ResearchLEAP

Journal of International Business Research and Marketing
Volume 4, Issue 3, 2019
journal homepage: www.researchleap.com

Applying Active Learning in Classroom Environment: Implications for Mathematical Achievement

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DOI: *10.18775/jibrm.1849-8558.2015.43.3005*
URL: *http://dx.doi.org/10.18775/jibrm.1849-8558.2015.43.3005*

Keywords:
Active learning, Student motivation factors, Mathematical achievement, Primary school Mathematics

ABSTRACT

The research focuses on scientific instructional approaches which take into consideration the impact of such factors as influence and motivation and thus can help provide guidance on practical classroom techniques that can help in fortifying the students' success in mathematics. The paper investigates ways to achieve better math results among students by stimulating their motivation using active learning paradigm. The study aims to explore the methods of active learning applied in primary school math classes. Our results appear to add to the literature supporting the supposition that active learning has a direct effect on the students' success and consequently, their achievement. We provide empirical evidence for factors predicting higher math learning achievement, and accordingly, propose an improved student-centered active learning teaching method to help students develop higher-order problem-solving skills, comprising of a combination of previously verified strategies which help to foster a positive attitude towards mathematics.

1. Introduction

Learning can be divided into various types, with active learning recently increasingly recognized as a key component that may benefit students in achieving better math results. Lately, there have been more and more studies focusing on active learning techniques that foster a positive learning environment which may result in higher academic success. Many academics have speculated, and our research provides the evidence supporting the notion that active learning strategies are conductive in enabling students to achieve high performance on math, thus backing the idea that active learning has a significant impact on student performance. Problem with the traditional, outdated teaching paradigm was mainly the lack of teacher-student interaction. Nowadays many teachers focus more on the creation of creative and positive learning environment through the student-centered active learning process within which teacher is merely a guide as the focal point of contemporary education systems. Since students participate actively in the learning process, they are more likely to grasp and understand the covered material in a more meaningful way. In addition, active learning allows the student to connect the learned knowledge to the real-life contexts and it plays a critical role in improving students' self-esteem and self-confidence.

Our results appear to add to the literature supporting the supposition that active learning has a direct effect on the students' success and consequently, their achievement. Student-centered active learning approach we propose where the instructor assumes the role of facilitator encouraging cooperative, collaborative and problem-solving strategies presents an inherently active process.

This study is unique in the sense that it investigates, within a framework of suggested integrative model, the correlation between active learning and math achievement as comprising of hypothesized variables' relationships, of which some were examined before in isolation, but have never been tested previously in so far-reaching way on a national scale. Although researchers have speculated that such links might exist, to our knowledge, this study is the first to take them all in the account and empirically demonstrate this relation.

Using different aspects of existing methodologies helped us identify key steps that may help deepen students' understanding of abstract concepts and deal with complicated mathematics problems on a contextual basis regarding real-life problems.

Our approach does not take into account the educational dimension only, but it also builds on improving the crucial social skills which strengthen during the cooperative instructor-peer and peer to peer interaction and also introduces the concept of responsibility to students while working in groups. Thus, this study method assisted in overcoming the difficulties previous studies had to face, such as the ones focusing solely on motivation and achievement, or self-efficacy, lacking in other relevant determinants.

The novelty in this area brought about by our research is presented in an analysis that provides in-depth knowledge of factors influencing mathematics achievement, but our findings also have a broader appliance and some propositions for entire educational system regarding pre-class preparation, and especially for STEM area. Our results show that increasing certain factors of student motivations will result in better math achievement. Thus, the findings of the research can be useful for educators and policymakers to suggest introducing more active learning into the curriculum.

2. Concept of Mathematical Learning

Due to its transcendental nature, i.e. dealing with abstract conceptions and formal accounts, math has previously been recognized as somewhat problematic and challenging subject for students to grasp. This difficulty may be contributed partially to the traditional way of teaching, where students did not receive as many stimulations, approval, support, time and challenging tasks, group support and group competition and also cooperation to engage them authentically, that should be carefully designed as to flair their curiosity. The previous methods applied in math classes lacked some true engagement, that was possibly their primary disadvantage. Actually, the traditional way of teaching makes a student significantly dependent on the support of the teachers. As a consequence, students may not be able to think independently. Active learning strategies were developed as a result of the student's dependency on the traditional lecturing format where they mainly learned in a passive way and content represented to them seemed distant and too abstract, lacking in concrete examples and practices. Children develop procedural fluency in math when solving a variety of problems helps them to apply and use approaches and methods (NCTM, n.d). On the other hand, conceptual understanding explains the perception of abstract notions (Rittle-Johnson & Schneider, 2014).

