ICT Based Mathematics Skill Development Program:

An Initiative to Overcome Mathematics Anxiety

https://doi.org/10.3991/ijet.v15i14.14149

Jashodhan Saha, Suman Ahmmed, Maruf Ahmed Tamal (✉), Mohammad Ali
Bangladesh Digital Education Research Limited, Dhaka, Bangladesh
tamal15-5620@diu.edu.bd

Karim Mohammed Rezaul
Wrexham Glyndwr University, Wales, United Kingdom

Abstract—This study introduces a complete ICT based Mathematics Skill Development Program (MSDP) web service that aims to enhance the positive attitudes of students towards Maths. The entire system is designed and implemented in such ways that students can learn Maths with fun and practical experiences in the classroom rather than only theoretical exercises. For the last 2 years (2018-2019), we have applied MSDP in 4 distinct primary and secondary schools in Bangladesh and followed up the students' (N = 200) attitudes towards Maths. Findings revealed that through the MSDP program, students have developed a significant positive attitude towards Maths that helps them overcome mathematics anxiety.

Keywords—Mathematics skill development program, mathematics anxiety, active learning, ICT

1 Introduction

Mathematics is a cognitive science that is considered as the basis of other academic subjects. Through problem-solving, decision-making and critical reasoning, mathematics enhances brain function. A good mathematical understanding not only leads to outstanding educational achievement but also contributes to the effective day to day activities. Nevertheless, despite having these good sides, mathematics is regarded as a tough and frightening subject to many students worldwide. As a consequence, increasing mathematics anxiety and reluctance for math among students has received attention from scholars in recent years. Researchers already developed several detective scales for measuring Maths' anxiety and reluctance. However, any significant preventive measures are not yet introduced. To bridge this gap, the current study has introduced an Information and Communication Technology (ICT) based Mathematics Skill Development Program (MSDP) for pre-primary to secondary level students that can attract students in learning math through an active learning environment. The contributions of the present study can be summarized as follows: (i) Finding out the

influencing factors behind students' negative attitudes towards Maths. (ii) Highlighting the role of ICT to modernize the mathematics learning environment and (iii) Introducing an ICT based MSDP web service to overcome mathematics anxiety.

2 Literature Review

In many countries, poor achievement and low participation in mathematics have now become a growing issue [1]. Anxiety and reluctance towards Maths have been considered one of the main reasons for poor performance in mathematics. At present, a considerable number of students experience Mathematics Anxiety (MA) which seriously interferes with their mathematics learning and performance by avoiding math. Previous studies have already identified some influencing factors of MA. For example, according to [2], MA occurs when students start to learn complex mathematical problems. However, a study [3] shows that students begin to face MA when they're in elementary school and this fear of math transferred through teaching methods by a school teacher. A similar finding has been reported in [4] that traditional teaching methods, learning strategies, and negative math-related experiences [5], [6] in the classroom may be the causes of student MA. According to their hypothesis, as traditional teaching and learning system is limited to textual/lecturing-based education only, it is not sufficient to learn Maths effectively. Lack of process-oriented learning, poor interactivity, and versatility can grow a negative attitude towards Maths in students. To overcome this crisis, the utilization of ICT in teaching and learning mathematics can play an important role by developing student's problem-solving skills, analytical ability, creativity and re-late Maths in practical life. Some initiatives are already taken to incorporate digital media in learning mathematics. In [7], researchers introduced Virtual Mathematics Kits (VMK) based on digital media that enhance the ability of mathematics learning by assisting students in problem-solving. Another study [8] revealed that incorporating ICT into education offers Maths teachers integrated teaching methods that encourage students to learn, support independent learning and helps to participate actively in the discovery of mathematical concepts, topics and thus help to gain a deeper knowledge of mathematical ideas. In [9] researchers found that ICT based learning plays an important role in ensuring and enhancing learning skills in kindergarten level students. Although earlier studies have shown that ICT based tools have a significant positive effect on students' mathematical learning, the system is not fully utilized yet. Based on these issues, the present study aims to develop and implement a complete ICT based MSDP programs to overcome existing deficits.

3 Framework and Implementation of ICT based Mathematics Skill Development Program

Fig.1 represents the framework of the MSDP program. As self-regulative [10] and active learning is more engaging than passive learning, the overall framework is de-

signed in such a way where students are treated as active learners. To fulfill the purpose of the study, the proposed framework has split into 6 major steps.

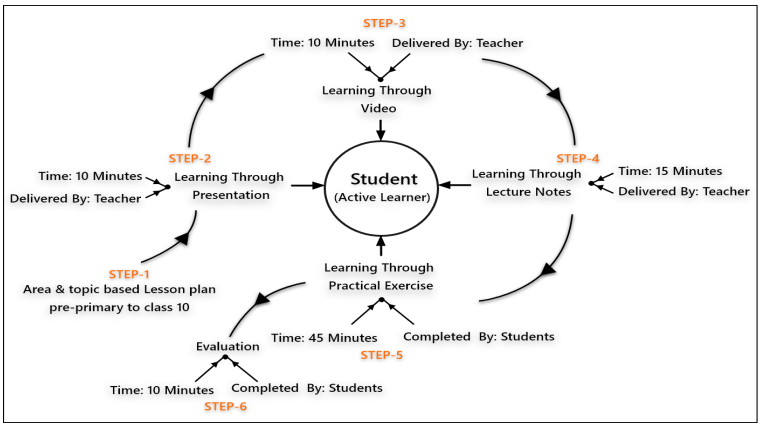

Fig. 1. MSDP Framework

Step 1: Area & topic-based lesson plan:

A lesson plan is a standardized roadmap of what students need to learn and how they can successfully perform it during class time. In MSDP, we organized an effective lesson plan based on class level, area of the topic, the objective of each topic and task of teachers and students (see Fig. 2). This gives a clear overview of what students going to learn and how they can successfully achieve their desired goal. As well as, area & topic-based structured lesson plan makes a teacher confident in delivering quality teaching, especially in mathematics. This lesson plan can be accessed and download through MSDP application by teachers, students, and guardians.

