Promoting Understanding Through Peer Teaching in Small Group Settings

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Abstract

Peer teaching involves students teaching students in small group settings, where the teaching role passes from student to student until each has taught at least once. The teaching is done with the focus on related topics within a given theme and under the supervision of the classroom instructor. Giving students the opportunity to teach learned concepts to others helps students optimize their own learning and understanding of those concepts. Teaching others also requires students to pay attention, complete tasks, and make vital connections between the information given and their own experiences and strengths. This type of peer teaching in science classes helps to build a sense of community and shared ownership in the learning process. Our experience demonstrates that peer teaching can be successfully adapted as an instructional framework in science courses especially for those who enrolled as non-science majors. In this paper we show how a class is divided into small groups and each group is given a science topic that is closely related to the other groups' topics within one theme. The students are then required to research their science topic and subsequently teach it to the members of the other groups.

Introduction:

Teachers use a number of strategies to determine whether their students understand the nature and significance of a target concept and whether they have achieved real conceptual change, or a deep understanding that facilitates an association between related concepts (Bruner 1977). One strategy to gauge student understanding is to give them an opportunity to teach their newly learned concept to a group of students who are unfamiliar with it. Giving students the opportunity to teach learned concepts to others helps students optimize their own learning and understanding of those concepts, especially when students utilize their own generational language and contemporary analogies and metaphors in the process of teaching their peers. Teaching others also requires students to pay attention, complete tasks, and make vital connections between the information given and their own experiences and strengths (Boyles and Contadino 1998).

However, one cannot effectively produce a conceptual change in others if he or she does not possess a high level of understanding. Education, whether formal or informal, is essentially about having students learn a concept that can be measured in terms of breadth of knowledge and depth of understanding which in turn facilitates an association between related concepts. Thus to promote understanding is to ensure that students fully comprehend the nature, character and function of the subject. The perception of the concept may change with different students. For example, historical understanding in nine-year-olds may be conceived in terms of acquisition of information about dates and events, while in the case of older students it would include the ability to recognize patterns and to see the significance of events. (Barrow and Millburn 1990, p. 320)

The teacher-student must also have the skills and understanding to effectively communicate the target concept to others for the purpose of conceptual change, using (when needed) their own generational language and contemporary analogies and metaphors.

From a biology student's perspective, a younger student's understanding of, for example, the human body would likely consist of basic nomenclature and facts about various organ systems; older students would also have the ability to identify the relationship between the structure and the functions of the parts as well as how these systems depend on each other to maintain homeostasis. The peer teaching strategy encompasses both the acquisition of knowledge and the act of understanding the knowledge being learned, and the ability to effectively communicate the understanding of acquired knowledge to their peers.

Peer Teaching in a Small Group Setting:

Peer teaching involves students teaching students in small group settings, where the teaching role passes from student to student until each has taught at least once. The teaching is done with the focus on related topics within a given theme and under the supervision of the classroom instructor. The instructor divides the class into small groups and gives each group a topic that is closely related to the other groups' topics within one theme. The students are then required to research their topic and subsequently teach it to the members of the other groups. This student-focused approach is similar to andragogy (the pedagogy for adults) in significant ways. Table 1 shows examples of biology topics that have been researched and taught by students to other students in small group settings.

Table 1: Sample themes and related topics that can be taught using the Peer Teaching Method

	Specific Themes	**Related Topics**
1	Environmental Issues	Pollution, Energy, Population, Desertification or Deforestation
2	Monogenic Human Genetic Disorders	Autosomal recessive, Autosomal dominant, X-linked recessive, X-linked dominance disorders
3	Inner Solar System: A Planetary Comparative Study	Mars, Earth, Venus, Mercury
4	Applications of Biotechnology	In agriculture, In medicine, In industry, In energy resources, In environmental management
5	Mechanisms of Trait Inheritance	Cell theory, trait theory, chromosome theory, theory of genetic control
6	World Biomes	Tundra, coniferous forest, deciduous forest, tropical rain forest, grasslands
7	Energy Flow and Food Web in Ecosystem	Producers, consumers, decomposers
8	Protein Synthesis	Transcription, translation, flow of genetic information
9	Mass Extinctions Triggered by Sweeping Environmental Changes	Volcanic eruptions, Ice ages, The impact of giant meteorites, Environmental changes caused by human activities

