*Harvard Conference on Preparing Students for an Uncertain Future, Boston, USA, November 2018, Vol. 16, No. 1*
*ISSN: 2330-1236*

# Active Learning Strategies in Mathematics and Science

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## Abstract

As students and teachers the diligence of education is learning. In the education system, mathematics and other theoretical sciences are often taught exhibiting lecture design which stimulates apathy and solitariness in students. In this study, we have discussed certain alternative teaching methods, including cooperative learning in small groups, essay writing assignments about technical topics and engaging in some events related to mathematics and science. The importance throughout is on getting pupils to participate more, interact more and extend their standpoints. These methods can reinforce students learning and attainment in science and mathematics to nurture student's confidence in their aptitude to do mathematics and science and increase the diversity of science and mathematical community. Professional societies and funding agencies can take the responsibility to give the support of training and resources for the use of active learning. I hope that the ongoing modernize curriculum and pedagogy will lead to more meaningful science and mathematical experiences for both students and teachers by implementing active learning methods.

**Keywords:** Active learning, Education system, Teaching methods.

## Introduction

In today's complex world, people must learn to apply tools and knowledge in new domains and different situations. People would also be creative and dynamic problem solvers at every organizational level (Lynton, 1989; Resnick, 1987; Nickerson, 1988; Bransford, Goldman, & Vye, 1991). It is important to have the ability to apply experience and knowledge to address novel problems. Subsequently, this is required to promote higher level skills like: critical thinking, applying, analyzing, evaluating, synthesizing to solve technical, social, economic, political, and scientific problems, and work in groups industriously those are vital skills for prosperous and pleasing participation in the modern and competitive society. Education is getting cumulative stress from changing the global economic circumstance and intricate societal necessities (Grabinger &Dunlap, 1995). The challenge for educationalists is to exploit strategies and teach content in ways that also assist in improving thinking, problem-solving, metacognitive, and life-long learning skills (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). The society, country as well as all over the world the requirement to know ourselves and changing ourselves according to how we are positioned within environments in which we find ourselves. The personal knowledge as identity is often not recognized in mathematics classroom; however, the constructive disciplinary knowledge is crucial as it influences the degree of potential engagement along with stated content and learning technique of the mathematics classroom.

It is stated that mathematics and science are the most important tools in the development of goals in education. There should be a deliberate strategy for stimulating and inspiring the enlargement of native knowledge and the application of such to local development to achieve the goals (Akase Jir, Mwekaven, Awuhe, & Tombuwua, 2015). Mathematics is known as basic science or knowledge-based supports of all subjects. It is well known that the role of mathematics is the key to the success of national development and supported by the evolution of science and technology.

Undergraduate mathematics students develop abilities to think scientifically and logically. This work sought to illustrate and enlighten the elements of active learning in mathematics and science along with the fundamentals theory and instructional policies to make a common ground for discussion. The beauty of this learning is to depend on the continuous collaborative process, such as active engagement, participation in the classroom, collaboration with classmates, lecturing in the classroom, and personal relevance. The instructor would be responsible for creating the procedure of building and reshaping understanding as the natural consequences of their experiences and trustworthy interactions with the world (Goodman, 1984; Forman & Pufall, 1988; Fosnot, 1989).

### Essential for educational modification

Teachers and students are responsible for updating the undergraduate education. Even the higher authorities of college and university, and university grants commission (UGC) would take responsibility for improvements. This is a joint project. Faculty members and administrators have to think as educators that have been following shared goals.

### Interaction between faculty and students

The rapport between teachers and students are very important for the success of students. There are some ways to support diverse learning styles by using different activities such as using examples that are relevant to student knowledge and experience, encouraging students to ask questions – both during the class as well as at the end, asking students to explain their

understanding of the concept to the classmate sitting next to them – teaching is an effective means of learning, doing problem solving exercises individually or in groups – applying a concept, and finally, reading key points from a book to break up the monotony of class lectures.

Evolve exchange and collaboration among pupils

Research has shown that collaborative and social activities are characteristics of good learning (Fosnot, 1989; Henry, 2010). They encourage students to join at least one activity that helps them to get to know one another, it is important to follow- up with student's engagement in class - listening, and active participation, inspire learners to participate in groups to be prepared for the exam and working on assignments, arrange projects and presentations in groups, and operate peer educating.

It is important to note that students need proper feedback on their performance for learning better. It is required to have proper opportunities to perform and receive suggestions for enlargement of students learning within the classroom. Learners need to know the reflection, what they have acquired, what they still essentially need to know, and how to evaluate themselves. Teachers would do well to provide instructive comments on student's discussion and give suggestions to overcome their errors, explain assessment techniques, such as – quizzes, assignments, tests, presentation, discuss the problems of assignments, quizzes and tests in the class and with individual students, return grades for quizzes, assignments and tests, and provide a question and answer session in every class.

Respect the talents and techniques of learning

Students must have the chance to show their talents and learn in ways as per choice. There are various ways to learn, and no two humans follow the same way. Students have several talents and learning modes in the classroom. Therefore, teachers should inspire students to speak up when they do not understand, practice different teaching methodologies and techniques to address a broad range of students, provide additional material or activities which do have a lack of sufficient knowledge or skills, and give a problem to solve that has multiple solutions within the classroom. Guide students with clues and examples.

