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ABSTRACT

In light of improving standards in education, some countries are going through major changes in their education systems. At the core of these movements lies the paradigm of changes in education. In the last two decades, constructivism became increasingly popular as a referent for professional actions in education. Under this constructivist worldview, teaching methods such as cooperative learning and inquiry in science instruction moved toward the front lines. The purpose of this paper is two fold. The first is to explain the theoretical bases for cooperative learning and inquiry learning through review of the literature in teaching and teacher education. The second is to explain the design of an integration of cooperative and inquiry learning in an instructional methods course for pre-service science teachers, specifically in Turkey. (SOE)

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Promoting Learner-Centered Instruction Through the Use of Cooperative and Inquiry Learning Strategies

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Promoting Learner-centered Instruction Through the Use of Cooperative and Inquiry Learning Strategies

Introduction

In the light of improving standards in education, some countries are going through major changes in their education systems. Turkey, for example, not only raised its compulsory education from five to eight years but also conducted major renovations in teacher education, by moving teacher certification to a master's level. (Yuksekogretim Kurulu, 1998). United States, on the other hand, focused its renovation attempts on the national standardizations in the areas of math and science education as well as the standardizations in advanced teacher certification, beginning teacher, licensure, and teacher preparation program accreditation. (Yinger, 1999). In order to improve the standards in both countries, expectations from teachers have been raised to a point, where the teachers required to create an environment, which results in productive learning.

In the core of these movements, lie the paradigm changes in education. As Maguire (1987) states, paradigms or worldviews create different lenses or windows from which we can observe and make sense of social reality. In the last two decades, constructivism became increasingly popular as referent for professional actions in education, as a conflicting paradigm to positivism. (Tobin, 1993).

From a constructivist perspective learning can be thought of as a social process of making sense of experience in terms of what is known. To improve learning, therefore, a teacher might consider how to improve the social processes, make sense of concepts, experiences, and extent knowledge. (Tobin, 1993). Tobin suggests teachers who are in countries where class sizes of more than 50 to 60 students, to think in terms of improving the quality of social interactions, providing

range of meaningful experiences to each learner and making it possible to each student to become aware of his/her relevant prior knowledge, and apply it to the process of learning.

Under this constructivist worldview, teaching methods such as cooperative learning and inquiry learning moved toward the front lines in the education field. The most important feature of these two methods share is that they both offer much promise in moving away from teacher-centered to student-centered instruction, enabling learners to construct their own knowledge. About the value of learner-centered approach Conti (1989) states "teaching style does make a difference in how students learn; generally the learner-centered approach is most effective." Further information about value of these two teaching approaches (cooperative and inquiry learning) will be discussed in the following section.

The purpose of this paper is two folded. First one is to explain the theoretical base for the two teaching strategies - cooperative learning and inquiry learning- through the review of literature in teaching and teacher education. Second, explain the design of an integration of cooperative and inquiry learning in an instructional methods course for pre-service science teachers in Turkey.

Review of Literature

"The nature of instruction is changing. At one time the teacher-centered approach was the norm." (Keefer, 1998/99) In the traditional method of teaching, the teacher was the sole source of information and knowledge. "Under constructivist approach, however, the teacher acts as a guide and a facilitator of learning rather than as an authoritarian dispenser of knowledge." (Keefer, 1998/99). Cooperative and inquiry learning are the two effective ways to practice this learner-centered instruction. The educational power of these two strategies are built on motivating the learners through their involvement in the instructional process, promoting self talk and analysis, and empowering the learners to feel like they are in charge of their learning process. Teachers

should not expect students to be consistently and invariantly knowledgeable or motivated in classroom. (Alexander, 1998). Cooperative and inquiry –based approaches can help teachers focus on creating interest and a positive environment for learners. Learners who have positive self-concepts and who believe to be in control of their learning are more likely to succeed in learning (Alexander, 1998). Moreover, teachers who plan student-centered instruction to get the students actively engaged in the learning environment will make the classroom more fulfilling for the students.

Although other terms such as collaborative learning, peer learning, peer-mediated learning, social learning, are used in literature; in this paper the term cooperative learning was chosen to broadly define the interaction of students working together in an educational environment in the roles of learners and/or teachers. As Webb and Palincsar (1996), state the concept of cooperative learning involves groups, which are considered to be constituted by people engaged in common tasks. These group members are independent in the performance of that task and interact in its pursuit. There are three overarching educational purposes of cooperative learning: a) social skills task of team building and cooperative skills (socio-psychological approaches); b) structured tasks of review and practice facts and skills (practice and organization perspectives); and c) unstructured tasks of conceptual, problem solving, thinking, and reasoning (cognitive approaches) (Woolfolk and Tschannen-Moran, 1999; and Slavin 1989, 1992).

