would be a difficult thing to ask of our students. Thus, it has been necessary to experiment with the rather basic set of clickers available in the PSME Division. New ways of implementing this technology, in which the students do not buy or own their own clickers, are in the process of development. While technology like `clickers' is only one example of peer-based instruction, it is generally hoped that experiments with peer instruction and related pedagogy can lead to greater student success in the learning outcomes for Geology 10. Experiments with these methods over the next few years will hopefully yield data that can be compared with the 2010-2011 and 2011-2012 cycles for SLO 1 and SLO 2.
		Use observations from the crust and lithosphere of the Earth to determine geologic history at				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		hand-sample, outcrop, local, and regional scales.				
		Use observations from the crust and lithosphere of the Earth to determine geologic history at hand-sample, outcrop, local, and regional scales.				
	GEOL 20	Analyze the dynamic movement of the water column of the oceans, through an application of the physical principles of ocean currents, waves, and tides and their effect on coastal systems and processes.				
		Analyze the dynamic movement of the water column of the oceans, through an application of the physical principles of ocean currents, waves, and tides and their effect on coastal systems and processes.				
		Apply scientific methodology and the principles of oceanography to analyze the impact of the ocean system on humanity, from specific natural hazards and the availability, use, and distribution of ocean resources.				
		Apply scientific methodology and the principles of oceanography to analyze the impact of the ocean system on humanity, from specific natural hazards and the availability, use, and distribution of ocean resources.				
		Apply the principles of scientific methodology to test hypotheses as to how the Earth's oceans work as an integrated system.				
		Apply the principles of scientific				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		methodology to test hypotheses as to how the Earth's oceans work as an integrated system.				
		Use observations and data to characterize the dynamic Earth processes that act to shape the ocean floor and analyze the record of these processes within marine sediments and oceanic crust.				
		Use observations and data to characterize the dynamic Earth processes that act to shape the ocean floor and analyze the record of these processes within marine sediments and oceanic crust.				
Dept - (PSME) Mathematics	MATH 10	Collect data, interpret, compose and defend conjectures, and communicate the results of random data using statistical analyses such as interval and point estimates, hypothesis tests, and regression analysis.				
		Collect data, interpret, compose and defend conjectures, and communicate the results of random data using statistical analyses such as interval and point estimates, hypothesis tests, and regression analysis.				
		Identify, evaluate, interpret and describe data distributions through the study of sampling distributions and probability theory.				
		Identify, evaluate, interpret and describe data distributions through the study of sampling distributions and probability				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		theory.				
		Organize, analyze, and utilize appropriate methods to draw conclusions based on sample data by constructing and/or evaluating tables, graphs, and numerical measures of characteristics of data.				
		Organize, analyze, and utilize appropriate methods to draw conclusions based on sample data by constructing and/or evaluating tables, graphs, and numerical measures of characteristics of data.				
	MATH 11	Compare, evaluate, judge, make informed decisions, and communicate results about various financial opportunities by applying the mathematical concepts and principles of the time value of money.				
		Compare, evaluate, judge, make informed decisions, and communicate results about various financial opportunities by applying the mathematical concepts and principles of the time value of money.				
		Identify, evaluate, and utilize appropriate linear and probability optimization models and communicate results.				
		Identify, evaluate, and utilize appropriate linear and probability optimization models and communicate results.				
	MATH 114	Analyze, interpret, and communicate results of exponential, logarithmic, rational, and discrete models in a logical manner from four points				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	MATH 114	of view - visual, formula, numerical, and written.				
		Analyze, interpret, and communicate results of exponential, logarithmic, rational, and discrete models in a logical manner from four points of view - visual, formula, numerical, and written.				
		Evaluate real-world situations and distinguish between and apply exponential, logarithmic, rational, and discrete function models appropriately.				
		Evaluate real-world situations and distinguish between and apply exponential, logarithmic, rational, and discrete function models appropriately.				
	MATH 12	Evaluate, solve, interpret and communicate business and social science applications using appropriate differentiation and integration methodologies.				
		Evaluate, solve, interpret and communicate business and social science applications using appropriate differentiation and integration methodologies.				
		Use correct notation and mathematical precision in the evaluation and interpretation of derivatives and integrals.				
		Use correct notation and mathematical precision in the evaluation and interpretation of derivatives and integrals.				