Engage in active learning

Active learning was first defined by Bonwell and Eison (1991). Active learning responds traditional lecture formats with more activities that invite students to participate in learning, developing conceptual awareness, applying knowledge, experience, and transferring skills across contexts and usually connect with comprehensive teaching. It is empirically shown to reducing the acquisition gap for underrepresented minorities and first generation undergraduate learners, especially in STEM grounds to reach "a diversity of pupils"; and to shape "higher- order thinking skills" across involved students (Bonwell & Eison,1991; Freeman et al. 2014).

Why Active Learning?

The earlier literature shows that when the material is delivered using a single method (i.e. students are passively listening) their concentration limit is between 10 to 20 minutes, a small fraction of a lecture. Passively listening of a lecture is suitable at promoting learning at the lower end of a taxonomy of learning such as: 'remembering' and 'understanding' – but it is not as good at stimulating higher-level skills like 'applying', 'analyzing' synthesizing, and 'evaluating'. While all of the above types of learning are vital and build on each other, higher-level critical thinking

skills are integral part of the study. Delivering mode: lectures, where students listen rather than interact, are not good at promoting higher-level learning and skills. Students are reluctant to continue their studies in mathematics and other STEM disciplines (Hsu, Murphy & Treisman, 2008). Students who intend to enter STEM fields face integral barriers to success in our current mathematics education system, barriers that will likely remain for the near future [16]. Improve the class environment by stimulating interconnections between students, which can enhance the sense of belonging and motivation for marginalized students and those with differing levels of academic preparation.

Types of Active Learning

*Think-pair-share activities*
Students work individually on an active learning or formative assessment activity (such as problem solving). They then compare their responses with a partner and synthesize a joint solution, and share with the entire class.

*Pair summarizing/checking*
One student can explain the concept. Classmates can listen and provide constructive feedback.

*Large-Group Discussion*
Pupils discuss a specific context in class based on a reading, or problem solving.

*Inquiry Based Learning:*
The instructor presents a major concept and then asks students to make observations.

*Problem creation*
Each student poses a problem about a concept. They then exchange problems with a classmate and solve.

*Peer Review*
Students complete individual homework, assignment or short paper. Before the deadline, students submit one copy to their partner or group, and then provide critical feedback of each.

Weaknesses of current education system

Recent researches show that students are not particularly strong in their thinking and reasoning ability (Resnick, 1987; Bransford, Goldman, & Vye, 1991). Conventional systems regularly apply basic and de-contextual instances and problems that lead to an insufficient understanding and capability to execute the acquired knowledge. Apart from the above illustration, several issues are very important namely, the lesson plan and adaptation must favor the standpoint of the learners, student's reasoning should be monitored and execute various formative assessment methods, instructors need to use different ideas depend on situation and contents, the instructor has to have better quality to understand student’s psychology, students have to write/copy from class by hand rather than only see from power points for mathematics, and for instructors, it is very important to know formative assessment techniques and practical application in undergraduate mathematics - identify misconceptions of potential students and planning to solve those misconceptions.

Instructional Resources

The primary instructional resource is a textbook, mathematical skills and concepts. Also, a practice set of tasks to be completed as homework, and personal and circumstantial factors of instructors influence the assessments and activities include the instructors' prior experiences, beliefs about teaching and learning, available resources, opportunities pronounced in the curriculum, norms of the department, among other factors.

Educational Goal

The objectives of a mathematics program are the requirement to cultivate a well-balanced foundation in mathematics content having an in-depth understanding of elementary principles to understand mathematics desired for our rapidly changing technological society and to place emphasis on how to design the best and most effective curriculum and ways to deliver this curriculum. Moreover, as per the demands of the 21$^{st}$ century, it is required to produce Ph.D. graduates who can become the leaders of the educational community concerning the teaching of mathematics. It is also important to produce high-quality teachers of mathematics at all levels.

## Research Design and Methodology

Participants

The participants were students of BRAC University enrolled in the course MAT 110 (Differential Calculus & Coordinate Geometry), MAT 120 (Integral Calculus & Differential Equations), and MAT 216 (Linear Algebra & Fourier Analysis) in the first; third; fifth and sixth semesters of Fall 2018. A total of 150 students (108 males) completed the survey with the prescribed questionnaire. Of these, 122 came from Computer Science & Engineering, 20 from Electrical & Electronic Engineering and remaining from other programs.

## Results

**Table:** Students response to each question using a five- points scale (Legend: SA – Strongly Agree; A – Agree; N – Neutral; D – Disagree; SD – Strongly Disagree):

| Sl | Question | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1. | I would learn math better if I try hard. | 103 | 43 | 3 | 1 | 0 |
| 2. | Natural (inherent, inborn) intelligence is required for being good in math. | 12 | 21 | 21 | 47 | 49 |
| 3. | When I learn a new object in math, I try to relate what I already know rather than just memorizing the new way how it is presented. | 51 | 77 | 17 | 4 | 1 |
| 4. | If we engage with other activities, we can learn more and open our minds rather than studying only notes. | 74 | 64 | 12 | 0 | 0 |
| 5. | I think student's involvement is more important than delivering lecture. | 76 | 68 | 6 | 0 | 0 |
| 6. | The topics should be reviewed after being discussed; these learning activities help us to learn more, enable us to interact more. | 74 | 69 | 7 | 0 | 0 |
| 7. | It is important to cooperate with classmates, learn from peers, and see how much we know. | 78 | 59 | 12 | 1 | 0 |
| 8. | As a student, if you guide your peer to solve their problems as a spearhead it would be inordinate key for your learning. | 58 | 80 | 6 | 0 | 0 |
| 9. | If instructors give a different way to study other than just reading through the notes, it would be a better learning technique. | 74 | 62 | 11 | 2 | 1 |
| 10. | If the classroom is interactive, and the instructor helps us to learn better, the class does not get monotonous. | 73 | 63 | 13 | 1 | 0 |
| 11. | Students should involve several course-related activities, for instance- assignment, presentation, etc. | 55 | 72 | 15 | 5 | 3 |
| 12. | I like power point presentation than board-and talk delivering lecture in math. | 4 | 6 | 17 | 68 | 55 |
| 13. | In active learning getting involvement as analyzing, synthesizing, and evaluating- I think active learning is better than traditional learning. | 80 | 64 | 6 | 0 | 0 |