Cooperative learning is not only an effective way to practice learner-centered instruction, but also an effective way to build community between home and school cultures with culturally and linguistically diverse students (Webb and Palincsar, 1996). Kagan (1994) suggests that balanced and heterogeneous groups with structure and guidance are most effective as an educational tool that meets the diverse needs of learners. Cooperative learning settings provide students from different backgrounds and characteristics to work together towards common goals, to get to know each other, and to work with each other as equals, which result in a wide variety of

outcomes. (Webb and Palincsar, 1996). Therefore, the advantage of using cooperative learning structures and dyads greatly increases student's participation and interaction with each other, thus, creating an environment for productive learning.

Inquiry learning, on the other hand, as a way to promote active learning, has become increasingly popular specifically in science education with the influence of National Science Education Standards. As Keefer (1998/99) states: " The operative theme of inquiry as a method of teaching science underpins the standards." Thus, the first teaching standard in the National Science Education Standards is " Teachers of science plan an inquiry-based science program for their students." (National Research Council, 1996). Inquiry learning has been characterized in the literature in many ways. (Collins, 1986; DeBoer, 1991; and Rakow, 1986, all cited in Haury, 1993). Some focus on the active student involvement aspect of learning generalizing it as the "hands-on learning", where as others emphasize the development of learners processing skills through the use of scientific method. (Haury, 1993). Therefore, inquiry involves not only the activity and the development of skills that are necessary but also personal curiosity and willingness toward increasing knowledge.

As an approach to education, inquiry gives full recognition to the relationship between individual and the society. On the one hand, it builds upon the experiences and interests of individuals and encourages them to direct their own learning, on the other; it seeks for the socially valued ways of thinking and acting. In inquiry, the importance of self-motivation is particularly evident, both in shaping of goals and in the ways in which learners work adaptively to achieve them. " Where one is involved in personally significant inquiry, there is an additional satisfaction and excitement in sharing what one is doing with others, in hearing what others are doing, and in discovering how these doings and understandings can be related." (Wells, 1999).

Although the value of inquiry approach is placed explicitly in the literature, the question of " "how to?" is not clearly stated. Though a number of examples have been provided in the text of

the National Science Education Standards. (National Research Council, 1996). Other suggestions from the literature can be summarized as follows;

a) Students need to be engaged in challenging activities that they find personally significant,
b) Teachers need to spend time with individuals or groups observing their progress and providing appropriate assistance when its needed,
c) The activities students engage need to be significant as a whole, provide opportunities for them to make systematic progress toward mastery of the tools and practices of the discipline,
d) Learning through action needs to be complemented by regular opportunities for learning through reflection.

Prospective teachers are reluctant to use diverse teaching strategies in their teaching because of the limited exposure in their preservice education programs. (Woolfolk and Tschannen-Moran, 1999). In addition, prospective teachers' beliefs about teaching and learning develop over the years of educational experiences and they can be highly resistant to change (Woolfolk and Tschannen-Moran, 1999). Therefore, preservice educators enter their professional program with preconceived beliefs about the teaching-learning process, and then they have little opportunity to change these beliefs in their program. Teachers' beliefs may have the greatest impact on what teachers do in the classroom, the ways they conceptualize the instructional process and the ways they learn from experience. (Brody and Davidson, 1998). Therefore, in order to make changes in teachers' beliefs, prospective teachers need to practice and learn diverse teaching strategies in the teacher education programs.