Peer teaching in small groups is an excellent learning method because it is student- centered and self-directed. It involves cooperative group investigation, interpretation of findings, deduction of informative conclusions, and communication of the results. On the individual level, it aims to help students achieve a breadth and depth of understanding beyond the basics by asking them to take responsibility for the target concept. These self-learning responsibilities, which are a natural part of peer teaching, include conducting individual research, interpreting and understanding the research findings, making informative inferences, and communicating the information to other students using their generational language and contemporary analogies and metaphors. By participating in this learning method, students strengthen skills that include collecting information, organizing data, thinking critically, making decisions, troubleshooting problems, communicating effectively, and writing clearly. Students also learn to make connections and discover relationships between the concepts being studied.

The Role of the Instructor and the Students:

In the peer teaching approach, the classroom instructor facilitates group activity by:

- Creating a theme that incorporates all required concepts, theories, and other related knowledge. (e.g., see column 1, Table 1).
- Organizing the group assignments and scheduling.
- Providing an adequate support network for the students.
- Critically evaluating the final results and providing constructive feedback.

The role of each student in the peer teaching approach is to choose one of the identified topics of a given theme to research and learn independently for one week. The student writes a report and then teaches the subject to a group of four to five students. This means that each student is a presenter once and a student in a group setting a number of times. At various times, each student is either teaching a particular topic or learning about one of the other related topics in a given theme.

Themes and Topics for the Peer Teaching Strategy:

I have found this approach to be very effective in teaching related topics that center around a specific theme, such as environmental issues, human genetic disorders, planetary studies, and the applications of biotechnology to name a few. As an example from Table 1, in studying the environmental issues theme, the instructor can form four groups: environmental pollution, energy, human population, and desertification or deforestation. Or for example, in studying the monogenic human genetic disorders theme, students could be grouped into the following: autosomal recessive, autosomal dominant, X-linked recessive and X-linked dominance disorder.

Students are initially asked to identify only the key concepts from their chosen topics and then organize the data around those concepts. Thus, the environmental pollution students could use the key concepts of defining the problem, examining the sources of the problem, examining the environmental impact, and investigating the short-term and long-term solutions. Through these key concepts, the presenter provides other students with current and meaningful information that will help them make more informed and responsible decisions on environmental issues, including the effect of their own life style on the environment. The same can be said about the other themes and their associated topics identified in Table 1. For example, within the theme of monogenic human genetic disorders, students in the autosomal recessive disorders group can use cystic fibrosis as the main focus of their teaching. The second group, focused on autosomal dominant disorders, can focus on neurofibromatosis disease. The third group, who deals with X-linked recessive disorders, can focus on hemophilia. Finally, the fourth group, or the X-linked dominance disorders group, can focus on color-blindness. In all cases, the presenter (student-teacher) provides other students with relevant information, including the main characteristics of the disorder, likely occurrences of the disorder in males and females, the effect of the disorder on one's life style, and the effect of one's life style on the occurrence of the disorder.

Mechanisms of the Peer Teaching Approach:

A class of twenty four students would be divided into four groups of six students. Each group chooses one of the four topics within a given selected theme to research. Over a period of one week, each student in a group does his or her own research and writes a three-page report on a given topic. This means that by the end of the week, there will be six reports on each of the selected topics. For example, if the selected theme is genetic disorders, there will be six reports for each of the following disorders: autosomal recessive, autosomal dominant, X-linked recessive, and X-linked dominant. Or if the selected theme is on environmental issues, there will be six reports for each of the following topics: energy, pollution, overpopulation, and desertification or deforestation. At the end of the week each student submits a copy of his/her research report to the instructor. The instructor reviews the quality and scientific information in each report and provides constructive feedback by the following week. In addition, the members of each group submit to the instructor four questions derived from their research. Some of these questions could be selected by the instructor to use in the mid-term or final exam.