## Results and Discussions

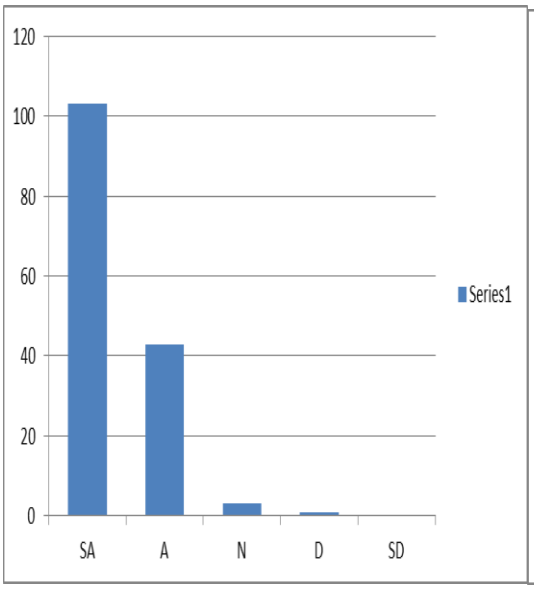



Fig: 1 Bar Chart

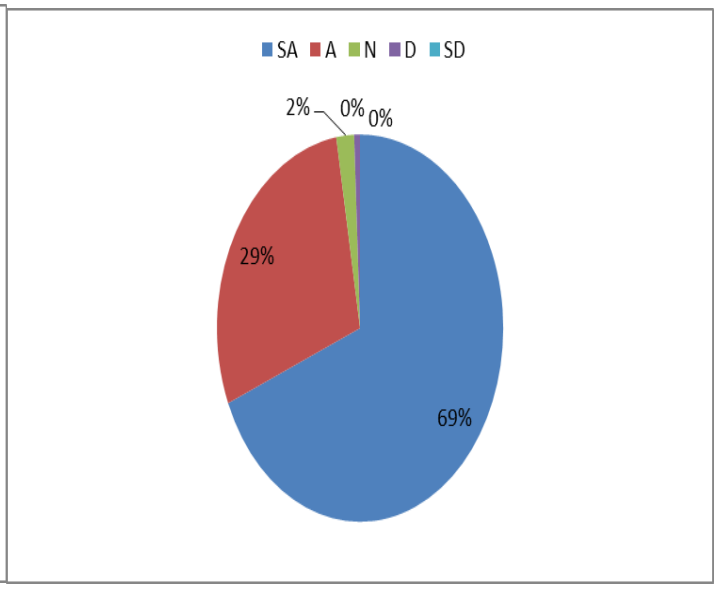



Fig. 2 Pie Chart

The above bar chart and pie charts show that 69% of the students strongly agreed, 29% agreed and 2% were neutral whereas no single student disagreed and strongly disagreed with the statement "Students learn mathematics better if they try hard."