	MATH 1A	Analyze and synthesize the concepts of limits, continuity, and differentiation from a graphical, numerical, analytical and verbal approach, using correct notation and mathematical precision.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Analyze and synthesize the concepts of limits, continuity, and differentiation from a graphical, numerical, analytical and verbal approach, using correct notation and mathematical precision.				
		Evaluate the behavior of graphs in the context of limits, continuity and differentiability.				
		Evaluate the behavior of graphs in the context of limits, continuity and differentiability.				
		Recognize, diagnose, and decide on the appropriate method for solving applied real world problems in optimization, related rates and numerical approximation.				
		Recognize, diagnose, and decide on the appropriate method for solving applied real world problems in optimization, related rates and numerical approximation.				
	MATH 1B	Analyze the definite integral from a graphical, numerical, analytical, and verbal approach, using correct notation and mathematical precision.				
		Analyze the definite integral from a graphical, numerical, analytical, and verbal approach, using correct notation and mathematical precision.				
		Apply the definite integral in solving problems in analytical geometry and the sciences.				
		Apply the definite integral in solving problems in analytical geometry and the sciences.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Formulate and use the Fundamental Theorem of Calculus.				
		Formulate and use the Fundamental Theorem of Calculus.				
	MATH 1C	Apply infinite sequences and series in approximating functions.				
		Apply infinite sequences and series in approximating functions.				
		Graphically, analytically, numerically and verbally analyze infinite sequences and series from the perspective of convergence, using correct notation and mathematical precision.				
		Graphically, analytically, numerically and verbally analyze infinite sequences and series from the perspective of convergence, using correct notation and mathematical precision.				
		Synthesize and apply vectors, polar coordinate system and parametric representations in solving problems in analytic geometry, including motion in space.				
		Synthesize and apply vectors, polar coordinate system and parametric representations in solving problems in analytic geometry, including motion in space.				
	MATH 1D	Graphically and analytically synthesize and apply multivariable and vector-valued functions and their derivatives,				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	MATH 1D	using correct notation and mathematical precision.				
		Graphically and analytically synthesize and apply multivariable and vector-valued functions and their derivatives, using correct notation and mathematical precision.				
		Synthesize the key concepts of differential, integral and multivariate calculus.				
		Synthesize the key concepts of differential, integral and multivariate calculus.				
		Use double, triple and line integrals in applications, including Green's Theorem, Stokes' Theorem and Divergence Theorem.				
		Use double, triple and line integrals in applications, including Green's Theorem, Stokes' Theorem and Divergence Theorem.				
	MATH 201	Place, via test at Placement Office, into a mathematics course above Math 210.				
		Place, via test at Placement Office, into a mathematics course above Math 210.	Exit Test			
	MATH 202	Place, via test at Placement Office, into a mathematics course above Math 212.				
		Place, via test at Placement Office, into a mathematics course above Math 212.				
	MATH 203	Place, via test at Placement Office, into a mathematics course above Math 114.				
		Place, via test at Placement Office, into a mathematics course above Math 114.				
	MATH	Demonstrate and apply a				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	210	systematic and logical approach to solving arithmetic and geometric problems.				
		Demonstrate and apply a systematic and logical approach to solving arithmetic and geometric problems.				
		Demonstrate and apply the knowledge and skills required to select the correct introductory formulas, procedures, and concepts from algebra and geometry and use them to solve problems.				
		Demonstrate and apply the knowledge and skills required to select the correct introductory formulas, procedures, and concepts from algebra and geometry and use them to solve problems.				
	MATH 212	Analyze, interpret, and communicate results of linear and quadratic models in a logical manner from four points of view - visual, formula, numerical, and written.				
		Analyze, interpret, and communicate results of linear and quadratic models in a logical manner from four points of view - visual, formula, numerical, and written.				
		Demonstrate an appreciation and awareness of applications in their daily lives.				
		Demonstrate an appreciation and awareness of applications in their daily lives.				
		Evaluate real-world situations and distinguish between and apply linear and quadratic function models appropriately.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Evaluate real-world situations and distinguish between and apply linear and quadratic function models appropriately.				
	MATH 22	Analyze and apply patterns of discrete mathematical structures to demonstrate mathematical thinking.				
		Analyze and apply patterns of discrete mathematical structures to demonstrate mathematical thinking.				
		Critique a mathematical statement for its truth value, defend choice by formulating a mathematical proof or constructing a counterexample.				
