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Improving Mathematics Skills of School Students using ERICS Technique

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Abstract: *The AIMS group used a computerized tool to generate multiple-choice problems for students to practice the content of the state's competency test. Eight AIMS students (57 percent) and two control students (14 percent) passed the retest. The outcomes offer promise for schools looking for evidence-based solutions to problems related to increasing numbers of students experiencing difficulties with high-stakes assessments. In the 21st century critical thinking skills h a ve become very important for students at every level of education; critical thinking is not in born and does not develop naturally. This paper explores the potential of the Simas eric model in providing a learning experience for critical thinking in students. Simas eric model dan conventional model were compared to consider the academic level of students, high academic level and low academic level, toward the increasing of students' critical thinking skill value. Test on the enhancement of students' critical thinking value was done before and after the treatment of learning model. Data analysis employed covarian (ANACOVA) and LSD test. The conclusions of the research were: 1) Simas eric model is able to improve students critical thinking skill at 140.9%. 2) High academic students were taught using Simas eric model had increasing 65.3% critical thinking skill higher than conventional class. 3) The increasing value of students' critical thinking skill with low academic were taught using Simas eric model is higher than the increasing value of students on high academic students which were taught using conventional model.*

Keywords: Competency Tests, Evidence-Based Solutions, High-Stakes Testing.

I. INTRODUCTION

The Center on Education Policy (Chudowsky et al. 2002) conducted an initial investigation to determine some baseline data for high school exit exams. The percentage of students who passed such tests on the first try varied considerably from 31 percent in Arizona to 91 percent in Georgia. More than half of the students in Alaska and California failed the test on the first try. In general students have multiple opportunities to retake the assessments with schools providing or requiring remediation. A view of elementary and middle grades mathematics performance raises concerns about the performance levels of generations of future students who will be required to successfully complete high school exit assessments. All states have developed or selected assessments that allow them to identify achievement levels for specific subjects, as determined by the states standards and definitions. For the 2000– 2001 academic year, the percentage of U.S. students at or above proficient levels in elementary mathematics ranged from twenty-three to ninty-one and for middle school mathematics ranged from eleven to ninty-three (U.S. Department of Education [DOE] 2004). The No Child Left Behind Act (NCLB; 2001) set forth the value of scientifically based research as the standard for what makes a difference in America's classrooms (cf. Paige 2003, 1) and ushered the search for validated practices into the minds of administrators and policymakers. Additionally, with the continuing press for achievement and educational outcomes, educators are searching for locally validated evidencebased instructional programs to improve achievement for students participating in mandatory, highstakes testing, and school-based evaluation research has become a popular base for "how-to" decision making in schools (Horowitz 2006; Ysseldyke et al. 2004). Accelerated Math (Renaissance Learning Systems 1998a; 1998b) is an instructional tool that can be used to help teachers match students' skill levels to instructional targets, generate appropriate practice, provide corrective feedback, and monitor progress. In this study, we evaluate the effects of using this automated instructional system on the mathematics achievement of students at risk of continued failure on their state's high school mathematics proficiency exam. We reasoned that this information would provide an informed, evidence-based grounding for decision makers interested in implementing the program in their schools. All participants were volunteers. As a motivator to encourage participation, school personnel offered them a senior privilege (all were

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juniors) of going off campus once a week to eat lunch. We joined students with the same test scores into pairs. We randomly placed one of each pair into the experimental (i.e., tutored) group and the control (nontutored) group. If a student designated as being in the experimental group declined to join the study, we removed the student and his or her control partner from the experiment and selected another pair. To provide backup students for the control group, we chose alternates who had the same test score as the student assigned to the control group. Originally we assigned twenty pairs of students to the experiment. Over the course of the year, six students in the experimental group left the school for various reasons. Each time a student in the experimental group left the school, we removed the student and his or her control partner, plus all alternates, from the study. Only one control student left the school and we substituted the first alternate.