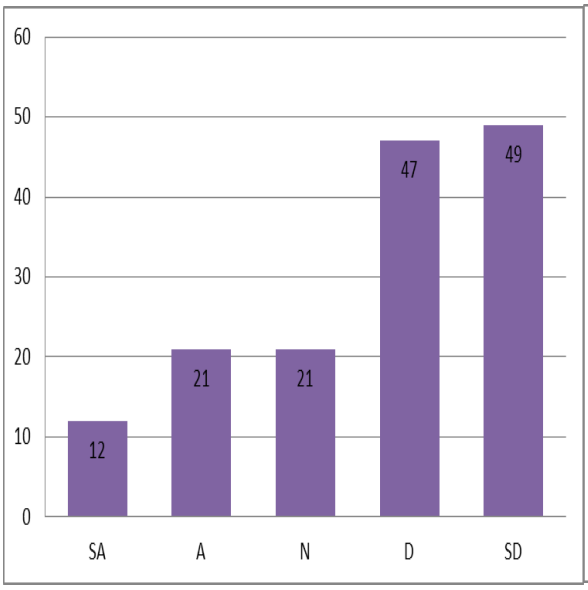



Fig. 3

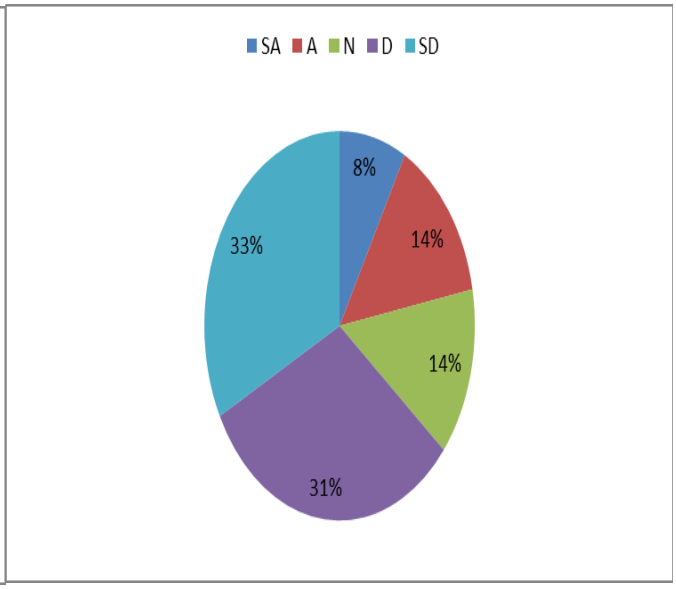
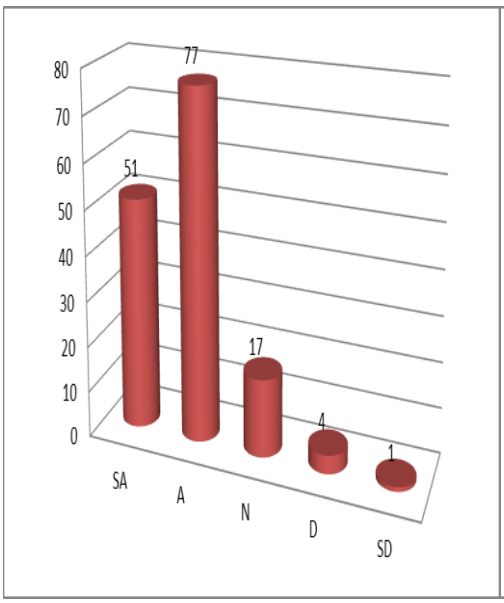



Fig. 4

The responses for the questionnaire "Natural (inherent, inborn) intelligence is required for being good in math" is displayed in Figures 3 and 4.



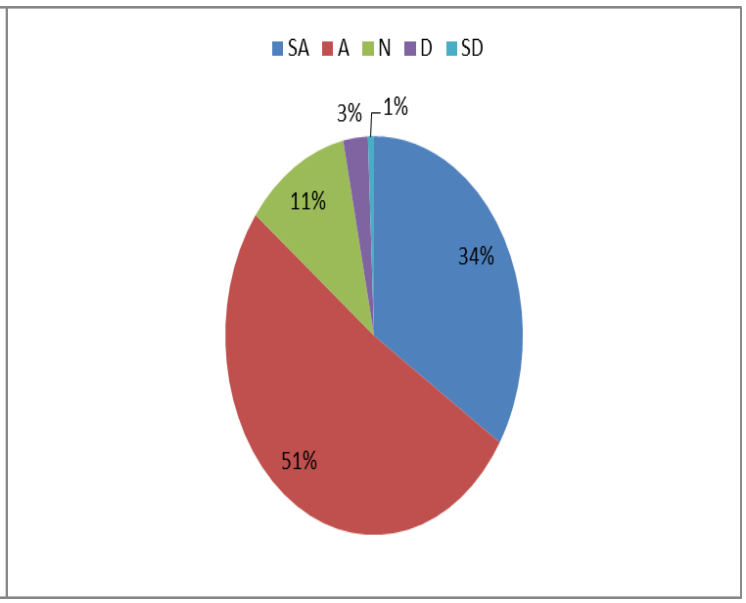
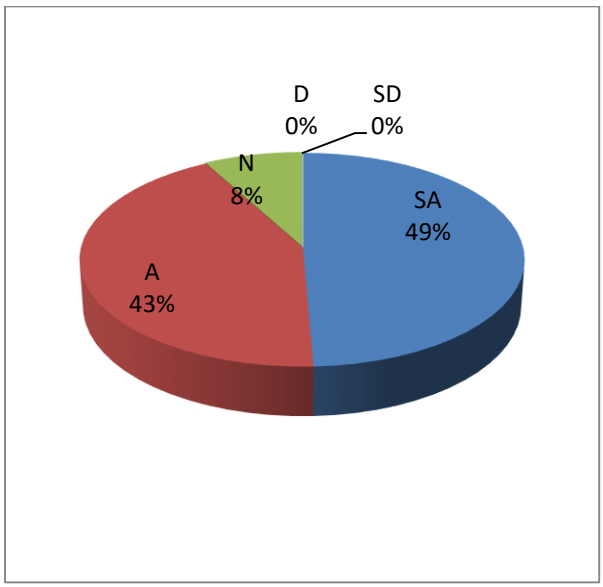




Fig. 5 Fig. 6

The result of students' opinions on "When they learn new object in math, they try to relate what I already know rather than just memorizing the new way how it is presented" is shown in Figures 5 and 6.