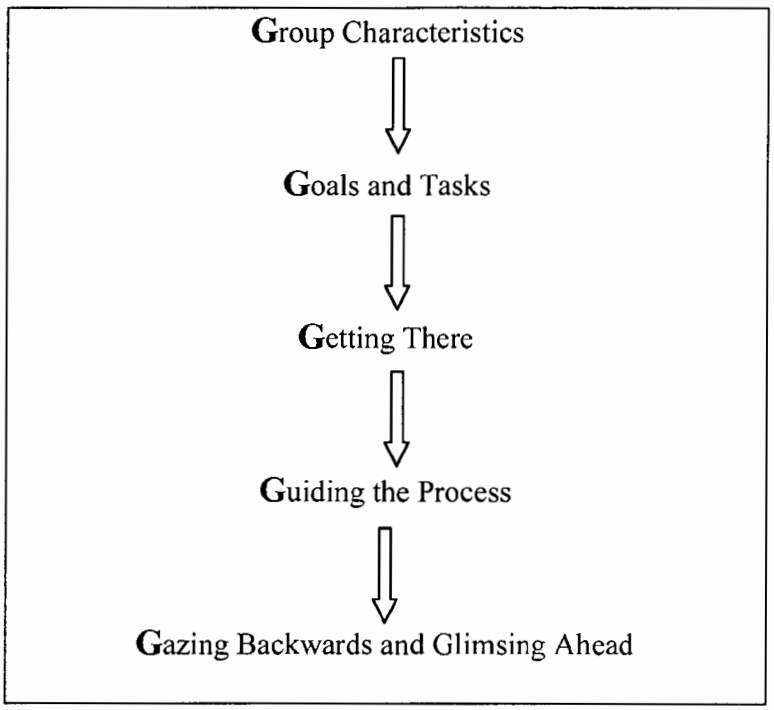
Effective educators are those who meet the needs of their learners. Meeting the needs of learners start with motivating them to think. Some of the most powerful actions that educators can use to meet the needs of the learners are to reduce social comparison, get learners actively

involved, focus on effort, promote beliefs in developing competency and increase the changes for success, all of which will motivate students as well as enhancing learning for all students. (Shuell, 1996). The following section of the paper aims to present a cooperative learning activity for preservice science teachers, with the purpose of introducing them to diverse teaching strategies, that are believed to be productive methods in science teaching, including inquiry-learning. The section will explain the design, implementation, and evaluation of the activity as well as describing some of the challenges that instructors are likely to face during the implementation.

Integrating Cooperative Learning and Inquiry in an Instructional Methods Course for Preservice Science Teachers

In this section, three hands-on activities (Guided, Challenge and Inquiry activities) are presented, in a cooperative learning setting. These activities are adapted from the web site of exploratorium institute for inquiry. (1997) The purpose is to develop pre-service science teachers' skills in cooperative learning as well as to introduce them to diverse teaching strategies, including inquiry learning. The strategies that are going to be presented should not be perceived as simply teaching methods, rather as powerful and flexible set of teaching approaches for a variety of student learning goals. During the process of planning, implementing, and assigning an activity certain crucial factors need to be taken into consideration. Woolfolk and Tschannen-Moran, (1999) suggest a five-step model called the "5-G Model" for teacher educators to assist pre-service teachers, as a guide to develop especially cooperative lesson plans. This 5-G model (See Figure 1) was taken into consideration during the facilitation, guiding, implementation, and assessment of this activity.

Figure 1- 5-G Model



Group Characteristics:

This cooperative learning activity is designed for a preservice teacher education program that certifies biology teachers in Turkey. The students in the program are required to have at least 3 years of undergraduate education in their fields. Due to their backgrounds, students are considered to have strong content knowledge. The classes usually compose of 35 to 45 students with similar backgrounds. Since the teacher education programs are not integrated pre-service teachers go on to specialize in their undergraduate content areas, which might reduce the power of cooperative interaction among groups. (Graduates of biology departments for example, specialize in biology teaching). The students, on the other hand, are self-motivated to be science teachers as they choose to continue their education in the education faculty to get their MEd. degrees and to be certified as teachers. The majority of the students come from competitive environments. This competitive environment they encounter through their educational life is closely related to the fact

that every student needs to pass the national university entrance examination in order to enter a university.

Lecture is the most common strategy used in the nations schools, where resources are limited, and the class sizes are large. In addition, there is also time strain to cover the national curriculum in order to prepare the students for the national examination. Therefore, pre-service teachers are accustomed to teacher-oriented environments, where the teacher is the only source of knowledge. In the last decade, there are movements in science education toward using hands-on activities in order to promote student learning. However, these movements are limited in their success because of the inexperienced teachers, and/or lack of time and resource issues.

Goals :

The activities that are going to be presented have two overall goals; a) cognitive and affective development of the groups as well as the individuals, through the use of cooperative learning, b) engagement of students in the investigative nature of science, through the use of three hands-on activities (guided, challenge, and inquiry activity). The pros and cons of using three different hands-on activities, as well as the use of cooperative learning will be discussed by the pre-service teachers at the end of the lesson.

Getting There:

Three foam activities that are going to be presented will allow preservice teachers to experience different hands-on approaches to the same subject as a way of approaching learning and science. These three activities are the guided activity, the challenge activity, and the inquiry activity. Together, these activities can get teachers to think about the different aspects of various hands-on approaches to learning. The way, pre-service teachers going to experience these activities is the Jigsaw model, which is one of the methods of cooperative learning approach.