		Critique a mathematical statement for its truth value, defend choice by formulating a mathematical proof or constructing a counterexample.				
	MATH 23	Collect data, interpret, compose and defend conjectures, and communicate the results of random data using statistical analyses such as interval and point estimates, hypothesis tests, and regression analysis.				
		Collect data, interpret, compose and defend conjectures, and communicate the results of random data using statistical analyses such as interval and point estimates, hypothesis tests, and regression analysis.				
		Organize, analyze, and utilize appropriate methods to draw conclusions based on sample data by constructing and/or evaluating tables, graphs, and numerical measures of characteristics of data.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Organize, analyze, and utilize appropriate methods to draw conclusions based on sample data by constructing and/or evaluating tables, graphs, and numerical measures of characteristics of data.				
		Use calculus based mathematics to construct, analyze, apply, and simulate probability and sampling distributions in theory and applications, and to justify appropriate statistical analyses and inferential methods.				
		Use calculus based mathematics to construct, analyze, apply, and simulate probability and sampling distributions in theory and applications, and to justify appropriate statistical analyses and inferential methods.				
	MATH 241	Analyze and develop linear, polynomial, exponential, logarithmic and implicit function models.				
		Analyze and develop linear, polynomial, exponential, logarithmic and implicit function models.				
		Communicate concepts and solutions for problems both verbally and in writing.				
		Communicate concepts and solutions for problems both verbally and in writing.				
	MATH 242	Analyze and develop trigonometric models.				
		Analyze and develop trigonometric models.				
		Communicate concepts and				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		solutions for problems both verbally and in writing.				
		Communicate concepts and solutions for problems both verbally and in writing.				
	MATH 243	Analyze and develop trigonometric, matrix, and discrete models for problems within two- and three-dimensional Cartesian or polar coordinate systems.				
		Analyze and develop trigonometric, matrix, and discrete models for problems within two- and three-dimensional Cartesian or polar coordinate systems.				
		Communicate concepts and solutions for problems both verbally and in writing.				
		Communicate concepts and solutions for problems both verbally and in writing.				
	MATH 2A	Classify, solve and analyze differential equation problems by applying appropriate techniques and theory.				
		Classify, solve and analyze differential equation problems by applying appropriate techniques and theory.				
		Construct and evaluate differential equation models to solve application problems.				
		Construct and evaluate differential equation models to solve application problems.				
	MATH 2B	Apply theoretical principles of linear algebra to define properties of linear transformations, matrices and vector spaces.				
		Apply theoretical principles of				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		linear algebra to define properties of linear transformations, matrices and vector spaces.				
		Construct and evaluate linear systems/models to solve application problems.				
		Construct and evaluate linear systems/models to solve application problems.				
		Solve problems by deciding upon and applying appropriate algorithms/concepts from linear algebra.				
		Solve problems by deciding upon and applying appropriate algorithms/concepts from linear algebra.				
	MATH 41	Investigate, evaluate, and differentiate between algebraic and transcendental functions in their graphic, formulaic, and tabular representations.				
		Investigate, evaluate, and differentiate between algebraic and transcendental functions in their graphic, formulaic, and tabular representations.				
		Synthesize, model, and communicate real-life applications and phenomena using algebraic and transcendental functions.				
		Synthesize, model, and communicate real-life applications and phenomena using algebraic and transcendental functions.				
	MATH 42	Formulate, construct, and evaluate trigonometric models to analyze periodic phenomena, identities, and geometric applications.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Formulate, construct, and evaluate trigonometric models to analyze periodic phenomena, identities, and geometric applications.				
	MATH 43	Analyze, develop, and evaluate formulas for sequences and series; Justify those formulas by mathematical induction.				
		Analyze, develop, and evaluate formulas for sequences and series; Justify those formulas by mathematical induction.				
		Analyze, investigate, and evaluate linear systems, vectors, and matrices related to two or three dimensional geometric objects.				
		Analyze, investigate, and evaluate linear systems, vectors, and matrices related to two or three dimensional geometric objects.				
		Graph and analyze regions/curves represented by inequalities or trigonometric, polar, and parametric equations, including conic sections.				
		Graph and analyze regions/curves represented by inequalities or trigonometric, polar, and parametric equations, including conic sections.				
	MATH 44	Analyze contemporary mathematical problems, apply problem solving techniques using a variety of methods, and communicate the results mathematically through a variety of forms.				