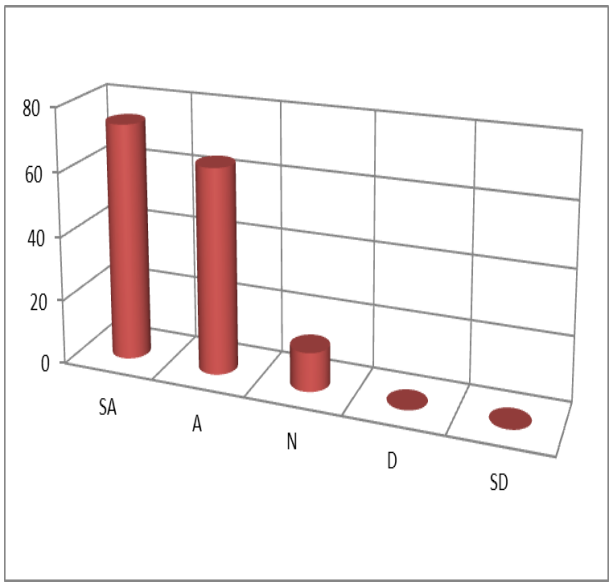
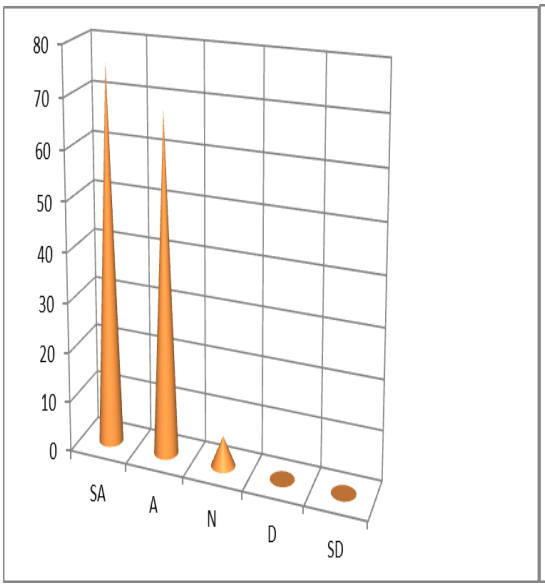




Fig. 7 Fig. 8

49% and 43% of the students strongly agreed and agreed respectively with the statement "If we engage with other activities we can learn more and open our minds rather than studying only notes".



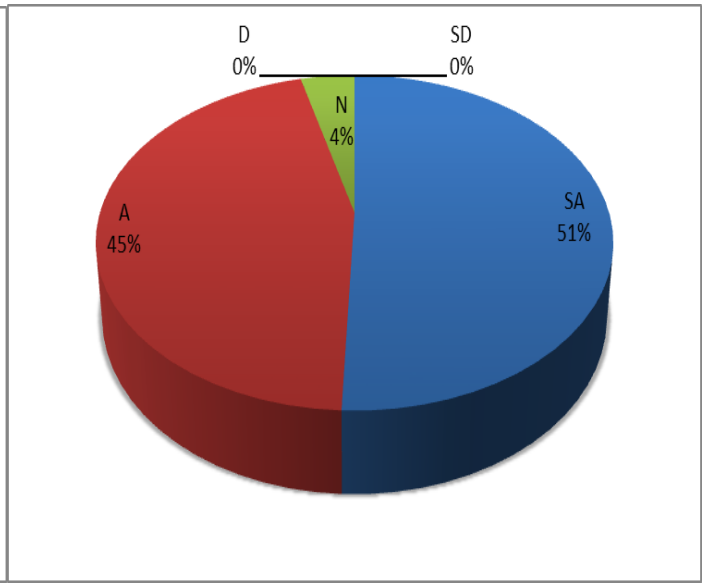
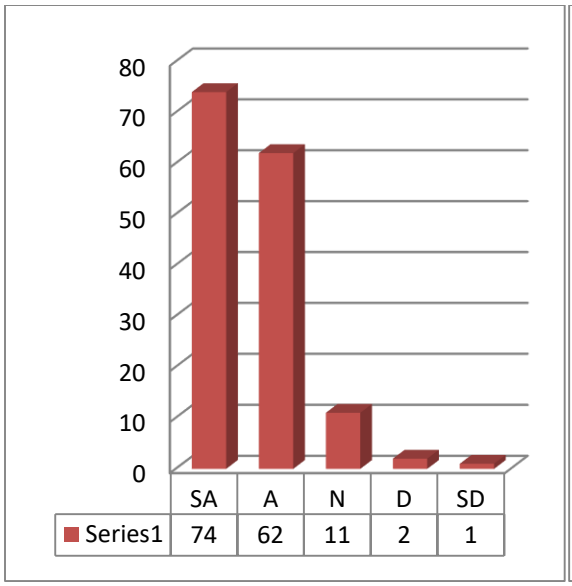




Fig. 9 Fig. 10

The report of questionnaire "student's involvement is more important than delivering the lecture" is presented in figures 9 and10.



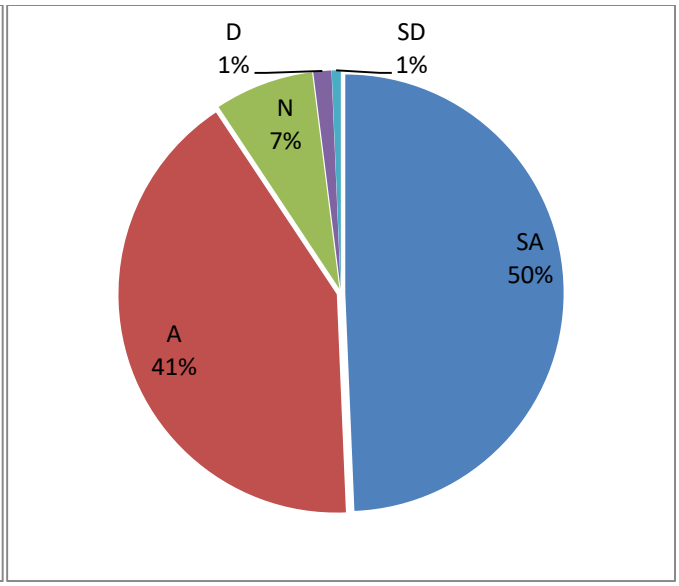




Fig. 11 Fig. 12

The result on student's view "The topics should be reviewed after being discussed; these learning activities help students to learn more, enable to interact more" is demonstrated in figures 11 and 12.