1.1 Erics Technique

Some of the skills needed in the 21st century competencies include problem solving, critical thinking, communication, collaboration and information literacy (NGSS Lead States, 2013; NRC, 2012; Griffin, 2012; OECD 2013). Scientific literacy and critical thinking are key components in preparing students to live in an era of science and technology (Vieira, 2014). Thinking must be habituated and familiarized to students to avoid the bias, partial, distorted and lack of literacy. This will affect the quality of life and productivity that depends on the quality of thought (Paul, 2006). These statements underlying the importance of engaging students to think critically, familiarize the ability, argue based on evidence and provide a scientific explanation (Lin, 2013). Based on Bunce (1991), as a part of the science, Biology requires teachers to guide students in the process of thinking, formulating question, and finding an answer. Learning of Biology consists of products and the processes. Products of Biology consist of facts, concepts, principles, theorys, laws and postulates related to lifeliving things and their interactions with environment (Rogers at al., 2015). Biology, in terms of process, has processing skills such as: observing with the senses, classifying or grouping, applying the concept or principle, using tools and materials, communicating, hypothesizing, interpreting data, doing experiment, and asking questions. Basically, learning of Biology tries to guide students with various skill ranges about how to know and understand the concept or the fact in depth. In addition, learning of Biology should be able to provide students' pleasure and intellectual satisfaction to explore various concepts. 2. Method This study was quasy experimental research. Pretest-posttest with non-equivalent control group design was used in this study. Simas eric model and conventional learning were the independent variables of this study, while the moderator variables were the high and low academic level. Control variables of this study were the ability of teachers, number of hours, and the material presented. The dependent variable was critical thinking skills. Learning activities were accomplished in 12 weeks. The population of the study was eleventh graders of Senior High School in Malang. The samples were done by means of random sampling. Simas eric model was carried out by one class , while another class was conventional class. There were two classes used in this research. The total number of samples was 100 students of high school students grade eleventh taken from 4 high schools in Malang, East Java – Indonesia. There were several steps employed in this experimental study. First, The first step was developing learning device. Before developing learning media, the researcher did a survey to know the real condition deal with the condition of critical thinking skills, students where the instrument used in the form of a questionnaire given to high school teachers in the city of Malang. Learning media then was validated by experts and teachers. In addition, a limited field trials conducted prior to experiment with lesson study activities. After that, critical thinking skills rubric was used to determine the score of critical thinking skills integrated with essay tests, in understanding of the concept. Each class was divided into academic treatment of the high and low academic level. IQ test was done by students to determine the value of academic test scores of students at the beginning of high school. Determination of the high and low academic to sort all samples based on IQ scores from highest to lowest value that consists of 50 students the first order for the top academic and 50 students last academic sequence below. High academic and low academic level in each class are used as research subjects. Descriptive statistics was used to analyze data. Before analyzing data using Anacova, they must be tested first by assumptions Anacova that includes normality and homogeneity of variance test data. Test for normality used OneSample Kolmogorov-Smirnov, while the homogeneity test used Levene's Test of Equality of Error Variances. It was carried out with the help of SPSS 18.0 statistical analysis program for Windows, statistical tests performed at the significance level of 0.5%.

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II. METHOD

To address the problem of large-scale failure on the state test, district administrators implemented an experimental program in two high schools. Students participating in the program used computer-aided practice and tutoring to improve mathematics skills; the control group received supplementary instruction regularly provided to students who fail the state wide competency test. The model we evaluated is commonly used in school districts across the country.

2.1 Procedure

Students in the experimental program received supplementary instruction and tutoring using the Accelerated Math AIMS program for an entire school year, fifty five minutes per day and five days per week. Students in the class demonstrated mastery of the entire set of concepts included in the state wide test two weeks before retaking the AIMS test. All students participated in a systematic review of the targeted content for the two-week period prior to taking the test.

