World Applied Sciences Journal 5 (1): 62-67, 2008
ISSN 1818-4952

Improving Science and Technology Education Achievement Using Mastery Learning Model

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Abstract: Core idea of mastery learning can be concluded as aptitude is the length of time it takes a person to learn not how bright a person is, i.e., everyone can learn given the right circumstances. The science and technology education programs aim reading and writing about science and technology for every student in primary school. If the educators have enough knowledge and instructional strategy about mastery learning model. This aim will become reality and almost every student can read and write about science and technology. The mastery-learning model is suitable for new science and technology education program, because, this new program aims to teach science and technology for every student in schools. Mastery learning model can be adapted and applied to the program easily. For this purpose, the educators should be trained about the application of mastery learning model to the program.

Key words: Science and technology education achievement · Mastery learning

INTRODUCTION

Mastery learning is an instructional *philosophy* based on the belief that all students can learn if given the appropriate amount of time and the appropriate instructional opportunities. Mastery learning proposes that all children can learn when provided with the appropriate learning conditions in the classroom. An education may also be possible as a result of the experiences gained through the family, environment, religion and mass communication media. But it should be known that the planned education is the responsibility of schools [1].

Mastery learning model is easily applicable to the program . Because, this model aims making science and technology more desirable, more reasoning, more discussing, more examining and more problem solving like science and technology objectives. This model, gives preference to interest and creativity for science education. There is a basic instinct interesting and learning for humans. In this model, students will like nature, science and technology and then want to learn more about science and technology. Mastery learning model, emphasizes interesting for learning science and technology and the learning period is continuous for teacher and the students. Science and technology education is very important for development a child. If a child doesn't know the nature, he/she will not like nature and life.

This model claims that students can achieve mastery when the curricular standards are clearly articulated and defined, when assessments accurately measure the students' progress toward performance of the objective(s) and when instructional lessons are tightly aligned to the curriculum. Mastery learning strategies have significant effect on students' cognitive and affective development and rate of learning. Mastery learning methods also contribute in increasing the learners' interest and aptitude for learning the subject than traditional approaches. The studies also indicate that mastery learning strategy can compensate learning deficiencies of culturally and socially deprived children [2].

The mastery learning model, it is aimed at providing appropriate learning environments by considering the individual differences of the students so that they do not hinder the target learning activity. Because, according to Bloom, the mastery learning theory is based on the idea that Cognitive Introduction Behaviors (i.e. pre-learning which is assumed to be necessary for learning a unit) which are the students' characteristics, Emotional Introduction Features (the level of motivation to learn the unit) and the quality of teaching activity are the basic indicators of learning output. The variables "clue, reinforcement, student's participation, feedback and

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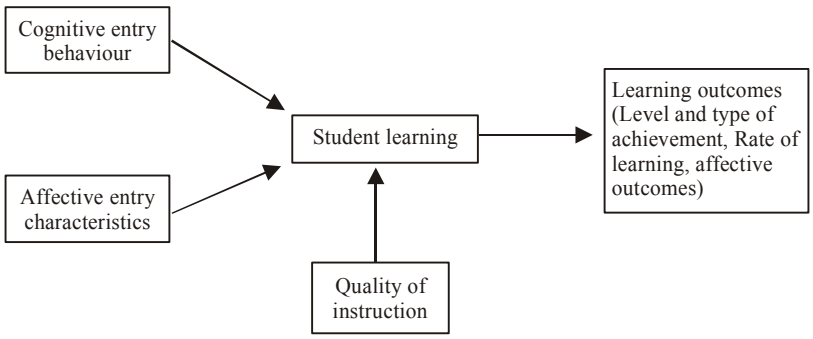

Fig. 1: The varibles of mastery learning [15]

correction", which Bloom described as the quality of teaching activity, explain the activities which are prepared by the teacher to enable mastery learning. According to this theory, if the related introduction features of the student along with the teaching activities are positive, the learning output will reach a high level and in respect to these outputs, the differentiation between the students will be at the minimum level [3]. The variables of mastery learning are shown in Fig. 1.

