

DIFFERENTIATED LEARNING ENVIRONMENT – A CLASSROOM FOR QUADRATIC EQUATION, FUNCTION AND GRAPHS

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ABSTRACT

This paper will cover the design of a learning environment as a classroom regarding the Quadratic Equations, Functions and Graphs. The goal of the learning environment offered in the paper is to design a classroom where students will enjoy the process, use their skills they already have during the learning process, control and plan their learning process, and have the right of free choice of which way they can learn easily. Besides, it is alleged that in the paper, students will be more engaged, motivated and self-confident in this learning environment in terms of theories and approaches. Besides, students will have computers and graph calculators in the classroom, and some applications and programs will be provided such as Cabri, Maple, Derive, etc.

KEYWORDS

Differentiated-learning, technology-based, student-centered, quadratic

1. INTRODUCTION

Learning happens in its natural habitat throughout history. People discover, explore, and learn in their daily life because, just like Dewey said, *"I believe that education, therefore, is a process of living and not a preparation for future living."*¹ If we would like to design an effective learning environment, this learning environment should represent the real life and contain the abilities of human being. Otherwise, as we all observe, students don't want to go to school. Fostering students to go to school voluntarily may be the hardest thing to be achieved. However, if learning environment – classroom – gives students the opportunities to use their own abilities that they already have, it will foster the students to learn willingly. Students are already learning what they need to learn in their daily experiences, so they can learn in the classroom as well.

According to the Gardner, it is a huge mistake to treat all children like they are different samples of the same individual, and this mistake leads to the formation of another mistake which is to try teaching the same things to all children in the same way. One of the main aims of this learning environment is to allow the students to enjoy the process, making them become willing to learn and assume the responsibility of their learning experiences.

The need for learning differs because of the existence and unique nature of man. When we look at the basis of education in education systems, the goals identified for the behavioral change to be gained by everyone are determined by assuming that the students have common characteristics in terms of their motoric, mental and affective developmental characteristics. Although individuals show similarities in terms of some mental and kinetic developmental characteristics, there are different forms of learning that emerge due to individual differences.

This study will cover the design of a learning environment for a classroom regarding the Quadratic Equations, Functions and Graphs that high school students find more difficult to learn. If we provide them an effective learning environment, the learning process of this topic would be beneficial. There are many studies

¹ This quote is from John Dewey's *My Pedagogic Creed* (1987), Article Two: What the School is.

made to show the difficulties that students faced through learning equations, functions and graphs in the literature (Bayazit, 2011; Golderberg & Kliman, 1988; Sezgin-Memnun et al., 2015).

Specifically, quadratic equations, functions and graphs are included in one of the categories of mathematics education which is algebra. Algebra contains abstract thinking in it, and with abstract structures, students can improve their critical thinking abilities and ability of noticing relationships of elements related to mathematics. Because of that, students' inability to learn algebra may lead them not to be capable of understand higher level mathematical matters, and withhold them to be successful in their educational lives (Williams, 1997). Functions and equations as abstract subjects in algebra are hard to comprehend, but they could be easier through graphs. Since, graphs are the visible way to understand what functions and equations represent. Graphical demonstrations of functions or expressions of equations both enhance students' reasoning skills and boost their mathematical skills including interpreting mathematical elements (Sezgin-Memnun et al., 2015).

2. THE LEARNING ENVIRONMENT

The class will be divided into three divisions. At the front of the class there will be a section where the students who want to listen to the teacher will be figured. In the middle of the class there will be round tables where group work can be performed, and the third part will be located at the back side of the classroom where the graph calculator can be used. This divisions will appeal to students' differences. If a student doesn't want to join a group work, that students will work independently in the setting, or if a student is motivated by recent technologies that s/he has never seen, that students will go towards to graph calculators.

In this learning environment, students need to control their learning throughout process. To foster voluntarily learning, students should set short-term and/or long-term objectives for themselves. People are committed to a goal in everything they do in their lives, therefore in education, setting a goal is not a different thing, it is the reflection of life. Secondly, planning can help students to engage in learning tasks easily. From the aspect of self-regulation, setting goals is the beginning of planning the learning process. With the help of goals, students can direct their attention and effort to the tasks they need to complete. While planning, students can use their prior knowledge or experience – they can use the knowledge of graph and relations from the subject of pattern. They can choose activities freely based on their own goals.

Functions can be visualized by graphs, so to engage students with the tasks, technological tools such as computer and graph calculator will be used to motivate students. Admittedly, in 21st-century students are already inundated with technology, therefore they are already accustomed to using technology. If we use technology as a tool or a platform (to create *macros*), it will automatically motivate students to engage with the subject. Hollar & Norwood (1999) reported that the graphing calculator facilitates to move among the representations fast. It should be noted that it does not have to be graphing calculator to use in the classroom, any graphing program would be useful for meaningful learning (such as Cabri, Maple, Derive, etc.). In this point, I need to indicate that students have different learning styles, and they are motivated by different technologies. Moreover, some of them may not be motivated by technology. In this learning environment, in front of every students will be computer, and in a corner of the classroom there will be graph calculator section, but the teacher never forces students to use them. If students would like to choose the traditional way to understand function, equation and graph, they will use pen and paper. Since, when any method, specifically technology is forced in the classroom, it might create motivational complications. Students will be free to choose their learning way. Therefore, students control their learning with setting goals, planning and motivating themselves with the learning style they choose according to their prior experiences, we can say that this learning environment will be learner-centered learning environment. Students can only learn deeper conceptual understanding by actively participating in their own learning (Sawyer, 2014).