In the second week, students of each group meet for 45 minutes to share and discuss their research findings and use the instructor's feedback to make their reports more scientifically accurate and comprehensive.

In the third week, all the students regroup into six presentation groups of four students each (Figure1). Each presentation group has one representative from the study groups. For example, if environmental issues are the theme, then the presentation group will consist of a representative from the energy, overpopulation, pollution, and desertification or deforestation groups. In each presentation group, in this case, peer teaching then starts with the energy group representative teaching the other three group members about energy for 10 minutes, followed by a five minute period of questions. During this time, the other three students in the group do not take notes, but only listen and ask questions. After the questions, the same student (on energy) again teaches that topic, this time for 15 minutes. On this occasion, however, the presenter is expected to include information from the previous questions asked by their classmates. Also, this time the three other students in the group are allowed to take notes. By the end of the second teaching period, all the students return to the main classroom and participate in a 10-15 minute discussion about energy led by one of the energy students with the help of the instructor. As an assignment, all students except those who researched and taught the energy topic prepare a 2-to-3 page summary on energy using the information they learned from their classmates as well as from the general discussion and their course textbook.

Similar processes and procedures are repeated in the following class meetings, with two changes: the topic being studied and the students who teach it are different. This means that during each class meeting the presentation groups could change. The only criterion for these groups is that they have a representative from each of the four study groups. Using the above mentioned example, the following class meeting would be devoted to overpopulation, the next meeting to pollution, and the last meeting to desertification or deforestation.

Even though each student only researches and presents one topic within a given theme, s/he will have learned and taken notes on all four topics. By the end of the exercise, each student will have written a 2-3 page summary as well as a report on the researched topic. At the same time, the instructor has collected 16 questions developed by the students on a given theme.

Advantages of the Peer Teaching Approach

There are several advantages to using this particular method of teaching and learning. As the students prepare their reports, each has a sense of ownership of the materials that establishes him or her as the center of the activity and the source of information on the topic. It is his/her responsibility to choose relevant key concepts and to teach them effectively to the group. The retention of these student-owned learning materials is high and thus a solid knowledge base is established for future self-study. As one of my students once said:

> *I felt I needed to become an expert in this area [energy] in order to best help the group. As a group member, I also sought to listen attentively, ask pertinent questions, and take good notes. I felt informed and enlightened. At the time of writing my final report, I discovered that I had established a solid knowledge base and developed a depth of understanding that enabled me to write a high quality final report. This discussion with the students, who researched the same topic I did, not only increased my level of confidence, but also empowered me as a student to take ownership of my own learning.*

Another student in a different class wrote:

> *Even though I taught the topic for only 15 minutes, I really fell in love with the topic of hemophilia and I read everything that I came across related to this topic. I learned that it is really one of the most common forms of heredity disorders that affect both male and females and that it is a group of genetic disorders that impairs the body's ability to control blood clotting or coagulation. It is fascinating why it is more common among male than females simply because it is a recessive sex linked disorder and females have two X-chromosomes instead of only one as males do. But females can be asymptomatic carriers of the disorder where males cannot. Thus while it is not impossible for a female to have hemophilia, it is very rare and unusual because she has to be the daughter of both a male hemophiliac and a female carrier. But then, I was totally surprised to find out that there is a type of hemophilia that doesn't discriminate between sexes called Hemophilia C. Thankfully it is very rare.*

Students are required to acquire and organize data, to sense problems, and to develop concepts and language to convey their understanding. Today, these skills are not only highly desirable in the job market, but are also part of the basic survival skills necessary in the 21st century (Metz 2011).

