A New Approach to Teaching Those with Disabilities: EMBed© Methodology and the Visually Disabled.

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At Arizona State University and peer institutions across the country, an increasingly large number of students with visual disabilities are enrolling in science courses *(1)*. Students may have disabilities that range from slight to severe learning disabilities and include those with multiple physical handicaps. Here, a case study will be presented using the Geological Sciences Department at Arizona State University as an example of how a university may offer learning accessible classes, teaching methods, and classrooms with adequate space and materials to teach to those with visual disabilities. This case study will also discuss how professors, instructors and teaching assistants can work with students in accordance with the Americans with Disabilities Act *(2)*.

Society and the Blind or the Visually Disabled

In American society today, more people with disabilities are taking harder and more complex courses at university than ever before. There has been a shift towards viewing a student with a disability or physical ailment not as someone to be put into a specialized learning institution, but as someone who can blend in and work within the modern world with little accommodation *(3)*. People once thought that those with a disability could not function in society; however, advances in accommodation have allowed all kinds of people to become professionals in many fields. New technology allows those with a disability to use voice recording devices, computers with programs for text reading, and even devices that amplify the clarity of pictures for those with partial vision *(4)*. A milestone in rights for the disabled was the 1990 passage of the Americans with Disabilities Act, legislation that greatly changed how society treats those with a disability both in everyday work situations and when considering general access to society's common necessities *(5)*.

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Working with the Visually Disabled

The introductory physical geology lab class(es) at Arizona State University use a proven and reliable lab manual called *Observing and Interpreting Geology – A Laboratory Manual for Introductory Geology* *(6)*. This manual was designed with the freshman student in mind and is aimed at helping them understand physical geology in the environment and how local geology reflects how people live and function in society. The lab manual is arranged in fourteen chapters and relies heavily on computer pictures, diagrams, group class activities, book illustrations , and physical examples in and out of the classroom setting. This format works well for those with some or no disabilities but not for those with visual disabilities.

The physical geology lab classes are taught by upper level undergraduate geology and graduate geology teaching assistants. During my time as a teaching assistant for this introductory geology course, I began to foresee the applicability of a revised lab manual geared toward the visually disabled. My experience in working as a teaching assistant in the geology lab was supplemented with a part time position as a tutor in the Disability Resource Center at ASU *(7)*. In the time between these two positions, I was able to work with visually disabled students in the lab course they were taking, and then individually engage them and review learned material. In working with these students I found out that some geologic teaching methods work well with most students, while some teaching methods are less efficient. Students are learning in the lab classes and lectures with handouts, power point presentations and physical examples, but sometimes don't understand the main concept of the material taught, especially those with a visual disability *(8)*. I soon found out that these traditional methods did not work on certain geology labs, so we arranged for myself and the student(s) to work independently of the assigned class on a one-on-one basis. I drew from these teaching experiences, and I set out to create a revised lab manual for visually disabled students and the ensuing EMBed© methodology for teaching those with more general disabilities besides the visual *(9)*.

EMBed© Methodology

EMBed © (Examples, Maps and Body) *(10)* was initially developed based on teaching the visually disabled. The emphasis on this methodology is a three-tiered teaching and learning approach. If the student does not understand one learning method, two others are used to help clarify the lesson objective, it is improvisational as well as predetermined, it can engage the student both mentally and physically and improve student test scores and overall retention of material *(11)*. This new or improved methodology was also based upon my experience in the United States Marine Corps. During training, Marines were told that we needed to overcome and adapt, or *improvise* when needed, thus the approach of EMBed©: *improvisation and adaptation to complete the objective at hand in understanding geology*.

Examples of EMBed© methods in geology can include a primary verbal and physical scenario with description(s) of the material *(12)*. This does not always clarify the task at hand in detail so we have begun to use contoured maps *(13)* to supplement to the verbal and physical scenarios in the second tier of teaching. These maps have indented contour lines and help the student to clarify different geological structures and terminology with similar rock samples of the area(s) of study. Large-scale Regional maps are also used to help the student understand regional geology of different areas of the United States and have raised contours and relief that enable the student to "feel" the changes of the land *(14)*. The final part of EMBed© teaching involves using the Body, mostly the arms and hands, to signify geological processes and to elucidate how these function or work in and on the earth. The process of using all three tiers together (Examples, Maps and Body) gives the student different aspects of understanding the material while navigating around the learning disability(ities) they have.

