AC 2008-2941: STEM COGNITIVE DEVELOPMENTAL TUTORING METHOD

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STEM Cognitive Developmental Tutoring Method

Abstract

The purpose of the Cognitive Developmental Method is to help provide students with the most resourceful and unique mentoring/tutoring experience. The STEM mentors have constructed a tutoring method that compensates the need for cognitive communal and educational development of STEM students from diverse backgrounds. Combined theories from distinguished professors serve as the underlying factors for our concept reasoning. The Cognitive Developmental Method exposes students to both the conceptual and the practical applications of science, technology, engineering and mathematics. Our overall goal is to enhance the STEM student's performance by isolating the various components in the delivery/retrieval processes of mathematical theories via concept discussions, highly enforced problem application, peer-peer subgroups, and constructive learning-centered activities.

I.   Introduction

The STEM Summer Bridge Program is part of a National Science Foundation HBCU-UP [1] grant awarded to Prairie View A&M University. The Summer Bridge Program is an excellent way for incoming freshmen to transition into college life. The STEM Summer Bridge Program selects motivated students who plan to major in the areas of Science, Technology, Engineering, or Mathematics. Participants spend eight-weeks during the summer, on Prairie View A&M University campus, and can earn up to 11 hours of college credit.

Growing up, students memorize how to solve different types of problems. Often times, however, college courses and personal circumstances have a much wider variety of problems that students have to figure out to solve by themselves. The Bridge Program emphasizes the skills essential to any field of study – simple problem-solving, programming, critical thinking and mathematical skills.

Problem-solving skills help students understand a problem, create steps to solve that problem, and finally, following those steps to get an answer. Problem-solving is very helpful in breaking a big problem into smaller, easier portions. Problem-solving is useful for well-structures problems for which solutions can be derived in the form of a formula. Other problems have structure but require programming to solve them, and hence programming is essential to solving some of the problems students encounter. Many problems in real life are complicated, without discernable structure. This is where critical thinking comes in, providing students the reasoning to solve a wider range of problems. In addition to these essential skills for college success, the Bridge Program also strengthens mathematical skills to prepare students for college level courses.

During the past few weeks of the STEM 2007 mentoring sessions we noticed via weekly exams that a portion of the students within the program were having distinct difficulties with the algebraic concepts. We initially integrated each student's problem from an objective point of view stating that they simply needed more problem-oriented help. However, after consulting with students, various professors, and STEM mentors about plausible reasons as to why students may not be maximizing their potential, we arrived at the following conclusion, that students

output is not necessarily a function of their individual problem solving abilities. From a student's perspective, the following reasons have been mentioned: lack of understanding concepts, lackadaisical environment, lack of enthusiasm, and student to mentor ratio. From the Professor's perspective, the following reasons have been mentioned: poor test scores, lack of ambition, and lack of understanding of concepts. Thus, we developed a probable time efficient and productive method to enhance each student's performance on their weekly exams.

The following sections focus on both the student's and professor's evaluations of an effective learning environment, along with the concerns that he or she may feel relevant to address in order to enhance each student's performance on weekly exams.

II. Background

Influential Perspective

As stated earlier, students performance were primarily linked to problem-solving abilities, however after further investigation, their problem was influenced by a host of other perceived problems. These problems are shown in Figure 1.
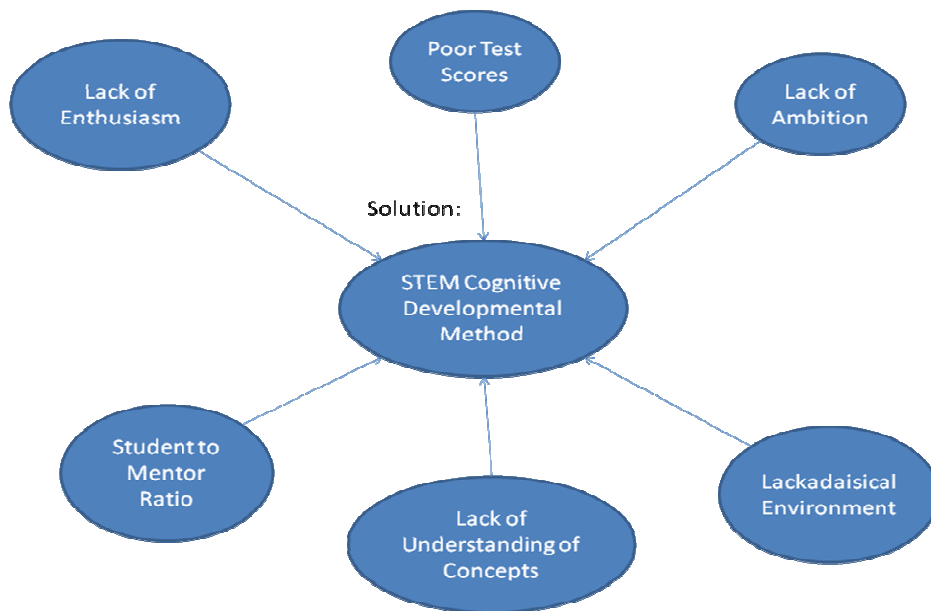

Figure 1

Constructive Mindset

In order for students to do well, they need to have constructive mindsets. As STEM mentors, we believed that it was necessary for the low-performing students to be able to interact with the other students during the time allotted for tutorials. It is believed that this interaction increases teamwork and also amplifies the students' confidence [2]. Many students from our observations simply gave up too easily when they did not grasp the concept. This is the reason why we have

the students sitting in a circle, so that no one person gets left behind. Sitting in a circle during instructional time promotes student-centered learning [3,4]. Students will have to help each other achieve the goal which will be winning the problem solving challenge at the end of each tutorial session. This gives the students something to work for besides a test grade. Our goal is to build and cultivate teamwork and confidence. Once that certain level of confidence is attained, the possibilities are endless. Our interest is to ignite the student's spirit by helping them understand that learning can be fun. This approach is primarily used in K-12 education; however, it may be implemented for undergraduate education.