While every student is involved with an independent, yet cooperatively investigated project, the focus is not on knowledge acquisition as an end in itself. Students must take their newly acquired knowledge and apply it by teaching it to their classmates, thus exercising a higher level of critical thinking. Students are also intellectually engaged in their own cognitive development through the analysis, synthesis, and evaluation of their own research, and the learning materials and methods of communication.

Psychologically, peer teaching gives students a greater feeling of control and responsibility that makes them more involved. This is a key property of the peer teaching method because an involved learner gains a better overall understanding than a passive learner.

Even though the approach of peer teaching is student-centered and self-directed, it is a cooperative group investigation and qualitatively holistic. As another one of my students wrote:

> *Toward the end of the exercise, I realized that the issues were related. For example, the use of certain kinds of energy causes desertification, or deforestations, which causes various types of pollutions including water pollution and soil erosion, which may eventually result in a decrease of population of a given living species. This helped me to understand the need for taking a holistic view in examining issues and a holistic approach in solving problems. But most of all, it forced me to critically question my own lifestyle.*

Peer teaching provides an opportunity for students to experience being the leader in one domain. It gives them a sense of power and teaches them leadership skills. Students also learn to be accountable for their own work and they achieve the goal of positive interdependence in a group.

Because presentations are restricted to a limited time, the presenters have to consider how to best convey their information and ideas so that their classmates can understand and take good notes. This forces students to think critically and to organize their data and information efficiently.

If you engage your students in peer teaching early in the semester and they complete their tasks, say before the middle of the semester, then most likely you will see your students differently than how you saw them at the beginning of the semester. Not only do they become more serious and engaged academically, but they also show more respect for their classmates, instructor, the academic discipline, and the value of teaching and learning in general.

Additional Concerns:

A few students may feel overwhelmed by the onset of new responsibilities with added psychosocial pressure. These students may be tempted to conclude "*It's too hard!*" or "*I can't do it!*" This situation is a wonderful opportunity for the instructor to provide extra guidance that will allow such students to overcome their inhibitions. Experiencing success will likely boost the students' confidence and leave a lasting impression, including a newly gained excitement for learning.

One other problem that might arise is an imbalance of ability or effort among the students. This could lead to inconsistent overall quality in the group. One way to counter this would be to make sure that group members meet regularly to review progress, share ideas, and check accuracy of interpretations and usefulness of selected analogies and metaphors, etc., so that any friction between them over the relative quality of presentations is minimized.

One more concern is the common overcrowding and other classroom population variances. The following alternatives were successfully tried:

1. Establish more related topics within a given theme.
2. Add two more students to each group, and select one member to act as the chair of the teaching group. A second member can be an outside media reporter who is writing a summary report about what has been discussed and taught in each group. This student reads his or her report to the group after all the students in a given group finish their teaching.

Suggestions for Adopting This Pedagogical Approach:

Those who wish to use this pedagogical approach are encouraged to adopt the following approaches:

1. Start with choosing less complicated investigative themes and topics with protocols and short learning curves.
2. Focus on themes and topics for which data can be collected in a short period of time.
3. Do not impose unrealistic expectations on your students that might lead to irreversible changes in personal attitude.
4. Start with only one or two targeted themes using this approach in a given semester until the instructor and students become comfortable with the approach.
5. Don't wait until you give the students their grades on tests and other assessments. Instead provide the students feedback on the quality of their instruction before the end of the semester. In doing this you are sending two important messages:
    a. To encourage students to take their assignment seriously by doing a good job, receiving good feedback from you, etc.
    b. To encourage them to do the same with you, as the instructor of the course, at the end of every teaching session by providing you with feedback on what you just taught them. So often we feel frustrated at the end of the class when we don't know what our students really experienced in the class we just taught them simply because they didn't provide any feedback.

    As Cantillon and Sargeant (2008) have argued: Without feedback, "*good practice is not reinforced, poor performance is not corrected, and the path to improvement not identified*" (p.2). Many other educators also have argued that "*feedback is most effective when it is well-timed according to daily work and is as close to the event that it evaluates as possible. And not when it is given after the fact, after the class is completed and the professor and students have gone their separate ways*" (Codone 2011, McKimm 2009, Kember, Leung, & Kwan 2002, Hesketh & Laidlaw 2002).