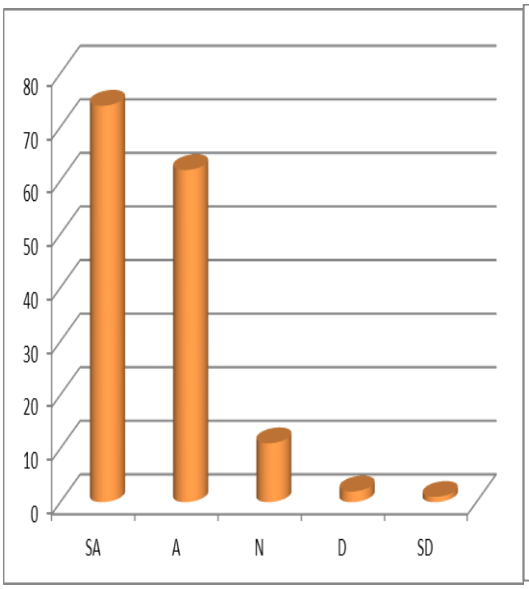



Fig. 13

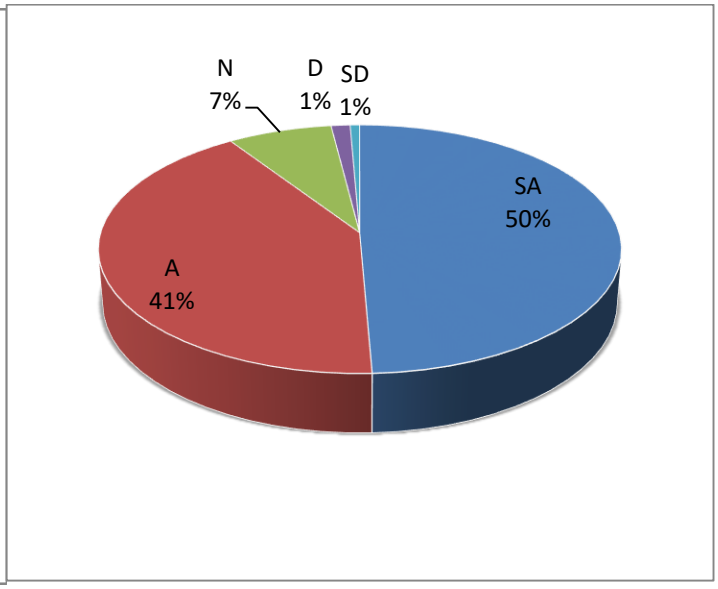



Fig. 14

The survey on "If instructors give the different way to study other than just reading through the notes it would be better learning technique" is illustrated through bar chart and pie charts.