		Analyze contemporary mathematical problems, apply problem solving techniques using a variety of methods, and				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		communicate the results mathematically through a variety of forms.				
		Demonstrate and correctly apply basic mathematical techniques in at least five of the following ten areas: symmetry, graph theory, fractals and chaos theory, topology, number theory, geometry, combinatorics, methods of social choice, probability and statistics, economics and personal finance.				
		Demonstrate and correctly apply basic mathematical techniques in at least five of the following ten areas: symmetry, graph theory, fractals and chaos theory, topology, number theory, geometry, combinatorics, methods of social choice, probability and statistics, economics and personal finance.				
		Examine and evaluate myths and realities about the contemporary discipline of mathematics and its practitioners.				
		Examine and evaluate myths and realities about the contemporary discipline of mathematics and its practitioners.				
	MATH 46	Analyze mathematical problems from elementary mathematics, apply problem solving techniques using a variety of methods, solve these problems individually and in groups, and communicate results mathematically through a variety of forms.				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		Analyze mathematical problems from elementary mathematics, apply problem solving techniques using a variety of methods, solve these problems individually and in groups, and communicate results mathematically through a variety of forms.				
		Examine and evaluate myths and realities about the contemporary discipline of mathematics and its practitioners.				
		Examine and evaluate myths and realities about the contemporary discipline of mathematics and its practitioners.				
		Identify and discuss developments in the history of elementary mathematics from a variety of cultures.				
		Identify and discuss developments in the history of elementary mathematics from a variety of cultures.				
		Utilize ideas from number theory, distinguish types and properties of numbers, and employ mathematical rules for operating on rational and irrational numbers using verbal, symbolic, geometric, and numerical methods.				
		Utilize ideas from number theory, distinguish types and properties of numbers, and employ mathematical rules for operating on rational and irrational numbers using verbal, symbolic, geometric, and numerical methods.				
	MATH	Investigate an area of special				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	77	interest and demonstrate an appropriate level of understanding and expertise.				
		Investigate an area of special interest and demonstrate an appropriate level of understanding and expertise.				
Dept - (PSME) Meteorology	MET 10	Analyze and explain the objective techniques used by synoptic meteorologists and climatologists to forecast our planet's weather and to predict future changes in our planet's climate. .				
		Analyze and explain the objective techniques used by synoptic meteorologists and climatologists to forecast our planet's weather and to predict future changes in our planet's climate. .				
		Assess and critique the impact of meteorology and climatology as sciences on local, national and international economic, environmental, ethical and political issues including climate change.				
		Assess and critique the impact of meteorology and climatology as sciences on local, national and international economic, environmental, ethical and political issues including climate change.				
	MET 10L	Assess and defend the analysis and decision-making skills employed by meteorologists to diagnose air patterns, understand air motions and predict future atmospheric conditions.				
		Assess and defend the analysis and decision-making skills				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		employed by meteorologists to diagnose air patterns, understand air motions and predict future atmospheric conditions.				
Dept - (PSME) Physics	PHYS 10	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of physics in general.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of physics in general.				
	PHYS 2A	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 2B	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of electricity and magnetism.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of electricity and magnetism.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 2C	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of optics, thermodynamics, fluids, and modern physics.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of optics, thermodynamics, fluids, and modern physics.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 4A	Critically examine new, previously un-encountered problems, analyzing and				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
	PHYS 4A	evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 4B	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of electricity and magnetism.				
		Critically examine new, previously un-encountered				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of electricity and magnetism.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 4C	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of waves, fluids, optics, and thermodynamics.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of waves, fluids, optics, and thermodynamics.				
		Gain confidence in taking				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 4D	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of modern physics.				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of modern physics.				
		Gain confidence in taking precise and accurate scientific measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
		Gain confidence in taking precise and accurate scientific				

Unit Name	Course /Service ID	Student Learning Outcome (SLO)	Assessment Method	Assessment Data Summary	Reflection and Analysis	Enhancement/Action
		measurements, with their uncertainties, and then with calculations from them, analyze their meaning as relative, in an experimental context, to the verification and support of physics theories.				
	PHYS 50	Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics				
		Critically examine new, previously un-encountered problems, analyzing and evaluating their constituent parts, to construct and explain a logical solution utilizing, and based upon, the fundamental laws of mechanics				