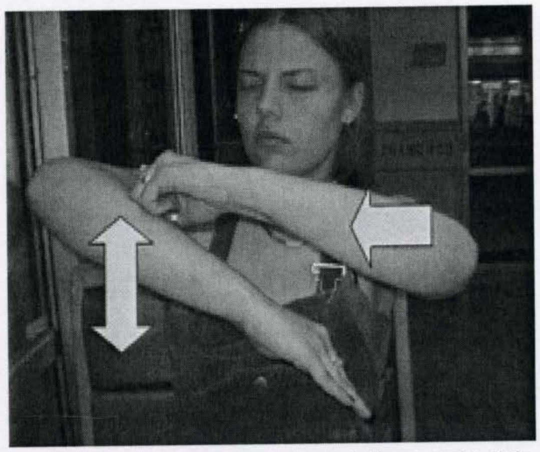

Figure 1. The subducting arm represents the oceanic plate, while the fist and the knuckles represent a volcano. Points on the arm are talked about as being where the rocks are now undergoing anatexis (melting of rock), metamorphism, and complete melting as the arm "subducts" deeper into the earth. Turning the hand 90° and vertical the fingers now identifies layers of rock for a clearer definition of the process. The fingers now represent a different metamorphic rock as they metamorphose at depth. The fingers become rock layers, with the top finger as shale, followed by slate, phyllites, schist and finally gneiss, all parts of the metamorphic process (16). Gneiss (a banded metamorphic rock) is demonstrated by each separate finger representing the alternating dark and white banding we see in the rock. The student may not see this or feel the texture, but this example works well in visualizing this banding process due to the white and black layering of Gneiss.

Examples and Research

Current lab testing uses various examples of EMBed© methods to demonstrate to and educate the student *(15)*. In one test (Body tier) designed to gauge the understanding of the differences between Igneous and Metamorphic rocks, we started with an example based on subduction of heavy oceanic rock slabs and what happens to these lithosphereic rocks that undergo this process. An example of the geologic process of subduction in the lithosphere is where an oceanic plate encounters a lighter continental plate and subducts, or slides below, the overlying continental plate. An analogy of the subduction process is placing cream in coffee. The cream floats to the top as it is lighter than the underlying coffee (the heavier oceanic plate / rocks), which is heavier than the overlying cream (continental plate / rocks). The motion of a subducting plate causes the rock to rise in temperature and pressure as it descends deeper into the earth, thus finally melting the rock in the final stage of subduction. This melting of rock then may cause magma to rise thereby forming a chain of volcanoes to appear on the surface, such as those seen in the Cascades Range of western North America. This geologic process example is easy to demonstrate using the arms and hands (Body tier of EMBed©) making the material very accessible to the student.

This example of EMBed methodology works well to "visualize" the problem at hand by modeling real world rocks and geologic events in time. The students who understand this EMBed© example might be taking a course in geology or geography, and have problems understanding the key concepts that are presented in the class or lab. The example of subduction is one of many aspects used to demonstrate basic principles of geology but also work well in getting the student to focus on the subject at hand. EMBed methodology may also work well in a class such as Organic Chemistry, in which using plastic models to define chemical components of molecules is part of the learning process to "visualize" something at the atomic scale *(17)*. This next leads into the second tier of the EMBed© methodology by using the maps to give form to the material that was discussed finally using the Body to bring it all together in a moving physical process of understanding.

While working using these methods it has been found that new methods or styles *arise* when working on a different geologic subject, but using a similar term in geology. One example was a demonstration of metamorphism using the hand. The hand is extended and it is explained that under metamorphic conditions the

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chemistry of the hand stays the same, but the *shape* changes, as the hand slowly becomes clenched. This can also help in explaining to the student who is being tutored on a subject besides geology.