    Consider these practices

    - ✓ Immediately at the end of the instruction, ask students if they learned a great deal about the topic that was presented by their classmates
    - ✓ Ask the student-teacher to reflect on whether or not he/she had a good handle on whether his/her instruction was working.

Why should you use this pedagogy in your classes?

1. It helps you to infuse new energy and enthusiasm into your existing classes.
2. It reduces the level of restless and frustration among your students by making them more engaged.
3. It is a leaner-centered learning approach which provides opportunities for more students to participate in the class and in the learning process.
4. It forces students to gather, organize, and synthesize their knowledge enabling them to exercise a higher level of thinking.

Assessment:

Two approaches could be used to assess the effectiveness of peer teaching in small group settings. First, consider administering short essay questions that will require an explanation related to the studied topics. The second approach is administering open-ended essay questions that force students to reflect on their experience and analyze what they have learned at both personal and academic levels. For example, they might comment on whether they would like to repeat the experience in different disciplines, or how this experience can be improved for better results, etc. In addition, students are assessed on how well they write their research papers

and how well they perform on their mid-term and final exams, which may include the student-submitted questions.

To make this teaching strategy more effective, instructors need to engage in a continuous cycle of assessment, analysis, adjustment, and improvement. For example, they need to continually assess the level of progress in respect to the overall educational objectives. Also, they need to continually make adjustments based on their observations in order to maximize student learning and understanding. This makes assessment an ongoing process that is aimed at understanding and improving student learning. And as Freiberg and Driscoll (2000) argued, "*Effective instructors always plan and develop their assessment beyond the measurement of student learning*" (p.401) to include teaching, curriculum, and conditions for learning.

Learning Gains:

It is hard to disagree that engaging students with learning tasks at both the cognitive and effective levels leads to better acquisition and retention of information, mastering of the subject matter, and achieving productive understanding. If the students are not active, "*they are neither fully engaged nor learning as much as they could*" (Ali 2007, p. 79). After all, we teach so that the students can learn, and to learn is to "*acquire an understanding of something that one did not have before; to promote understanding is to ensure that students fully comprehend the nature, character, and function of the subject*" (Barrow and Millburn 1990, p. 320).