Math is often exercised in isolation from other courses, which creates a loss of motivation for some learners and then becomes an obstacle to master math (Nikitina and Mansilla 2003). Mathematical theories should be taught with real-life connections. To promote students' interest and produce authentic relationships, multidisciplinary themes can be used (National Council of Teachers of Mathematics 1995).

Children are playful when they are working on problems, and gain knowledge through talking and mathematical thinking (Ontario Ministry of Education, 2003). They do not learn math by heart, thus, the education in early childhood should concentrate on profiting from this challenging behavior by encouraging their observations and curiosity (Berger, n.d). Through "Math Talk," the children can be encouraged to discuss mathematical equations in the class environment. Math Talk enables the pupils to create well developed and meaningful mathematical discussions based on their knowledge (Hufferd-Ackles, Fuson, & Gamoran Sherin, 2004). The students partially build their analytical perception by exchanging ideas with one another, justifying their notions, and asking questions (Wagganer, 2015). The pupils are asked to support their reasoning, demonstrate their opinions, compare and contrast concepts and resolutions and question each other on their findings (Suurtamm et al., 2015).

Results of the more recent research on active learning and instructors' intervention in courses (Corkin, D. M., Horn, C., & Pattison, D., 2017) show that participants of the classes engaging in active learning create a perception that the course is more interesting, thus increasing the curiosity and value for the subject matter and achievement in comparison to their traditional classrooms counterpart.

The review of the literature shows the critical importance of 4 major variables that impact student's math achievement. The first motivational variable is concerned with values, i.e. how well the student is motivated to get the right answer while solving the math problem. Secondly, how well are students enjoying the process of solving the math problem. Thirdly, what kind of negative and positive attitudes they have towards math activities. Finally, the last motivational factor can be explained by the availability of self-confidence in students to be able to solve the math problems.

Student's attitude towards mathematics is critically important in order to understand the subject properly and therefore helps in examining how children solve the specific problems. Therefore, it is important to prevent negative attitudes of students in order to ensure their success in problem-solving in mathematics module. Problem-solving skill is not only helpful in dealing with math problems but also critical to solving the real-life situations which we encounter in our daily lives (Morgan 2007). It is believed that students who show a high level of positive attitude in mathematics are more likely to succeed later in life. Therefore, it should be stressed that student's willingness plays a critical role in their mathematical achievements (Higgins 2011). Especially, high achieving students show higher levels of willingness towards solving math problems compared to those middle-level students. Since our results show that students attitude towards the subject determines students success, it is important to prevent negative

attitudes in order to ensure their success in problem-solving in mathematics.

In this regard, it is worth to consider that solving math problems requires a lot of persistence, perseverance, and willingness. Moreover, the student should be ready to accept the risks. Perseverance plays a critical role in mathematics. In other words, the results of the findings show that perseverance allows the student to continue learning and solving the problem until they achieve the correct answer.

Students' commitment to mathematics is critical in ensuring their achievements. It is worth to mention that when there is a discussion about commitment in mathematics most of the researchers refer to the idea of motivation of students to learn mathematics. Thus, a student's motivation plays an important role in enabling them to acquire enough skills and knowledge. Performance and achievement goals also play a critical role in math learning. Performance and achievement goals define student's main purpose of the learning behavior and what they are willing to achieve by studying the particular subject. It is important to differentiate between the three types of achievement goals in order to understand its impact on math achievement. Particularly, they include mastery goals. Particularly, it can be said that when mastery goal is high, math achievement is also going to be high. In other words, when students learn math in order to learn something new or to develop their existing knowledge and competence, they are going to achieve high results. Another important aspect of the achievement goals that are directly linked to improved math performance can be explained by performance approach (Hedges 2007).

Gender is also believed to impact on math performance and achievement. Particularly, one of the studies showed that while solving math problems, especially open-ended questions males are more likely to show better results compared to females.

3. Review of Prior Studies

Research on math education demonstrates the correlation between success in math and attitude towards math (Ma & Kishor, 1997; Ma, 1997; Ma & Xu, 2004). There is a reciprocal relationship between success in math and attitude towards math based on the evidence of Ma (Ma 1997).