2.2 Intervention

The AIMS class used an approach Renaissance Learning developed and implemented in over seventy thousand schools nationwide to improve reading and mathematics skills. The program uses widely accepted content libraries of math concepts, called objectives, from first grade through calculus. In a typical class using Accelerated Math, the instructor selects about 150 concepts aligned to state standards. Although the content used in this evaluation was guided by local objectives, the program has been used in similar ways in other states. It "is flexible enough to allow students the opportunity to develop more advanced mathematics skills if their pace and understanding move ahead of others" and to help "teachers assign instruction that is matched to the skill development of the learner and monitors student progress toward mastery of math objectives" (Ysseldyke et al. 2004, 299). Much like other commercially available educational resources, consultants 38 The Clearing House September/October 2007 work closely with school personnel in implementing the broadly designed models to meet local expectations and needs. Each student works on about five concepts at a time. The program prints out a Practice lesson consisting of six problems for each of the concepts being tested; the thirty, four-option multiple-choice problems are presented in random order. The student marks the answer in pencil on an optical sense card. When a practice assignment is completed, the student scans the card using a small optical scanner connected to a computer. The program grades the student's work, prints out a report showing any problems missed, then prints out the next practice assignment. If the student completes 80 percent or more of the problems for a concept correctly, the program begins assignments using the next concept on the list of those selected by the instructor. If the student's performance is below 80 percent, six more problems for the concept are printed. Because many different problems for each concept exist and the problems are algorithm based, the student never receives exactly the same problem on a practice assignment. As part of the instructional process in both groups, teachers encouraged students to figure out why they missed the problem. If they could not do this, they were free to ask for help from the teacher or a tutor. If the student failed to master a problem set for a concept three times, the program provided information indicating that additional instruction was needed. In the experimental group, this typically involved the instructor or a tutor printing out a problem set and working with the student to teach the concept. When students passed approximately five concepts, they were given a mastery test. Unlike practice tests, they were not allowed to receive any help on the mastery test. If they completed 80 percent or more of the problems for a concept correctly, they were said to have mastered the concept. Two weeks after a student mastered a concept, he received a review problem. Over time, students completed four such review problems for each concept they mastered. If they were unable to complete three out of four of the review problems correctly, the program provided additional information indicating a need for intervention. After further instruction, the students were retested. The process of actively monitoring and supporting instruction was a critical factor in the program and the computer-based program greatly facilitated it.

2.3 Critical Thinking Skills Improvement through Simas eric Model

Communicating is a class discussion conducted by individuals who work in groups. In communicating the issues related learning materials enables the process self-regulation in preparing students for understanding a subject. Able to communicate well, a critical-thinking skills to participate actively communicating activated at this stage. This refraction step for students to think critically, (Nugent, 2008) says there are at least three activities that should be familiarized

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namely: problem solving, decision-making, and check the answer/ diagnostic reasoning. Mind mapping, questions and answers from the student subsequently collected for the benefit of the assessment which will underlie the evaluation of the assessment which besides others. After the students read the questions and answers individually in front of the class, to continue the discussion and collaborative work in heterogeneous groups believed that various important or the most important contents of the reading material has actually been disseminated to the entire class.