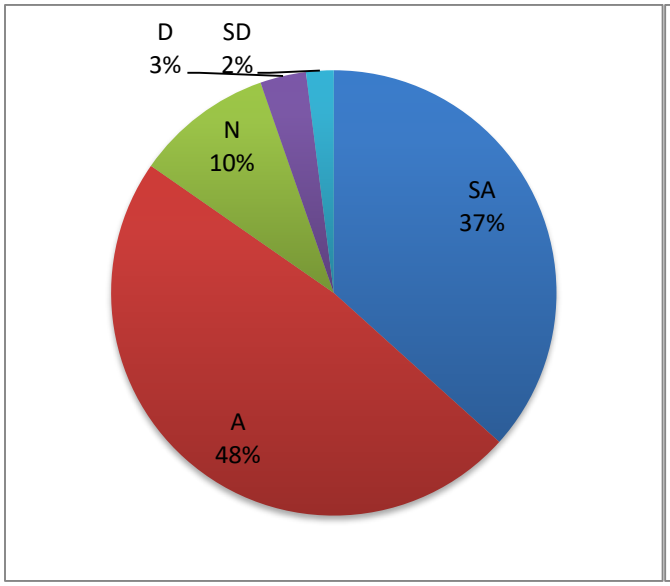



Fig. 15

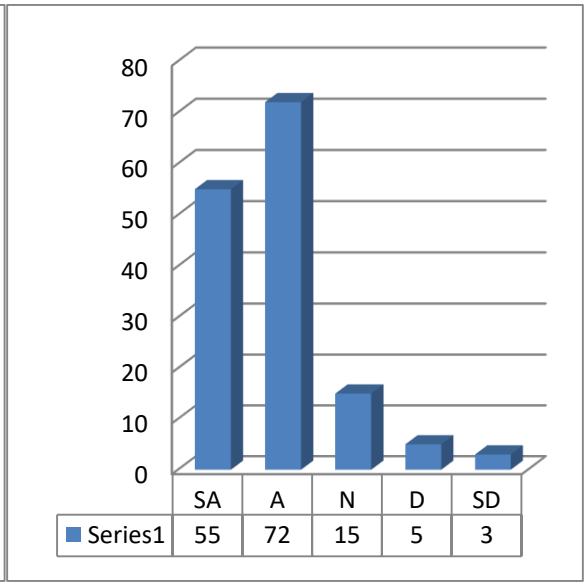
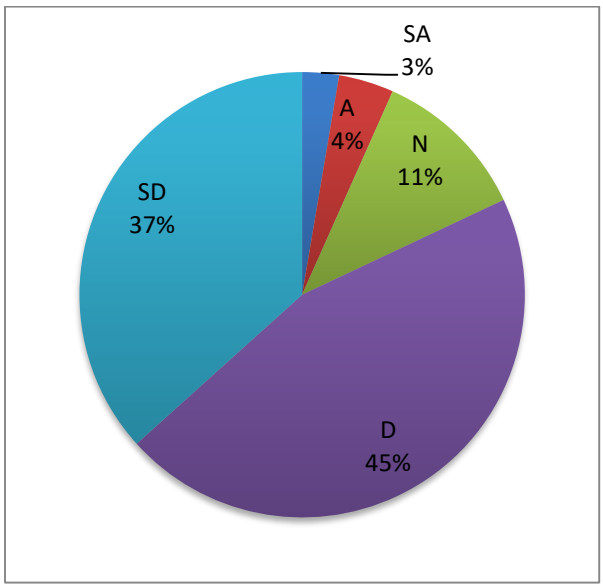



Fig. 16

The above pie and bar charts reflect the pupils thought "Students should involve in several course related activities, for instance- assignment, presentation, etc".



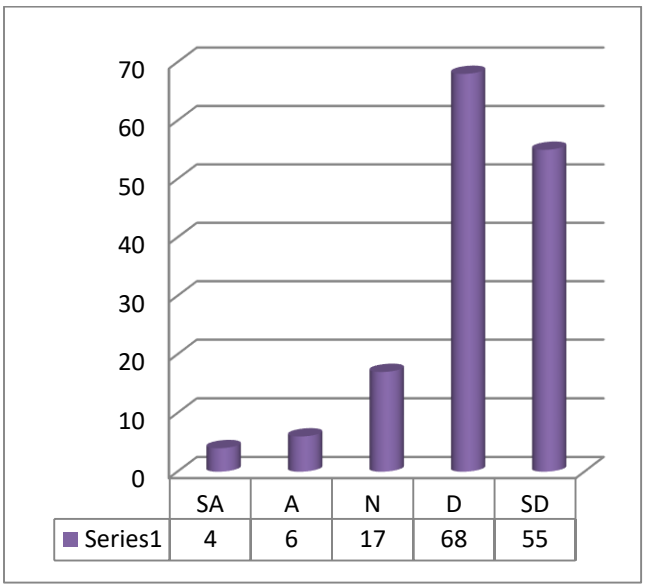




Fig. 17 Fig. 18

Figures 17 and 18 show the students responses on "Pupils like power point presentation than board-and talk delivering lecture in math".

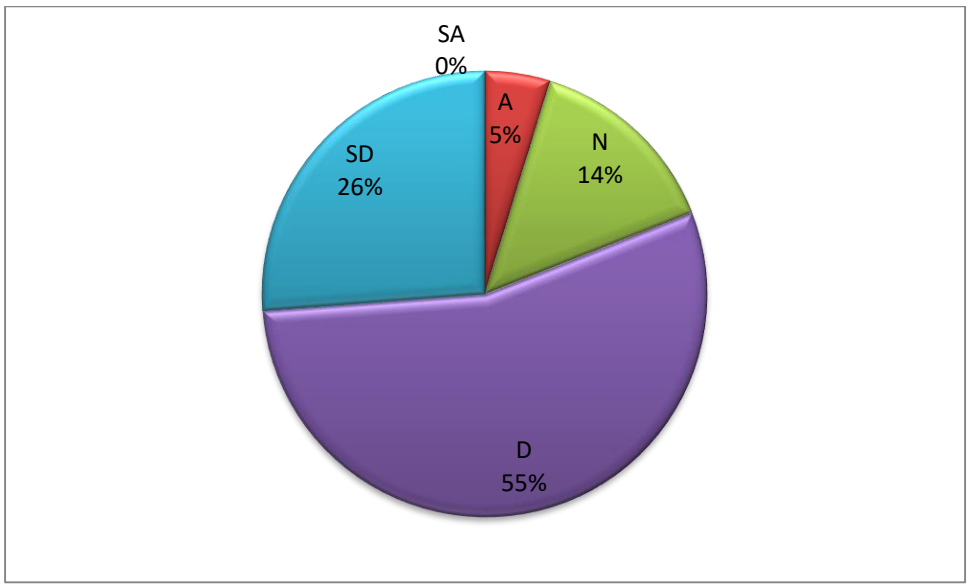
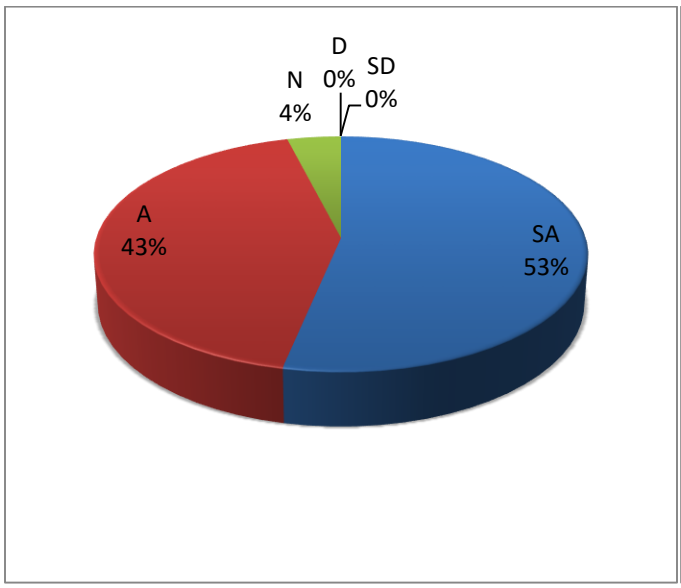