Mastery learning's effect on achievement and motivation was examined by Clark, Guskey and Benninga [4]. The study examined a mastery learning group and a traditional group that used the lecture format. The main variable for this study was motivation and its effect on student achievement. These authors found that the mastery learning group demonstrated higher levels of achievement, fewer absences and more motivation toward learning course material. In a similar study, Ritchie and Thorkildsen [5] examined achievement and accountability. This study compared two mastery learning groups. The treatment variance was that one group was aware they were in a mastery learning program while the other group was unaware. These authors found a statistically significant difference between the two groups with the informed group showing higher levels of achievement. They theorized this difference may have related to the awareness and the subjects may have been more motivated to meet the specific goals. That is the informed group may have altered their attention to the learning environment. Both of these studies challenge claims of mastery learning critics that conclude mastery learning programs increase achievement solely by increasing instructional time because of remediation.

Many students use rote learning involving verbatim memorization. This type of learning can not be applied to novel situations. On the other hand, meaningful learning can be manipulated to novel situations and used in problem solving in our daily life. Learning process should be done for applications and daily-life. There are some factors influencing ability to learn how to learn. These are confidence in one's ability to learn, practice with learning tasks, requirement to solve complex problems, rewards for successful learning, consequences for lack of meaningful learning and understanding the relationship between meaningful learning and life goals. Mastery learning creates a climate of success in science education.

Science and technology education is very important for a country. According to Turkish Ministry of National Education, "the basic purposes of the science and technology education are exploring, developing new ideas, solving problems, understanding and implementing new technology and developing new ones by this education. On the other hand, the other targets are orienting occupations and acquiring environmental attitudes."

All people in a society must be reader-writer about science and technology. This obligation has the same importance as alphabet learning. If a person in a society has no science and technology education, this person may be oriented some non-scientific methods for solving a problem.

The application of mastery learning is based on Benjamin Bloom's Learning for Mastery model, with refinements made by Block. Mastery learning is predominantly a group-based, teacher-paced instructional approach, in which students learn by cooperating with their classmates. However, some mastery learning strategies require students to work independently, rather than with classmates.

The goal of the Turkish national education system could be summed up as being one where all individuals of the state are gathered together as an inseparable whole, united in national consciousness and thinking, trained to think along scientific lines with intellectually broadened views on world affairs and to be productive happy individuals, who through their skills contribute to the

prosperity of society and are instrumental in making the Turkish nation a creative and distinguished member of the modern world.

The new curriculum defines the goal of Science and Technology courses as helping students "to become science and technology literate". Moreover, it is emphasized that science and technology literacy does not consist in knowing scientific principles and theories, but includes acquiring knowledge on the nature of scientific thinking and processes, on scientific values, the general nature of science and technology and science-technology-society interactions. This is an important and appropriate statement on which there is general scientific agreement. It is very important that students gain a sound opinion on the nature of science and especially on scientific methods. However, fashionable approaches should be avoided: For example, the scientific method is presented in this curriculum within the framework of a questionable learning theory based on social discussion and agreement, through expressions such as "unique (personal) and social knowledge". Whereas, the most important achievement of this course should be to give the students an idea about the objectivity of nature and that scientific knowledge is made of hypotheses testable by independent researchers, that the cornerstone of science is the pairing of observation and experimentation. This critical approach to science independent of all personal or social opinion should be the basis of "scientific literacy". Therefore, it is important to give examples of observation/experimentation in science and technology education.

The new science and technology curriculum seems to emphasize technology rather than curiosity towards nature that can be awakened through questions such as 'what?' and 'how?' This imbalance should be redressed in favor of science, through interesting observations and experiments, since many technological inventions would not materialize without related advances in science. A determining characteristic of science and technology is that they are oriented toward problem solving rather than passive knowledge. In this curriculum, more stress should be given to setting up and solving problems and evaluations should also test this skill.

In mastery learning, a curriculum is broken down into a set of sub skills, which are then ordered in a hierarchy of instructional objectives. For each step in the instructional hierarchy, a criterion-referenced test is designed and a performance criterion indicating mastery of the sub skill is specified. The teacher starts at the lowest step in the hierarchy, pretests, teaches the objective and posttests on the material. If the student does not demonstrate mastery, the teacher uses corrective strategies until mastery is achieved. The teacher then advances the student to the next, more difficult step in the hierarchy.

Like behavioral assessment, mastery learning provides information for instructional placement, formative evaluation and diagnostic decisions. It communicates clearly to teachers and students about what is important to teach and learn. However, mastery learning suffers from the same limitation as behavioral assessment: it focuses on discrete behaviors in both assessment and instruction. Because little emphasis has been placed on its reliability or validity, users do not know what exactly is being assessed, how to interpret the resulting information and how to use the measures effectively. Moreover, the measurement system dictates a specific approach to instruction, leaving the teacher few instructional choices. The focus of measurement changes each time a student achieves mastery of a step in the curriculum and the steps may be of unequal difficulty, so progress cannot be judged over time. Finally, because different students need to be measured simultaneously on different steps of the curriculum, mastery learning systems can become unmanageable for teachers.