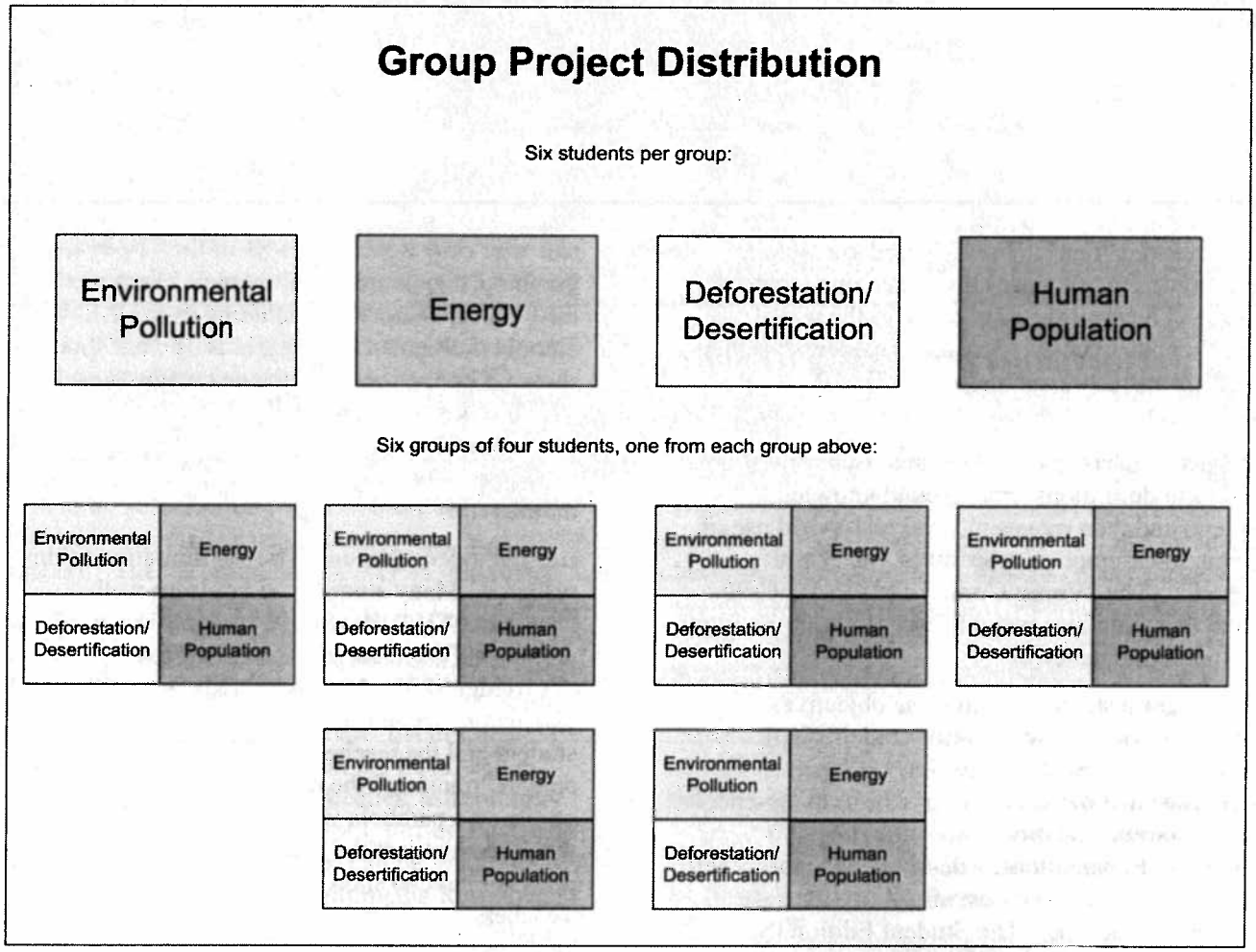
Peer teaching in small group settings helps develop a breadth of knowledge and depth of understanding. It also helps students to activate prior knowledge, to practice knowledge organization, and to simplify skills and concepts by breaking them down into basic components. This method also works by increasing student motivation to master new knowledge and skills, a key necessity to any person looking to succeed in this world. In addition, it helps to make students better peer mentors and gives them the chance to develop leadership skills early in their college careers.

In this peer teaching activity, students are not merely acquiring information from a teacher lecturing at them, they are being taught *how* to acquire their own knowledge (via independent research and group discussions) and then they are taught to apply their knowledge by teaching it to others. In this way, teachers are actually teaching students how to learn. As Ali (2007) explains:

> *As teachers teach to acquire information, ideas, skills, values, ways of thinking, and means of expressing themselves, they are also teaching them how to learn. In fact, the most important long-term outcome of instruction may be the students' increased capabilities to learn more easily and effectively in the future, both because of the knowledge and skill they have acquired and because they have mastered more learning processes.* (p.427)

Through the peer teaching approach, students are constantly engaged in their own learning. As they are required to teach the information to their classmates, they learn to synthesize information, pulling out the most important aspects of their chosen topic as well as any interesting points they feel compelled to share and teach. Through researching, discussing, organizing and analyzing, synthesizing, and finally teaching the information, students learn much more than their chosen topic; they learn about the learning process.

Figure 1: A class of twenty four is divided into four groups of six students. Each group chooses one of the four topics to research and write a report on a given topic individually. This means the class produces six reports on each of the selected topics: energy, pollution, overpopulation, and acid rain. Then all the students regroup into six presentation groups of four students each. Each of the presentation groups has one representative from the study groups on energy, overpopulation, pollution, and deforestation.



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