The researchers previously devoted much of their time to examining the learning environment and the relationships between students and teachers. Some academics aimed at demonstrating how to structure a goal, support the students academically, and what teaching techniques, materials, and practices to implement, as well as how to direct teacher's beliefs (Wentzel et al. 2010; Church, Elliot, and Gable 2001). Data shows that teacher support of the peer has a positive impact on academic attitudes, feelings, self-efficacy, motivation, and success (Danielsen et al. 2010; Eccles and Roeser 2011). Math achievement is related to education methods significantly according to experts. Mainly, the instructor's responsiveness, behavior, and assistance play an essential role (Puklek Levpuscek and Zupancic 2009; Patrick, Ryan, and Kaplan 2007). Teacher's supportiveness and experience in teaching are also critical factors (Ahmed et al. 2010; Bagaka's 2011). Cavanagh et. al (2018) conducted a study on a sample of 245 students to examine the student-level factor contributing to positive outcomes arising from engaging in active learning practices. Results of the study show that student trust of instructor and students' views of their own intelligence are both associated with student commitment to, and engagement in, active learning. This study shows a crucial role of the instructor-student relationship as a contributor to desired learning outcomes in active-learning contexts.

Peers are also crucial in students' educational and development achievements in early adolescence. Academic achievement and engaging in classroom activities are also significant. They positively affect the acceptance of the student. Children should cooperate and become friends with their peers and successful students especially (Chen 2005; Clark, Scafidi, and Swinton 2011; Crosnoe et al. 2008). But, a negative impact of the teamwork can also be observed in other researches. Especially, receiving inadequate support from peers within classrooms focusing on competition (Chen 2005; Frenzel et al. 2010). It causes a decrease in achievement and withdrawal from learning activities.

Another relevant factor was considered as influential on math achievement, that is, self-efficacy and it concerns learners' beliefs regarding their capacity to fulfill specific tasks (Albert Bandura 1977; 1986). Bandura, as well as many other researchers, have shown that it influences endurance, ambition, performance, manners, and success (Zimmerman, Bandura, & Martinez-Pons, 1992; Bandura, 1977, 2000). The more self-efficacy is, the better the attainment will be (Bong & Skaalvik, 2003). Masitoh&Fitryanib (2018) highlight that the effort to improve student self-efficacy can be done by improving the mathematics learning process. The research revealed that the problem-based learning approach could improve student's mathematics self-efficacy, which in turn leads to better achievement as a result of good learning outcomes.

The function of self-efficacy regarding math and math achievement is based on structural equation modeling (Randhawa, Beamer, and Lundberg 1993). Students' confidence when they are participating and finishing math programs, answering math questions, and carrying out daily life tasks related to math was assessed with the Mathematics Self-efficacy Scale (MSES). Data showed that attitude towards math had both directly and indirectly affected math achievement

Advocates suggest that Active Learning maximizes the success and productivity of teaching, collaboration and learning

methods (Bonwell and Eison, 1991; Raux and College, 2004). Manley (2001) described these practices and claimed that these learning methods must be 'active.'

Meyers and Jones (1993) later described the concept of Active Learning as the learning methodology that enables the students to engage in communication, reading, and writing actively. According to this methodology, the students should also be able to display their thoughts upon the course through exercises requiring problem-solving skills, case studies, teamwork, role-playing, simulations, and similar tasks. Dewing (2008) suggests that Active Learning is highly compatible with the theoretical constructs, philosophical values and beliefs and approaches supporting transformational and emancipatory practice development and Active Learning allows for various opportunities. Results of a research (Clark, Stabryla & Gilbertson, 2018) on design thinking process showed there was a statistically significant increase from the start to the end of the course in students' beliefs that they could learn to be creative when active learning was applied.

According to scholars, the achievement goals are behaviors that supervise the students' strategy, commitment, and assessment based on their instruction techniques (Ames 1992; Pintrich 2000). There are differences among achievement goals and mastery as well as their approaches and avoidance orientations according to the research (Ames 1992; Dweck and Leggett 1988; Church, Elliot, and Gable 2001; Middleton and Midgley 1997). Researchers claimed that the combination of performance and mastery goals are much more doable than seeking each objective individually (Schwinger and Wild 2011; Pintrich 2000).