In Turkey, there is a thought-provoking situations in science and technology education. There are many students in elementary education has zero grades in public exams. 70 of 100 students can never solve science and technology questions in public exams. This situation forces every one thinking about science and technology education in Turkey. Turkish Ministry of National Education opened a discussion forum about this subject and calls everyone contributing to new science and technology education program in elementary schools. After a long period of time, the name and content of program is constituted and prepared to apply. This new program has suitable experiments for every schools in villages or cities. Mastery learning model can be easily applied to this new program and thus the students can answer experimental, conceptual and intellectual questions about science and technology.

Mastery learning has been widely applied in schools and training settings and research shows that it can improve instructional effectiveness [6,7]. On the other hand, there are some theoretical and practical weaknesses including the fact that people do differ in ability and tend to reach different levels of achievement [8]. Furthermore, mastery learning programs tend to require considerable amounts of time and effort to implement which most teachers and schools are not prepared to expend.

Reasons of Failure Science and Technology Education with Traditional Methods: Mastery learning does not focus on content, but on the process of mastering it. This type of learning works best with the traditional content-focused curriculum, one based on well-defined learning objectives organized into smaller, sequentially organized units.

There are some reasons about failure of applying science and technology education:

- The number of science laboratory and equipments are insufficient.
- The students are passive and the teachers are knowledge transferring position in the class.
- The evaluation materials have only knowledge based and multiple choice questions.
- The intensity of science and technology education program.
- The inadequacy of instructors about learning models (i.e mastery learning model)

Teaching Strategies For Mastery Learning Model In Science Education: Mastery Learning model is based on the different learning levels and periods for students. This model claims that if the appropriate method is applied and enough time is given; every student can learn every subject. This model contains learning a subject efficiently and not to pass higher level of subjects without learning the lower level of subject. Every student's background, motivation and attitudes should be determined before applying this model and every student's participation to the lesson effectively should be provided.

Most importantly, however, is the idea that mastery of individual concepts enhances a student's ability in overall course performance: This should make sense. If a student achieves mastery with one concept, then his/her understanding of the next concept can presumably begin at a higher level. If mastery learning techniques are also used with the subsequent concept, then the process continues and deep understanding of all concepts can be achieved, ultimately resulting in a stronger understanding of all concepts and their relationships at the end of a course or unit.

The developers of mastery learning assert that it is most useful with basic skills and slow learners at both elementary and secondary levels. Group instruction is often given to the entire class by the instructor with individual time for learning provided until mastery is met. The goal of mastery learning is success for the student. It is asserted that success in achievement, attitude and motivation in the education or learning environment makes learning more effective [9].

How to Teach for Mastery Learning in Science Education Program:

1. Major objectives representing the purposes of the course or unit define mastery of the subject.
2. The substance is divided into relatively small learning units, each with their own objectives and assessment.
3. Learning materials and instructional strategies are identified; teaching, modeling, practice, formative evaluation, re-teaching and reinforcement, etc. and summative evaluation are included.
4. Each unit is proceeded by brief diagnostic tests.
5. The results of diagnostic tests are used to provide supplementary instruction to help student(s) overcome problems.

Instruction Process in Science and Technology Education Using Mastery Learning Model: This strategy captures many of the elements of successful tutoring and the independent functionality seen in high-end students. In a mastery learning environment, the teacher directs a variety of group-based instructional techniques. The teacher also provides frequent and specific feedback by using diagnostic, formative tests, as well as regularly correcting mistakes students make along their learning path. This model is applicable to new Turkish science and technology program. The following procedures should be done with harmony:

- The students are motivated to the science and technology subjects and the relation between the subjects and daily-life is established.
- The basic principle is causing students to try to acquire learning objectives.
- The instructors guide and orient students toward instruction period.
- The optimum conditions are established for learning.
- The applicable methods and techniques are determined according to multiple intellectual theory.
- The class medium is prepared based on confidence.
- The education technology is used for effective learning.
- The interactive learning is suggested.
- The viewing exam is made after every unit and the additional programs are applied for poor students if necessary.