Fig. 19

Figure 19 discloses the comparison between male and female students about their opinion. Whereas 26% of the female students strongly disagreed, 55% percent disagreed and no female strongly agreed with the statements.



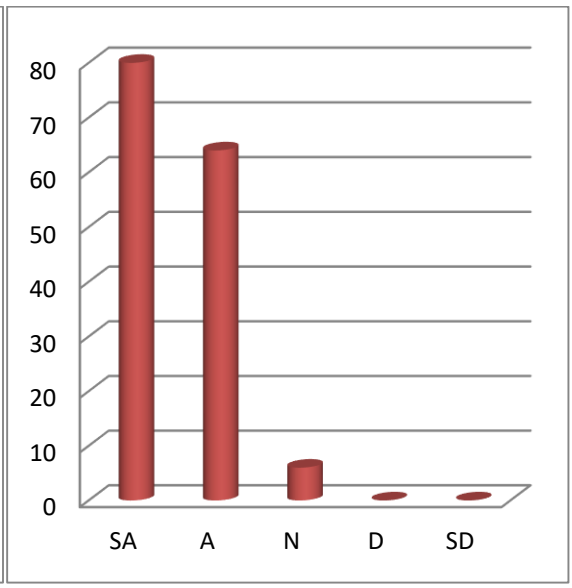
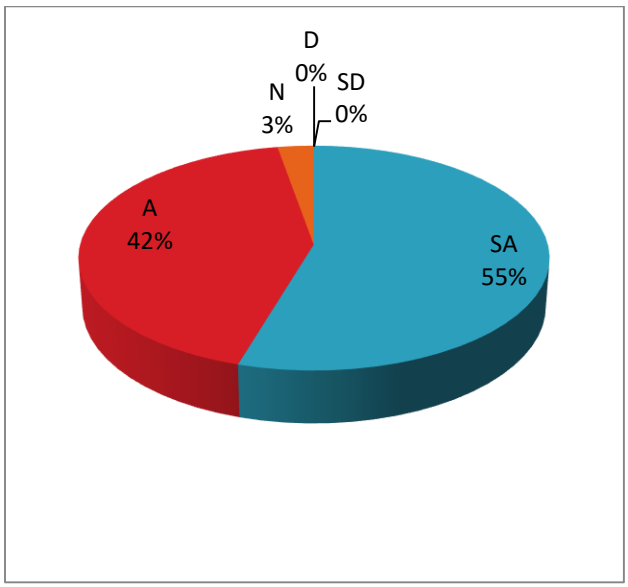




Fig. 20 Fig. 21

In active learning, getting involvement as analyzing, synthesizing, and evaluating- learners think active learning is better than the traditional learning which is demonstrated in figures 20 and 21.



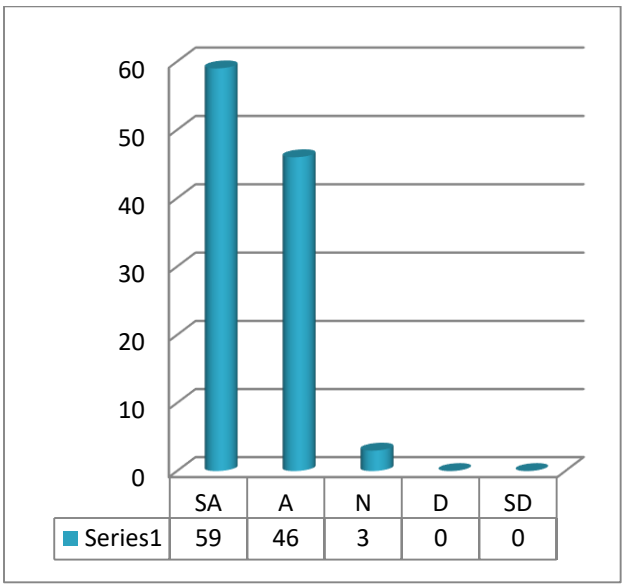




Fig. 22 Fig. 23

Figures 22 and 23 indicate the comparison of the opinion of girls and boys. No boys strongly disagreed and disagreed, but fifty five percent strongly agreed with above statement.

## Conclusion

Students are very smart and busy with many activities. For attracting their attention in study, we should think about how to deliver the lecture. Depends on student's quality and their thinking it is required to collect some questionnaires. As per the survey report and illustrations from pie charts and bar charts, we can conclude that students love to learn from the board rather than power point presentation for mathematics. Pupils also like their involvement in class; they prefer active learning technique to learn better.

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**Acknowledgements**

Authors would like to express their heartfelt thanks to BRAC University, Bangladesh for providing suitable research facilities. Authors are also pleased to share their sincere appreciation to the anonymous referees for their valuable comments and suggestions.