III. DISCUSSION

Although control of education in the United States is less centralized, the influence of documents from professional organizations, such as the National Council of Teachers of Mathematics, is evident in state educational policies (Ridgway and McCusker 2003). Such a major impact on curriculum at the state level allows for the development of computer-based assessments that exemplify these goals and can be easily aligned to state mathematics curricular frameworks. Continued feedback mechanisms and opportunities to define performance levels provide an environment in which desirable changes in performance can be promoted. Computerized programs allow for differentiated instruction that assists educators in meeting the individual learning needs of diverse classrooms (cf. Ysseldyke and Tardrew 2003). In this study, we examined the effects of using a specialized remedial program grounded in evidence based effective instructional practices (that is, increased practice of critical skills with continuous monitoring of progress and constant adjustment based on performance). Overall, students who participated in the experimental treatment demonstrated greater gains in overall performance in mathematics achievement as measured by their state's critical competency test required for high school graduation. Accelerated Math provides an instructional management system that allows students to spend more time reviewing concepts and skills to enhance their performance, resulting in positive growth in measured mathematics competence. Students who use such systems consistently demonstrate greater mathematics gains than control groups (cf. Ysseldyke et al. 2003). Such programs increase the use of time spent on the needed improvement of students' mastery of computational and foundational mathematics skills and objectives. The requirement to pass the AIMS math test is likely to create a crisis by the end of the 2006 school year unless something is done to increase the percentage of students passing the test. It is likely that at least half of the students failing the test would pass a retest after taking the AIMS math course. We strongly recommend that high schools and secondary education programs implement this approach. This study demonstrates the positive impact of the program on students' mathematics performance. These results are consistent with other studies involving the use of Accelerated Math. Ysseldyke et al. (2003) report significant differences in student performance on the Northwest Achievement Levels Test for the fourth- and fifth-grade students who used Accelerated Math in conjunction with the classroom mathematics program (Everyday Math) compared with students using the same mathematics curriculum without access to Accelerated Math ($t = 3.32$, $df = 1\ 96$, $p < .001$). In a large-scale study with 2,202 students in grades three to ten, students who used Accelerated Math experienced exceptional gains compared with control classrooms: consistently strong gains for low-, middle-, and high-achieving students and for students who are gifted and talented, English language learners, eligible for free or reduced lunch, and Title 1 (Ysseldyke and Tardrew 2003; Ysseldyke et al. 2004). Our current study is important because the results extend findings of previous research by demonstrating the potential of Accelerated Math to influence the performance of students who have previously failed a high school exit examination. The intervention we described in this study underscores the positive impact that such programs can have on student achievement. High school exit exams, in general, have been associated with positive effects on curriculum and instruction as well as students' motivation and achievement (Gayler et al. 2004). High school exit exams appear to encourage school districts to cover more content included in state standards frameworks, to promote a stronger alignment between curriculum and instruction with standards, and to provide remedial and other special courses for at-risk students. This study demonstrates how programs such as Accelerated Math can be linked in positive ways to the instructional and curricular emphasis of high school exit exams so that students' mathematics performance significantly improves. Using the Accelerated Math program, the teacher is still responsible for instruction and students complete assignments using pencil and paper. The differences achieved with technology are more a function of personalized practice and progress monitoring than presentations of content. Research shows, and virtually all educators agree, that academic improvement requires practice to reinforce skills being learned and continuous monitoring of progress to ensure appropriate areas are targeted for instruction. Unfortunately, the roles of practice and progress monitoring are often overlooked and misunderstood components of effective instruction. Setting aside time for student

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practice is not enough. Similarly, checking performance several times a year provides insufficient evidence for improving skills requiring more frequent attention. Practice must be personalized to each student's individual ability level and immediately followed by informed feedback to ensure a high rate of engagement and success. It must also provide progress-monitoring evidence for teachers and other professionals to improve instruction and outcomes. The program we evaluated in this study was grounded in these principles, and administrators in the district considered the costs nominal. For example, the hardware and software to create the Accelerated Math tool served classes of up to thirty students. The system was networked to bring the cost per student down substantially. Although math knowledgeable adult tutors are preferred to provide ongoing instructional support, if unavailable, peer tutors will suffice as a viable alternative. Peer tutoring can improve the amount of time spent on academics and student engagement on tasks and has positively impacted both mathematics and reading performance (Dufrene et al. 2005). Accelerated Math is based on a number of principles, including active and ongoing assessment of skill level and instruction matched to individual performance levels, personalized goal setting, optimal amounts of practice time, and corrective and supportive feedback. These fundamentals are widely recognized as essential to effective instruction (cf. Algozzine, Ysseldyke, and Elliott 1997) and our intention is not to suggest or advertise the program per se as the basis for improved performance. It is clear in the outcomes of this evaluation that the implementation of principles of effective instruction through the use of Accelerated Math was related to important changes in academic outcomes for students at risk of school failure (i.e., missed graduation requirement). Students who participated in this program demonstrated significant gains in mathematics achievement, which translated into higher levels of overall content mastery necessary for high school completion. Continued implementation appears warranted and subsequent research addressing the importance of key features of the program is justified to add to the growing body of knowledge on evidence-based interventions for students experiencing academic difficulties in the upper grades.

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