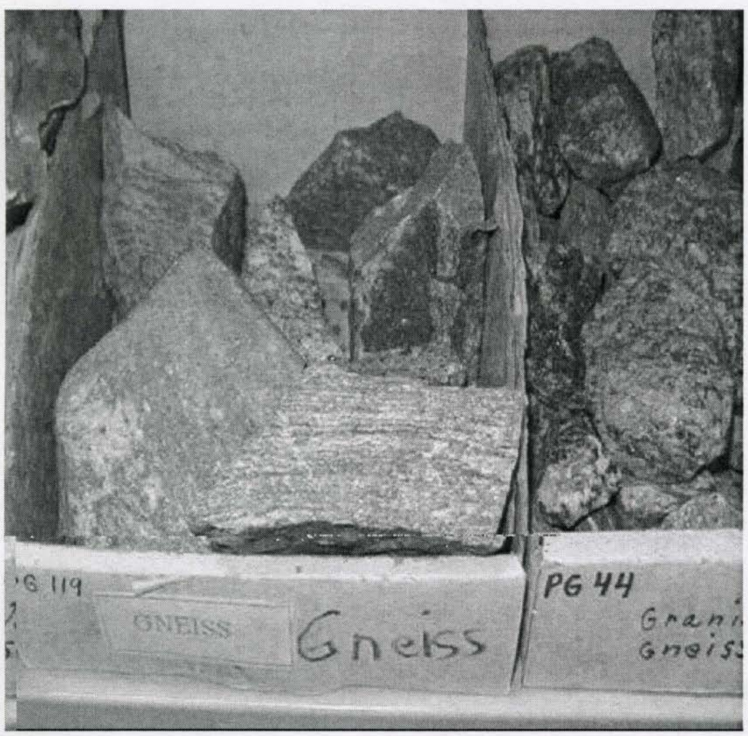
An example of this could be in mathematics during the explanation of a parabolic trend, in this case: x^2. The graph of this function around the y axis is a parabola and the fingers in a "v" fashion correspond to the changes in y as defined by x. The process is the same; the hand is still the same, the fingers just split apart to show changes as x increases or decreases and y changes *(18)*.

On going research based on new and dynamic testing of these methods for the lab chapter revisions have given good clues and stronger character to the lab material. This has also brought many new examples and references to the table for the student and instructor to use *(19)*.

Results and Conclusions

The EMBed© methods and tests were designed to examine the most efficient and effective means of enhancing individual memorization and cognitive learning. These physical examples and aides are to be used as supplements to the physical geology lab manual when those with visual disabilities take the lab course. These revised labs will replace certain disadvantageous labs for the visually impaired and expand on others that we understand these students need more time to fully understand and work on. In working with students with various other disabilities, these methods add to other methods of teaching.

Our current research *(20)* shows that the redesign of certain labs for visually disabled students has improved their ability in the aforementioned cognitive memorization and mnemonic methods of the lab material. Individual chapter research and revisions are currently ongoing, but tutoring individual students other than those with visual disabilities, while using the same teaching methods, has helped open a revised approach to this teaching *(21)*.



Results of these teaching methods with students other than those with visual disabilities has resulted in higher individual lab scores than based on taking the lab in the regular class group sessions *(22)*. These higher scores are the results of the EMBed© methods but also individual teaching focus, additional time spent with the student(s), access to more teaching material (i.e. rocks and field trips) and additional quizzes of material and lab grading. Additional informal surveys have brought about varied responses from students who have been asked about the effect EMBed© methods have had on their learning and retention of new information. This information has helped to refine and reevaluate the teaching and research focus of working with those with disabilities *(23)*. Students understand that being blind limits their ability to easily learn certain things that one with sight can accomplish readily. They also understand that these new methods of teaching and applying them with a significant amount of time to work with them will increase their desire to thoroughly learn it and enjoy it. Students may come into coursework at a university willing to settle for a passing grade, but I have found that by being positive and excited in teaching any subject, the student has a better chance of retaining the material, and perhaps even enhancing their comprehension and appreciation of it. At times it may behoove us all to remember that we all need a little help in understanding a problem, a question or life's simple quarks and the solution may be in utilizing a different approach to learning and understanding.

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Graphical References:

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