Regarding the correlation between achievement and differences based on gender, there are mixed results according to some studies. Based on their orientation, the female students are likely to be mastery according to the data (Steinmayr, Bipp, and Spinath 2011; Shim, Ryan, and Anderson 2008; Pekrun, Elliot, and Maier 2006). In comparison to the male students, the females tend to be much more performance-avoidance oriented (Steinmayr and Spinath 2008). The male students tend to be much more approach and performance oriented than the girls.
It is worth to mention that in the case of mathematics, it is important for the teachers to create an environment where their students can share their idea and discuss math problems with their peers (Greenhouse 2009). In other words, a classroom environment where math is taught should make each student feel free to share his idea, ask questions from teachers and debate with their peers.

4. Use of Active Learning in the Classroom Environment

Learning can be divided into various types, with active learning being recognized as a key component that may result in better math achievement. The active learning is a learning process in which the learner takes the responsibility of his/her learning and s/he is given the opportunity to make decisions about various dimensions of the learning process and to perform self-regulation (Açkgöz, 2003). In an active learning process, learning is no longer a standard process, but it is transformed into a personalized process. Here, the skills of problem-solving, critical thinking and conceptualizing are developed. Even though Active Learning has much in common with the process of action learning, it emphasizes a variety of principles within the boundaries of the classroom, including the critical reflection, multiple intelligences, skilled facilitation, learning from self, from dialogue and shared experiences with others and intentional action. The student-centered active learning process within which the teacher is merely a guide is the focal point of contemporary education systems.

The active learning environment in the classroom is created based on the usage of several active learning strategies that have been discussed in the above chapters of literature review. Moreover, using active learning strategies allows the student to be involved in the classroom learning process and makes them more interested. Particularly, in an active learning environment, students can move freely around the classroom and talk to their friends and teacher regarding the topic. In other words, time is flexible rather than being structured. In this regard, the role of teacher moves to be a facilitator rather than an instructor. It is important to focus on the individual needs of students while teaching them since each student requires special attention from the teacher (Burgan 2006). To form authentic relationships which will result in improved learning outcomes and higher test scores, the lecturer should be prepared to devote more time to each student individually. To challenge students, a teacher needs to prepare maximally the material and plan his activities, which may be time-consuming.

Thus, active learning strategies can play an essential role in facilitating teachers to adopt the student to the active learning environment. There was a lack of student interaction in the traditional learning environment. Thus, nowadays many teachers use active learning strategies that pay attention to the creation of a positive learning environment (Morgan 2007). Positive learning environment enables the students to interact positively with the teacher and with each other. Positive learning environment enables the students to perform better.
Active learning strategies create a competitive environment in the classroom. Precisely, students are motivated to learn and study hard in order to improve their skills and knowledge (Klein 2009). Math learning value is considered as an important factor in achieving higher performance in mathematics, with active learning positively contributing to its creation. During the classroom where active learning is used student will observe how their peers are taking part in discussion and debates so that they will be able to learn and understand the idea behind the mathematics.

Creation of the supportive classroom environment plays a critical role in developing the student's confidence in learning math. In other words, it is important to create a safe and positive space in the classroom in order to enhance the students' performance. It is vital that the learning environment in classes where active learning is used is completely different from the learning environment where traditional teaching and learning approaches are utilized. Research (Hyun, Ediger & Lee, 2017) confirmed that space may help enhance active learning pedagogical activities due to multimedia elements. Also, active learning environment comprises of introducing more visuals, presentations, charts and video content, and individualization of assignments and involves a shift from older, well established and long-nurtured methodology to a newer, all-inclusive and personalized way of teaching. Through active learning, learners may become thoroughly involved in significant emotional and sensual experiences. Since there are certain types of learners, one has bear this in mind when designing a preparatory curriculum. Active learning is based upon active engagement, hence, instructors should use various multimedia such as debating, writing, Q&A, group competitions, audio tapes listening and video watching to maximize the effect of learning in order to obtain relevant responses and improve mathematics achievement.

5. Implications of Active Learning for Mathematical Achievement

Active learning has an overall positive influence on student performance, with some relevant educational and pedagogical implications regarding teaching curriculum modifications that should be introduced into math class. Stimulating certain factors such as curiosity by challenging students and engaging them in fun and meaningful debates, and fostering a positive attitude towards learning will result in higher math achievement. Implementing successful practices of active learning can help improve analytical thinking and social skills and boost students' self-confidence, which also proved to be beneficial when solving difficult issues and grasping abstract concepts.