Prior to conducting the activities preservice teachers will be grouped according to their preferences. They will choose from one of the statements below and form a group accordingly.

I would feel more comfortable to conduct a science activity, where.....

a) I follow the steps and get the expected conclusion, (Group A)
b) I am challenged to solve a problem, (Group B)
c) I am free to explore the questions that emerge on my mind without the time constrain. (Group C)

The group sizes will not exceed 6 people in order to keep the students in focus, and interested. This is also suggested by O' Donnel and O'Kelly (1994) as to benefit from social, structured, and unstructured tasks of cooperative learning. If the class size will be too crowded to get the aimed group sizes, then the class will be divide in half and students will experience the activity in separate days.

The purpose of grouping the students in a certain way is to define the groups that have common interests, and give them challenging activities, which they either haven't experienced or failed to succeed in before. This way, it is expected that groups will accomplish team building, and will foster the development of cooperation skills within the group members. For example, the group members who choose to be in Group A will experience the challenge activity, where they will be freer to explore and experience the group dynamics. Accordingly, group B will experience the inquiry activity, and Group C will experience the guided activity. To facilitate group members thinking, and to keep the individuals in focus, each member of the group will be provided with an evaluation worksheet. Everybody will be expected to complete the form until the end of his or her activity. These worksheets then will be used to foster the discussion, which is going to be conducted at the end of the activities, in a jigsaw model. After all the groups have conducted their

activities, 2-3 students from each group will come together and form new groups to share their experiences and the pros and cons of each groups' activity. The class will conclude with a final class discussion of the teaching methods used during the class session

Guiding Process:

The instructor will introduce the activity to the class by emphasizing its purpose and design. Then, the preservice teachers will be reminded that the central experience in all of these investigations are one of the inquiry steps- observing, hypothesizing, testing, rethinking, questioning, searching, creating meaning, and understanding through a personal process of learning. Background information about the strategies that are being used will be provided to the students through the reading assignments.

The purpose of this activity will be presented to students as, letting them experience various hands-on activities. They will also be asked to think about the strengths and weaknesses of their activity, and where and why they might want to use each activity. They will also be reminded that there will be a discussion session after the activities, and they will be regrouped to explain what they have done in their group to their new group members, and evaluation forms can guide them during this discussion.

All three groups will design activities with soap foam. The main reason for this is that, foam is not a part of anyone's curriculum and this will help teachers to see that the activities are designed for analyzing different teaching strategies rather than classroom use. In addition, it's fun to work with, thus keeping individuals motivated in the activity.

Gazing Backwards and Glimpsing Ahead:

The instructor needs to be aware of the potential dysfunctional aspects of cooperative learning that may create stumbling blocks instead of stepping-stones to knowledge. Possible

directions the instructor could take as a facilitator and the challenges s/he might face will be discussed at the end of each activity. In order to see whether the objectives of the class is being met, the worksheets that each group member has filled out will be reviewed and, everybody will be expected to design an inquiry-based activity, that they are likely to teach in the future. This activity could either be a design of their own, or a modification of an existing activity. Through the use of the 5-G Model, they are going to explain how they plan to conduct the activity.

I- Guided Activity:

The group members will be provided with the self-explanatory worksheet (See Table 1), with the materials listed. They are expected to follow the directions on the worksheet and come to conclusions.

Facilitator's Challenges through the Guided Activity:

Since the instructions are all on the worksheet, the facilitation of this activity can be very light handed, but the instructor needs to make sure that people follow directions. One of the issues that might arise at this activity involves time. It's very likely that guided activity group finishes its activity before the others, and does not know what to do while other groups are still working. Alternatively, some groups might run out of time and feel failure in what they are doing. These issues are similar to what teachers are likely to experience in classrooms. Therefore, they need to be addressed in the discussion session.

Table 1- Guided Activity Worksheet

Guided Activity Worksheet

Foam is a material made up of gas bubbles separated from one another by a liquid film. Foam has physical properties, which can serve as a model for may other phenomena. It also serves as a vehicle for learning about the complexities of surface area. In the following investigation, you will explore some of the physical properties of foam.