Socio-cultural Influence

In psychology, there are many socio-cultural influences that affect the way an individual thinks and develops cognitively. The environment which the mind is developed in plays the greatest role in how the individual thinks. Psychological research has shown that an environment where there are a lot of resources and equal opportunity is present promotes greater use of thinking abilities, therefore, expanding the individual's knowledge and experiences [3].

Effective Group-Based Structuralism

A team is a group of people who work together interdependently and adaptively towards a common goal. To be effective, the group must be well balanced in skills and characteristics. The groups have been constructed to where there is an even distribution of capability and personalities. We looked not only at the student's scores, but their behavior, character traits, and environmental backgrounds to be able to more effectively serve their individual needs. After each student's communal and educational backgrounds were evaluated then we conducted each team accordingly.

III. Cognitive Developmental Method

The purpose of the Cognitive Developmental Method is to help provide students with the most resourceful and unique mentoring/tutoring experience. The following topics will deal specifically with the prospective methodology that we desire to implement into the two hour mentoring sessions.

Socio-culture Based Group Assignment

We realized students needed to be placed in an environment conducive to learning. The students' personalities were analyzed then they were placed into what we decided was the most efficient group for them. In the team selection process, we started by selecting the top eight students to be the team leaders. In this way, every group has a person who is knowledgeable and confident about the subject material. Next, we decided that the students who appear to be less focused amongst each other should be separated into different groups. Each group was placed into separate rooms. This was done to promote learning and growth. In the real world, there are people of several races and cultural backgrounds that the students will have to work with. For

this reason, we integrated different ethnicities so students can increase cultural awareness. See table 1 for the group assignment.

Table 1: Assigned groups

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Jackie	Trenton	Elizabeth	Jonathan	Michael	Christopher A
Aaron	Erica	Emmett	Jacolby	Joshua G	Gifty
Nathan	Vincent	Jamie	Christopher B	Anthony	Marissa
Chantel	Corey	Scott	Pershauna	Mia	Bradford
Dominique	Samuel	Jarred	Alex	Efrain	James
Sylvester	Christian	Ronald R	Titus	London	Ronald D
Oneisha	Mark M	Joshua M	Shaunte		

Reinforced Environmental Structure

The circle format has been constructed to establish a unified, "help when you need it" atmosphere. When a student has a problem he/she doesn't have to worry about the mentor being swamped by five other students. Now the student can first refer to any person within their respective groups and if that group can't answer the student's question amongst themselves, then the student can refer the question to the mentor or supervisor (if the mentor is preoccupied by another student). The mentor will then work the problem in full view of the groups.

Time-Dependent Theme Allocation

One of the key concerns regarding the allocation of time during the two hour tutoring period was that it simply was too extraneous on the students after a long day of classes. The professors in contrast understand that extra time simply must be put forth solving problems even after attending classes in order to enhance educational success. Upon careful review of the students and professors concerns as to how effectively the tutoring hours were used, we began to consider various themes that would meet each student and professor's concern. Table 2 lists each theme that will be implemented curing the 2 hour period, along with the amount of time we will spend on each section.

Table 2: Time-dependent theme allocation

MONDAY – THURSDAY		
Theme	**Percentage**	**Location**
Concept	30 min	Perspective Group Room
Application	60 + min	Perspective Group Room
Activity	30 min	Perspective Group Room

Constructive Course-Specific Activities

Situation Set-up:
- Sitting face-to-face

Game Rules:
- One individual in a group works on a problem in its entirety
- All people in group work on problem until the a team member finishes
- Random team members are chosen and play against each other

Game Activities:
- Work-out homework problems
- Similar problems as homework
- Concept review
- Formula memorization

These activities have been formulated to take away from the monotony of going over homework problems and instead give a little "spice" to the vast amount of assigned problems. In addition the activities will allow the students to be exposed to a time-constrained environment; thus, helping them cope with test situations that may cause them anxiety.

IV. Conclusion

In our paper we described the method used to aid the students who participated in the STEM 2007 program. The purpose of the Cognitive Developmental Method is to help provide students with the most resourceful and unique mentoring/tutoring experience. The STEM mentors constructed a tutoring method that balances the need for cognitive communal learning and educational development of STEM students from diverse backgrounds. We combined theories from distinguished professors, which served as the underlying factors for our concept reasoning. In using the Cognitive Developmental Method, we were able to expose students to both the conceptual and the practical applications of science, technology, engineering and mathematics. Our overall goal was to enhance the STEM student's performance by isolating the various components in the delivery/retrieval processes of mathematical theories via concept discussions, highly enforced problem application, peer-peer subgroups, and constructive learning-centered activities. We placed first priority on the productivity of the STEM students. Our expectations for using this methodology yielded a substantial increase in student's scores on their remaining exams. What's more, we believe that the implementation of our methods will positively influence each student's future as a whole.

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