Problem-based learning involves providing different problems for students in order to stimulate motivation, increase self-efficacy and ensure their understanding of the material covered. This instruction method involves using real-life problems as an exemplary context for students. It also fosters motivating, challenging and fun conditions where students are able to actively participate in improving their thinking skills and understanding of deeper math concepts. The instructor may ask thought-provoking questions to the children when to boost their mental skills. Students should be allowed to play in class (Berger, n.d). The teacher should stimulate the students to talk about analytical concepts with proper terminology and increase their knowledge (Berger, n.d). Elementary school teachers should advocate Math Talk to promote dialogue (Student Achievement Division, 2011).

Students learn math in order to develop and improve their lifelong skills such as critical thinking and analytical capabilities that will be essential for them in their long term careers. People are taught math from their early childhood. Mathematics enables people to think better and more. Active learning strategies result in the creation of the belief in students' mindset that they can achieve higher performance and learn new skills. Thus, active learning is important in enabling the student to have strong self-confidence.

Active learning allows students to connect the learned knowledge to real-life contexts. Moreover, it plays a critical role in improving students' self-esteem and self-confidence. As a result of increased self-esteem, students are more likely to be motivated to learn more. In the process of active learning, students are more likely to develop high order thinking skills. Additionally, since they work in different groups of the student including their friends and peers, they are more likely to improve their social interaction skills, and feel as a part of the group and will be able to accept others' ideas and listen to them.

Active learning strategies are more student-centered rather than teacher centered. Since students participate actively in the active learning process, they are more likely to grasp and understand the covered material in a more meaningful way. As it was already mentioned there are several active learning strategies that can impact positively on math achievement. One of the most widely used active learning strategies is to make student solve the math problems in a group or individually. Both of these methods offer some type of advantages and at the same time some disadvantages for students. When students solve the math problems in a group by collaborating with their peers, they are more likely to understand the topic in a better way. This can be explained by the fact that during this process, students help each other by exchanging their ideas and solving strategies with each other.

Intergroup collaboration is based on cooperative learning, and it involves individual accountability, mutual independence, interactions which are face to face, and ongoing assessment of the learning process. A significant advantage of collaboration in the classroom is that it helps to increase problem-solving skills. Brainstorming in small groups in a problem-solving process would have positive influences on the problem-solving process at the later stages of mental development. The findings demonstrated that there is a meaningful relationship between the support provided to the student from the group of peers during an exchange of ideas in cooperative work in collaborative exercises and students' effort, self-efficacy, feeling of social belonging, satisfaction and positive attitude toward mathematics.

According to this research, the amount of active learning provided is directly proportional to the students' success. In

learning environments where the teacher provides support, the students can quickly find informative answers to their questions regarding confusing concepts and therefore their level of success and engagement increases. As a result of active learning, the students have a chance to discuss and resolve, formulate and solve problems, and finally actively participate in the classroom activities by putting forward their arguments and ideas. In short, active learning has many implications for the academic community regarding our way of teaching, interacting, and learning.

6. Discussion

There is a burgeoning discussion among the developed countries which focus on the importance of developing mathematical achievement of students at schools. It is believed that math enables young people to be better prepared for future jobs and enhance their working skills. As a result of this increasing importance of math-related subjects, the majority of researchers has focused on understanding the importance of factors which are most likely to impact individual math achievement.

Implementing active learning strategies in schools can help increase students efficacy, improve their problem solving skills and learning outcomes, and consequently, enhance the educative curriculum, yet, not only does it entail a change in a pedagogical measures including extra-curriculum preparations, but multidisciplinary themes should be introduced meaning technological improvements in the learning surrounding are necessary as well. The information and materials provided by teachers to students during the classroom should appeal to majority types of learners including visual, auditory and kinesthetic learners. Student perceives the same information in a different way and there are a variety of ways through which student receive information effectively. Active learning techniques can comply with this need due to their diversity, using diagrams, charts, audio tapes, and videos and active inter-group competition. This, in turn, helps students to apply their social, critical, analytical and problem-solving skills in the out-of-classroom environment and can be very useful for future education, as well as valuable for preparing the students for working positions.

Furthermore, transitioning from a traditional one-sided lecturing method to a new, interactive and cooperative way of learning includes much of out-of-class preparation for the in-class activities, further professional pedagogical and psychological education for instructors, continued training as well as it necessarily involves teachers' willingness to change. Further, active learning implies teaching should be multidisciplinary and be composed of key issues, problems, questions or plans that correlate math, science and reading. Math is often exercised in isolation from other courses, which becomes an obstacle and creates a loss of motivation for some learners who dislike pure technicality and like diversity. Mathematical theories should be taught with real-life connections, in different contexts and their relation to other subjects. Correlating math curriculum with other subjects may require some institution level or even education level coordinating.