Materials:
Two 6" desert size plastic coated plates
2 bowls
1 teaspoon
1 cup (about 8 oz.)
1 or preferably 2 hand mixers
One set of pointed dowels
1 ruler
1 magnifying glass
Spoons or tongue depressors

Directions:
Put 1 tsp. of Joy or Dawn detergent and 1 cup (8 oz.) of water in each of two bowls.
Beat each mixture with an eggbeater counting the strokes.
Bowl A 200 strokes
Bowl B 600 strokes

1) Which foam has bigger bubbles, A or B?
On the small plastic plates, build piles of foam as high as you can.

2) How high a pile can you build with A?
How high a pile can you build with B?
On small plastic plates, build mounds of foam 4 inches high; one with foam A and one with foam B. Try to make a dowel stand vertically in the foam, with the pointed end of the dowel down.

3) Which is the longest dowel that will stand in foam A?
Which is the longest dowel that will stand in foam B?

4) Which foam is the strongest, A or B?

5) In the experiments above, what other differences did you notice between foam A and B?

II- Challenge Activity:

This activity asks people in this group to build a foam tower at least 12'' high.

Materials:

- 1 11" plastic coated plate
- 1 or 2 bowls
- 1 hand mixers and/or 1 electric mixer
- 1 yardstick
- Dish soap
- Water
- Spoons or tongue depressors

Facilitator's Challenges through the Challenge Activity:

The instructions for this activity are simple; one needs only to set the challenge and the parameters. The group members first need to be reminded that the challenge of this activity is to build a foam tower at least 12'' high, and the parameters are that; the tower must be completely contained on an 11'' plastic plate, and there may not be any support other than foam itself. The facilitator should be the judge of the tower height, as well as the reminder of time. For groups who do not meet the challenge in the time limit, will often get frustrated. Which will lead to a feeling of failure and further feeling of not being good at science. This issue needs to be addressed during the discussion. In this challenge both competition with the other groups and cooperation within the group members are possible. This is another important point that needs to be brought up in the final discussion. In addition to the pitfalls of the activity, it's important to bring up the positive aspects as well. First, challenges can be very engaging for both adults and children. They provide a clear goal and give students the opportunity to experiment and find a way to meet that goal. Challenges can also push people to do things that they never would have suspected they were capable of doing. In that way, they can enhance the learners' confidence.

II- Inquiry Activity:

At this activity, preservice teachers will be expected to explore soap foam and to learn about its physical properties, including what makes it strong. It's however, important to emphasize preservice teachers that this activity will provide them the opportunity to experience the "first-phase" or " exploration phase" of the inquiry process. Experiencing only the first phase may lead to the idea that this state is all that there is to inquiry, leaving off the other important parts of hypothesizing, testing, analyzing, drawing conclusions, and developing theories that fit with existing understanding and knowledge. If students get beyond the exploratory phase, and find a question that they can pursue in an intentional way within the time provided, it's important to encourage them to pursue those questions.

Materials:

- 6 bowls for beating foam
- 2-4 hand beaters
- 4-6 electric beaters
- Plastic coated plates
- 2-4 pints of Joy or Dawn detergent (preferably some of each)
- 3-4 cans of shaving cream
- Covering for tables
- One set of 1/4" dowels, as in the guided activity
- Several yardsticks and/or rulers
- Plastic spoons
- Tongue depressors
- Magnifying glasses and or/ dissecting scope and slides
- Measuring spoons
- 8-oz paper cups
- 2-4 qt. bottles of root beer
- 1 dozen eggs

Facilitator's Challenges through the Inquiry Activity:

In this activity the facilitator can constantly interact with the group, asking questions, suggesting things to try, and helping people figure out what to do next if they get stuck. Since the groups are not accustomed to working in a free exploratory environment and be creative they may quit or get bored. This provides an important discussion point on how an expectation of structure can limit creativity and interest.

Evaluation Worksheet:

The point of doing these foam activities is to provide first hand experiences with three sorts of hands-on activities, and to generate thoughtful discussions about the differences noted and experiences among the three. The facilitation of the discussions and other processing of the experience is therefore the most critical element of the activity. This is planned to be done through the use of diverse evaluation methods. The following questions that will be incorporated in a worksheet, can get students thinking about the activities they are conducting,

Prompt Questions:

To be completed at the end of every activity:

- How did you feel about working at this activity?
- What do you think are the strengths and weaknesses of your approach?
- What kind of questions came up in the group during the activity and how do they differ?

To be completed during the discussion session:

- How did you feel like working in a cooperative group environment?
- What other ways do you think could have been used to group the students?
- Did you feel that all the students in your group were motivated?