- The laboratory conditions should be confident and activities should be done by every student.
- General evaluation exams are applied in every period of time.

In summary, mastery learning is not a new method of instruction. It is based on the concept that all students can learn when provided with conditions appropriate to their situation. The student must reach a predetermined level of mastery on one unit before they are allowed to progress to the next. In a mastery learning setting, students are given specific feedback about their learning progress at regular intervals throughout the instructional period. This feedback, helps students identify what they have learned well and what they have not learned well. Areas that were not learned well are allotted more time to achieve mastery. Only grades of "A" and "B" are permitted because these are the accepted standards of mastery. Traditional instruction holds time constant and allows mastery to vary while mastery learning or systematic instruction holds mastery constant and allows time to vary [10].

Suggestions for Parents

1. Household responsibilities, i.e., one chore to be done one time.
2. Regular times for eating, studying, sleeping, working, playing.
3. School work and reading come before play--even before other work. [Musicians practice regularly or they don't make it!]
4. Praise for good school work--occasionally before others.
5. A quiet place to study.
6. Family exchange on what pupil is doing...listen to the child's report.
7. Visit libraries, zoos, museums, etc., as a family.
8. Encourage good speech habits. At dinner or another time when everyone has a chance to talk.
9. Discuss what is being studied, materials used, etc.
10. Give special help when needed.
11. Talk re. planning for future, prep. For college, vocation, etc. There is a very high correlation between home environment/attitude toward education and school success.

ADVANTAGES

- Students have prerequisite skills to move to the next unit
- Requires teachers to do task analysis, thereby becoming better prepared to teach each unit
- Requires teachers to state objectives before designating activities
- Can break cycle of failure (especially important for minority and disadvantaged students)

DISADVANTAGES

One aspect of mastery learning that receives much consideraton is time. Mastery learning theorists, especially Bloom [11], contend that mastery learning techniques reduce the amount of time needed to achieve mastery. Arlin and Webster [12] conducted an experiment to test these time claims. Mastery learning students were compared to non-mastery students. The variables assessed were achievement, time and learning rate. The authors found significant increases in learning rate and achievement in the mastery group. In relation to learning rate, mastery students learned 15.75 items per hour as compared to 12.08 items in the non-mastery students. The mastery students spent significantly more time on instruction areas than non-mastery students. Mastery students averaged 40.9 minutes per chapter, in contrast to 20.8 minutes per chapter in non-mastery students. In summary, these authors state it is possible to significantly raise achievement levels using mastery learning, but the time needed for this increase is considerable. The disadvantages can be listed as follows:

- Not all students will progress at same pace; this requires students who have demonstrated mastery to wait for those who have not or to individualize instruction
- Must have a variety of materials for remediation:
- Must have several tests for each unit
- If only objective tests are used can lead to memorizing and learning specifics rather than higher levels of learning [13].

CONCLUSION

Levine [14] suggests some major points for school systems to explore when considering implementing a mastery learning program. Foremost, the principal must take on the role of instructional leader. Instructional leadership involves an understanding of mastery learning principles, a commitment to preparing and supporting staff, constant awareness and a system for setting and monitoring goals, directions and results of the program.

Another important point is planning prior to the implementation of the mastery learning program. Principles must be developed and all involved must have a clear understanding of the program. Selecting material that is well organized and conforms to the principles enables easier transition to the program for both the student and teacher.

Bloom, Block and Carroll believe that mastery learning can be handled in a normal classroom. Another group has developed a comprehensive curriculum system for use in reorganized schools. It provides for organization of schools and classes to provide for more individualized instruction than is possible in most systems. School systems must recognize that traditional methods of teaching and learning are unsuccessful for many students.Mastery learning is an alternative to the unsuccessful traditional methods of teaching and learning. Robinson [10] states a change from traditional curriculum and instruction models and adoption of a new method will require major restructuring of how the schools are organized and how teachers are prepared and empowered. School systems have the task of defining success, determine what it requires to be successful in the twenty-first century and then evaluating research, outcomes and discussions of which method would best be implemented to meet each individual's needs. The plan must also include a method to monitor student achievement as well as student and teacher attitude toward the mastery learning program. Concrete results have been observed in the areas of student achievement, improved attitude and increased expectations in all school systems addressed. Each school system reviewed literature and voluntarily choose the mastery learning approach. By implementing mastery learning these school systems have shown the capability to attain the scholastic excellence that is increasingly demanded in today's changing economy.

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