Active learning combines deferent types of learning and is considered to be multidimensional in nature, namely, it is comprised of its social and educational aspects. Cooperative learning occurs in groups, working together to maximize their own and each other's knowledge. Considering groups are small, each student assumes a certain role within a group and plays a part in order for the task to be accomplished. Assuming a role implies distributing responsibility, and distributing responsibility implies introducing a concept of accountability associated with contributing to or failing a group. In the process of solving mathematical problems, such learning can be utilized as it may attain optimal outcome and build a foundation for the future of students' learning.

Traditional teaching methods and classroom are outdated and there is increasing evidence of extensive literature in favor of student-centered methodology. Therefore, it is important to admit that traditional lectures cannot be considered as an effective method of teaching and learning for students. However, when the teaching method is active and students take responsibility for their learning, they are more likely to be able to comprehend the material in a better way. Active learning enables students to develop their critical thinking skills. Particularly, by reading information, by scanning, by summarizing and connecting different parts of information, they will come up with logical arguments and their point of views. It is most effective when teachers try to connect the new knowledge delivered to students by relating it to their previous knowledge. When knowledge is connected with the prior knowledge and experience of the student, the student will be able to understand the given information using his or her reasoning skills. Thus, this information is more likely to stay on the mind of the student for a longer period of time.

In order to learn, one must have some social capabilities which make it possible to communicate or express themselves to interact with the other members of their society. Approaches to active learning focus on the factors concerning such capabilities, which can be exemplified as the ability to solve issues by cooperating, using mutual instruments to achieve broader conception of the knowledge, or performing better in most of the cases. In this way, students can take part in the dialogues, debates, or common ideas shared by a group. They can study responsibly and in collaboration with the others who intend to conceive the knowledge. Active learning is widely used in the context of math classes in order to ensure students understanding of important topics related to mathematics. Particularly, if a teacher wants their students to understand and solve the important math formulas, then it is important for them

to create an active learning environment. Otherwise, it would be a challenge for both students and teachers. The learning process should be organized interactively, fun, challenging and motivating the students to actively participate in the learning process.

In this regard, it is important to highlight the importance of problem-solving based learning. Problem-based learning involves providing different problems for students in order to motivate them and ensure their understanding of the material which is being covered. However, it should be noted that in math it is important for teachers to present the content of the lesson in as interactive way as possible so that students will be able to understand the material being more engaged. In other words, students should learn math by doing the math.

As a result of the research, it has been identified that such factors as an attitude towards the subject as well as emotions it brings about play a vital role in achieving high academic results in mathematics and science. Therefore, it is important to prevent negative attitudes of students in order to ensure their success in problem-solving in mathematics module. Instructors' role must be promoting positive attitudes towards a better future regarding students' education. It is worth to mention that student's attitude towards the subject determines student's success. The instructors can shape negative attitudes into positive attitudes.

A significant result of this study concerns the use of active learning pedagogy in school classrooms and other educational institutions. Student-centered active learning approach we propose where the instructor assumes the role of facilitator encouraging cooperative, collaborative and problem-solving strategies presents an inherently active process. In learning environments where the teacher provides support, the students can quickly find informative answers to their questions regarding confusing concepts and therefore their level of success and engagement increases, confirming the correlation between active learning and math achievement.

This research aimed to bridge the gaps among some previous studies by providing practical information and guidance for future practices. Students should be able to be given constant opportunities to solve rich and interesting math problems. Various studies suggest that questions labeled as problems in the classroom neglect the real world and they are rigid, and concentrate too much on procedural fluency. International research on problem-solving skills revealed that learners often ignore the reality when they are solving mathematical problems since the questions merely help students to repeat a procedure or an algorithm.

Correlating abstract concept and notions to practical examples in other subjects or even real-life situations and the possibility of group brainstorming and designing alternative solutions may not just improve problem-solving skills, but even make mathematics seem more approachable and fun. This is crucial since the review on the previous literature highlighted the importance of four major variables influencing math achievement, namely, motivation to get the right answer, second enjoying the process of solving the problem, thirdly the kind of negative and positive attitude towards math and availability of self-confidence. This model encompasses all four elements. Motivation is fueled by previous positive outcomes and new challenges to apply existing knowledge, enjoying the process is facilitated through competition on finding the best solution or group experimentation. Nurturing nature of facilitator versus the instructor in traditional sense creates more positive surrounding by providing encouragement and approval and facilitating a friendly environment. Finally, self-confidence grows in observing oneself mastering the assignment and being able to ask a question and get answers in time.