In addition to the setting goals, planning and motivating, self-monitoring will be encouraged by the teacher. Self-monitoring is a self-regulation process, and it affects academic performance since it includes self-assessment and self-recording (Shapiro et al., 2002, Graham et al., 1992). While drawing a graph or writing the function from graph, students will keep a record of the number of times they work on a specific task, the time that spends on working on the task and the steps faced with failure or success (the task could be drawing a graph, writing the function or implementing the graph). This self-monitoring helps students to observe and evaluate their development and make changes while needed. Just as working on a specific

learning task, students will seek help from other students or the teacher. Consequently, social support will turn into feedback, naturally. With this feature, the learning environment turns into assessment-centered learning setting. The key principles of assessment in this kind of learning environment are that they provide opportunities for revision and feedback (Bransford, Brown & Cocking, 1999).

As Sezgin-Memnun et al. (2015) indicated that memorizing is the problem in learning with understanding. In this environment, learning and interpreting the equations, functions and graphs is easier to achieve than memorizing them. This environment is evaluating the understanding rather than memorization, it provides a depth of study. Planning will be a strong element through process, since it helps the knowledge to be well-organized. Also, with the help of records, understanding will be considered carefully and students will improve metacognitively by expecting additional information to make sense and asking for clarification when they face with complication during keeping record. Considering these features that the learning environment provide, we can name it as knowledge-centered learning setting. Since, knowledge-centered environments emphasis on sense-making, makes students more knowledgeable and consider students' preconceptions brought to the environment (Brandsford, Brown & Cocking, 1999).

2.1 Affecting Theories

In education, Piaget, the Swiss developmental psychologist, described constructivism as the process that students constructed their own knowledge. Constructivism based on Piaget's research results is not an instructional approach, but an information learning approach (Pehlivan, 2010). As a result, teachers focus on individual process of knowledge construction rather than imposing upon their own knowledge. Papert, a student of Piaget, expanded his teacher's strategy to constructionism by helping students construct their own knowledge that others can see and criticize (Papert & Harel, 1991; Kafai, 2006). Besides, constructivism is affected by Vygotsky's theory (Vygotsky, 1978), there are three major points alleged: (i) social interaction plays a significant role through cognitive development, (ii) having at least one person who has better understanding in the environment – this person could be a teacher or a peer, and (iii) the Zone of Proximal Development which is the distance between a student's ability to perform a task with guidance or a peer and ability to study independently. Vygotsky said that learning takes place in this zone.

In addition to these, constructivism is linked to instructional approaches and strategies such as metacognition and self-regulation. Both have important roles in students' learning process and refer to; process of monitoring, self-management, and evaluating a students' understanding (Hattie et al., 1996; Dignath et al., 2008). Metacognition means that one is aware of his own processes of thinking and can control these processes (Jaleel, 2016). Metacognitive approach is crucial because it encourages the students to think creatively and solve problems, and helps them to use their prior knowledge and experiences (Salmon, 2008). This theory claims that individuals must be the one who builds the knowledge, therefore, during process students regulate their own cognitive structure. When looking at the cognitive constructive view, self-regulation must be considered.

When it comes to learning process of equations, function and graphs, in this learning setting students will be encouraged to construct their own knowledge, and teacher has a role which is just a counselor, facilitator and scaffolder. When a student faced with problems to understand, another student can assist him/her or the teacher will scaffold the learner. So, this verifies Vygotsky's second point. As students creating and interpreting the function, equation and graph with the help of apps, calculators or just using pen and paper, teacher will give directions instead of imposing his/her own understanding to the students. Additionally, during the process that students exert effort to find out the conception that the facts bear out related to subject, they will need help and they will be in search of assistance. At this juncture, social interaction with peers or the teacher will be formed as feedback. Just as the constructionist approach advocates, other learners will see and critique the construction built by a learner. This confirms Vygotsky's first and third points. The records kept throughout process will provide monitoring students' understanding, and help the teacher to specify the misunderstandings and/or misconception. This will make easier the evaluation for the teacher. The process of monitoring derives the most effective assessment, and permanent and strong learning. An important goal of this environment is that fostering voluntarily study including setting goals, monitoring the process and evaluating the learning. Students will take active roles and the setting will provide them great opportunities to reflect on what they learn and how they learn with their peers and the teacher.

3. CONCLUSION

Given the structure, the number of students should be limited because there are some reports that indicates the class size is a significant element for the benefit of learning (Farrie et al, 2016; Bosworth, 2014). Students can get more attention from teacher, and teachers know well their students. Every student will be involved to the process, and none of them will be neglected.

Because all the information is transferred from teacher to themselves in current educational system – teacher-centered, students will have difficulties in controlling their learning and studying on their own. However, problems and difficulties would be eliminated with a well-trained teacher about counseling, scaffolding, self-regulated learning and educational psychology. At this point, we need to assume that the teacher has the abilities mentioned above.

Students will learn the understanding of function, equation and graphs in a unique way rather than traditional learning. Also, with the help of interaction and having the freedom to choose the learning way, the ability of working with other people would be improved, their self-esteem and confidence would be settled, and their construction of knowledge will be cumulated by means of others feedback. Students will understand and see the true meaning of and differences between function, equation and graphs, and can easily interpret and recognize them.

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