- Did you experience any time constrains in conducting your activity, either finishing early or running out of time?
- What might be some ways to deal with the time issue?
- In what ways do you think you benefited from working in a cooperative learning environment?
- What are some of the ways you might implement this method (cooperative learning), as a teacher?

Conclusion:

In the beginning the purpose of the foam activity was described as making distinctions between different kinds of hands-on science activities, and understanding that all hands-on activities are not inquiry. The use of cooperative learning approach as a way of implementation was the other aspect of the whole activity. The style of instruction illustrated by each of the foam activity had different strengths and weaknesses. It's expected that preservice teachers have gained these distinctions through the use of several evaluation methods.

Due to the nature of the group, evaluation and assessment plays a critical role in the success of the foam activity as a whole. Therefore, three different methods of evaluation is planned to be used. The first method is the evaluation worksheet every group member is expected to fill out during his or her activity, which is going to be reviewed by the instructor at the end of the class. The main purpose of using this evaluation is to promote pre-service teachers' thinking during the activities, as well as to keep them in focus, and motivated. The second evaluation method is the small group and class discussions that are going to be conducted after the activities. During these discussions preservice teachers will be provided with cooperative learning and inquiry learning worksheets (See Table 2, and Table 3), and expected to take notes. These forms will be the part of their homework, which can easily be filled out during the class discussion. The

purpose of this evaluation is to create shared knowledge by using experiences of each group. The last and by far the most important evaluation that is going to be conducted is the individual project. The projects require the design of an inquiry-based activity for the future use of preservice teachers. In their projects preservice teachers are expected to follow 5-G model to explain how they plan to implement their activity. The individual project assignments not only aim to assess whether the preservice teachers have gained the knowledge but also whether they can implement what they have learnt. This part of the evaluation is especially important for students who are accustomed to be evaluated through the use of traditional methods. Therefore, implementing this kind of an assessment will increase the motivation. After the activity and the following assessments, the preservice teachers will have a better basis for deciding when it would be strategic to use different styles of instruction, as well as how to implement them.

Table 2-Cooperative Learning Worksheet
Please fill out the worksheet and explain your responses at the back.

	Social-behavioral		Cognitive		
Consideration	*Motivation*	*Social Cohesion*	*Elaboration*	*Piagetian*	*Vygotskian*
Goals/incentives					
Group size					
Group composition					
Tasks					
Teacher role					
Potential problems					
Averting problems					

Table 3. Inquiry Activity Worksheet

Inquiry Activity Worksheet

Please provide 2 or 3 sentences as to how you can implement the following statements in the inquiry process.

Students must have a problem to solve-

Students must know that they can solve the initial problem-

Students must have background information that a) either is provided to them by constructivist engagement with the teacher or b) they must be acquire it themselves-

Students must come to see that their way of approaching the problem will not work,

Students must come to a recognition, on their own, that the approach offered by the instructor has promise in the solution of the problem-

Adequate time must be provided for students to be able to work out the details of a new approach on their own or with their parents-

Students must practice from examples and the discrimination of nonexamples that relate to the problem-

Students should experience success-

Note: These criteria are adapted form "Criteria For Designing an Inquiry Activity" by Keefer (1998/99).

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Key Considerations in Cooperative Learning from a Variety of Theoretical Perspectives

	Social-behavioral		Cognitive		
Consideration	*Motivation*	*Social Cohesion*	*Elaboration*	*Piagetian*	*Vygotskian*
Goals/incentives	Rewards essential	Rewards non-essential	Rewards nonessential	Rewards nonessential	Rewards nonessential
Group size	Large (4-6)	Large (4-6)	Small (2-4)	Small	Dyads
Group composition	Heterogeneous	Heterogeneous	Heterogeneous/ Homogeneous	Heterogeneous	Heterogeneous
Tasks	Rehearsal	Rehearsal/integrative	Rehearsal/integrative	Exploratory	Skills
Teacher role	Director	Facilitator	Facilitator	Facilitator	Model/guide
Potential problems	Use of reward Group size	Poor social skills Social loafing Cognitive loafing	Poor help-giving Unequal participation	Inactive Non cognitive conflict	Poor help giving Providing adequate time/dialogue
Averting problems	Improvement scores Simpler tasks Social cohesion	Team building Conflict resolution strategies Discuss group process	Direct instruction in help-giving Modeling help-giving Scripting interaction	Structuring controversy	Direct instruction in help-giving Modeling help-giving

Table from O'Donnell and O'Kelly (1994), Learning from peers: Beyond the rhetoric of positive results, p. 327.

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