7. Conclusion

From the extensive literature summary and discussion, we can conclude that the whole process of learning is inherently active and involves such higher-order thinking as analysis, synthesis, and evaluation. As a result, the interpretation of the term Active Learning corresponds to a concept in which the student or the learner consciously consider their activities and are aware of the flow of their thoughts.

Active learning components identified in this research as beneficial to fostering to students needs and improving the development of their critical thinking skills, cooperation and responsibility may help to induce improved results in other areas of the educational system and scientific subjects. These findings can also be valuable for pedagogical purposes, meaning that applying active learning methods highlighted in this paper can help teachers and instructors to identify problematic subjects and provide real-time insights, as well as help them in better preparation of key points for future lectures. Results on the correlation between active learning and motivation and higher achievements may also be useful for future research on applying cooperative active learning methods in small teams in working place. Evidence suggests that positive attitudes, high motivation and engaging in problem-solving play a vital role in achievement in science and math, but this can be further examined in other contexts.

The findings of the research suggest that active learning enhances student motivation. The findings confirm that attitudes and interest affect achievement, therefore developing policies and strategies to improve engagement and participation in classroom activities is worthy of consideration. Using different aspects of existing methodologies helped us identify key steps that may help deepen students' understanding of abstract concepts and deal with complicated mathematics problems on a contextual basis regarding real-life problems.

The new model we designed encompasses all four key elements. Motivation is fueled by previous positive outcomes and new challenges to apply existing knowledge; enjoying the process is facilitated through competition on finding the best solution or group experimentation. Nurturing nature of facilitator versus the instructor in traditional sense creates more positive surrounding by providing encouragement and approval and facilitating a friendly environment. Finally, self-confidence grows in observing oneself mastering the assignment. Our results appear to add to the literature supporting the supposition that active learning has a direct effect on the students' success and consequently, their achievement.

References

- Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of educational psychology*, *84*(3), 261. Crossref
- Bagaka's, J. G. (2011). The Role of Teacher Characteristics and Practices on Upper Secondary School Students'mathematics Self-Efficacy in Nyanza Province of Kenya: A Multilevel Analysis. International Journal of Science and Mathematics Education, 9(4), 817-842. Crossref
- Clark, C., Scafidi, B., & Swinton, J. R. (2011). Do peers influence achievement in high school economics? Evidence from Georgia's economics end of course test. Journal of Economic Education, 42(1), 3-18. Crossref
- Corkin, D. M., Horn, C., & Pattison, D. (2017). The effects of an active learning intervention in biology on college students' classroom motivational climate perceptions, motivation, and achievement. Educational Psychology, 37(9), 1106-1124. Crossref
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review*, *95*(2), 256. Crossref
- Eccles, J. S., & Roeser, R. W. (2011). Schools as developmental contexts during adolescence. Journal of research on adolescence, 21(1), 225-241. Crossref
- Frank, K. A., Muller, C., Schiller, K. S., Riegle-Crumb, C., Mueller, A. S., Crosnoe, R., & Pearson, J. (2008). The social dynamics of mathematics coursetaking in high school. American Journal of Sociology, 113(6), 1645-1696. Crossref
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. PNAS Proceedings of the National Academy of Sciences of the United States of America, 111(23), 8410– 8415. Crossref
- Geoffrey, N. (2016). Analyzing the Determinants of Teachers' Mathematics Teaching Competencies in Upper Primary Phase: Evidence from Namibia. International Journal of Innovation and Economic Development, 2(4),35-47.
- Goodman IF, et al. (2002) Final Report of the Women's Experiences in College Engineering (WECE) Project (Goodman Research Group, Cambridge, MA).
- Greenhouse JB, Iyengar S (2009) Sensitivity analysis, and diagnostics. The Handbook of Research Synthesis and Meta-Analysis, eds Cooper H, Hedges LV, Valentine JC (Russell Sage Foundation, New York), pp 417–433.
- Gurevitch J, Hedges LV (1999) Statistical issues in ecological meta-analyses. Ecology 80(4):1142–1149. CrossRefWeb of Science. Crossref
- Haak DC, HilleRisLambers J, Pitre E, Freeman S (2011) Increased structure, and active learning reduces the achievement gap in introductory biology. Mathematics 332(6034):1213–1216. Abstract/FREE Full Text
- Handelsman J, et al. (2004) Education. Scientific teaching. Mathematics 304(5670):521–522. Abstract/FREE Full Text
- Haukoos GD, Penick JE (1983) The influence of classroom climate on mathematics process and content achievement of community college students. J Res Sci Teach 20(7):629–637. Crossref
- Hedges LV (2007) Correcting a significance test for clustering. J Educ Behav Stat 32(2):151–179. Crossref
- Hedges LV (2009) Statistical considerations. The Handbook of Research Synthesis and Meta-Analysis, eds Cooper H, Hedges LV, Valentine JC (Russell Sage Foundation, New York), pp 38–47.
- Henderson C, Beach A, Finkelstein N (2011) Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. J Res Sci Teach 48(8):952–984. Crossref
- Higgins JPT, Green S, (2011) Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0 (The Cochrane Collaboration, Oxford). Available at www.cochrane-handbook.org. Accessed December 14, 2012.
- Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). Describing levels and components of a math-talk learning community. Journal for research in mathematics education, 81-116. Crossref
- Hyun, J., Ediger, R., & Lee, D. (2017). Students' Satisfaction on Their Learning Process in Active Learning and Traditional Classrooms. *International Journal of Teaching and Learning in Higher Education*, *29*(1), 108-118.
- Church, M. A., Elliot, A. J., & Gable, S. L. (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. Journal of educational psychology, 93(1), 43. Crossref
- Jensen JL, Lawson A (2011) Effects of collaborative group composition and inquiry instruction on reasoning gains and achievement in undergraduate biology. CBE Life Sci Educ 10(1):64–73. Crossref
- Levpuscek, M. P., & Zupancic, M. (2009). The Journal of Early. The Journal of Early Adolescence, 29(4), 541-570.

Crossref

- Lipsey MW, et al. (2012) Translating the Statistical Representation of the Effects of Educational Interventions into Readily Interpretable Forms (US Department of Education, Washington).
- Lipsey MW, Wilson DB (2001) Practical Meta-Analysis (Sage Publications, Thousand Oaks, CA).
- Ma, X., & Xu, J. (2004). Determining the causal ordering between attitude toward mathematics and achievement in mathematics. American journal of education, 110(3), 256-280. Crossref
- Middleton, M. J., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of educational psychology*, *89*(4), 710. Crossref
- Morgan, K. (2007). The learning region: institutions, innovation and regional renewal. Regional studies, 41(S1), S147-S159. Crossref
- Nikitina, S., & Mansilla, V. B. (2003). Three strategies for interdisciplinary math and science teaching: A case of the Illinois Mathematics and Science Academy. Project Zero, Havard Graduate School of Education-Interdiciplinary Studies Project, 1-21.
- Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. Journal of educational psychology, 99(1), 83. Crossref
- Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of educational Psychology*, *98*(3), 583. Crossref
- Pintrich, P. R. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of educational psychology*, *92*(3), 544. Crossref
- Rittle-Johnson, B., Schneider, M., & Star, J. R. (2015). Not a one-way street: Bidirectional relations between procedural and conceptual knowledge of mathematics. Educational Psychology Review, 27(4), 587-597. Crossref
- Shim, S. S., Ryan, A. M., & Anderson, C. J. (2008). Achievement goals and achievement during early adolescence: Examining time-varying predictor and outcome variables in growth-curve analysis. *Journal of Educational psychology*, *100*(3), 655. Crossref
- Schwinger, M., & Stiensmeier-Pelster, J. (2011). Performance-approach and performance-avoidance classroom goals and the adoption of personal achievement goals. *British Journal of Educational Psychology*, *81*(4), 680-699. Crossref
- Steinmayr, R., & Spinath, B. (2008). Sex differences in school achievement: What are the roles of personality and achievement motivation?. *European Journal of Personality: Published for the European Association of Personality Psychology*, *22*(3), 185-209. Crossref
- Steinmayr, R., Bipp, T., & Spinath, B. (2011). Goal orientations predict academic performance beyond intelligence and personality. *Learning and Individual Differences*, *21*(2), 196-200. Crossref
- Suurtamm, Christine, et al. Assessment in mathematics education: Large-scale assessment and classroom assessment. Springer, 2016.
- Wagganer, E. L. (2015). Creating math talk communities. Teaching children mathematics, 22(4), 248-254. Crossref
- Wentzel, K. R., Battle, A., Russell, S. L., & Looney, L. B. (2010). Social supports from teachers and peers as predictors of academic and social motivation. Contemporary educational psychology, 35(3), 193-202. Crossref
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