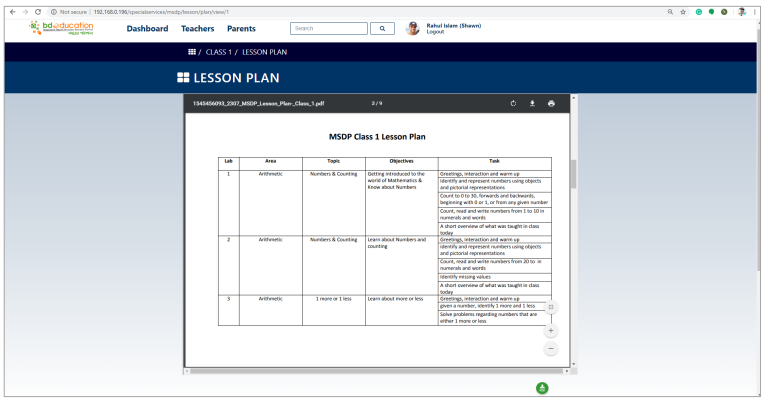

Fig. 2. Area and topic-based lesson plan

Step 2: Learning Maths through presentation:

Presentation motivates the students to listen carefully and provides a meaningful learning experience in terms of learning mathematics. Without introducing the topic, directly going through the theory and solving math problems is a bad practice that encourages a student to memorize math, rather than understand. To avoid this problem, MSDP includes the topic-wise thematic presentation slides (see Fig.3) that help a teacher to be prepared both emotionally and psychologically to organize his/her thoughts before taking every class. For each mathematics topic, teachers have to deliver a 10-minute presentation form the MSDP application. At the same time, students will be able to download ppt and pdf files of each presentation slide from online that helps them to recall the topic covered in their classrooms.

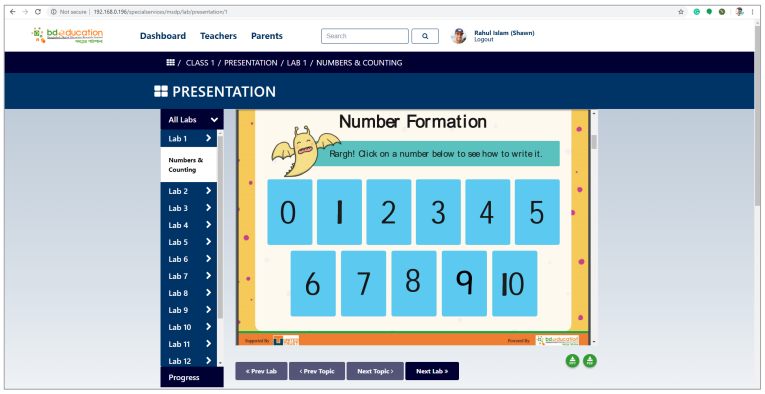

Fig. 3. Topic-wise presentation slides

Step 3: Learning Maths through topic-based video:

Topic-based video in learning is being popular over the last few years. Sometimes presentation and lecture notes are not enough to explain a complex math problem clearly. In that case, video can be used for more engaging and insightful learning. It helps students to develop strong background knowledge in a particular math topic that allows them to build a positive attitude towards Maths. As a consequence, we have included topic-based videos (10 minutes for each topic) in MSDP that present complex math-related topics in an easier way (see Fig. 4). Simultaneously, videos are made in such a way that they can catch the attention of the students easily.

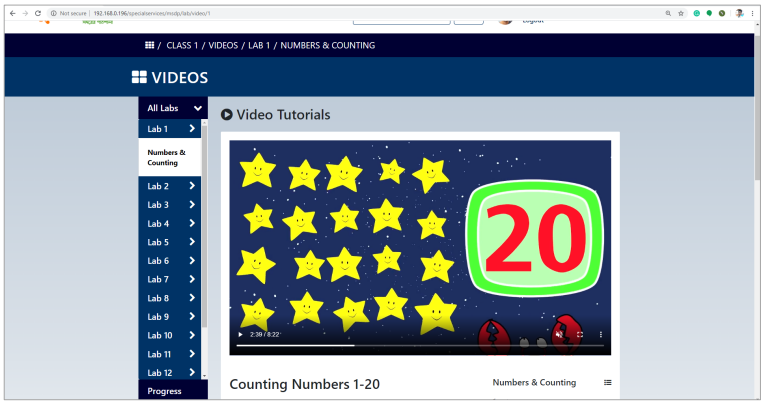

Fig. 4. Topic-based videos

Step: 4 Learning Maths through lecture notes:

Lecture note is a concise and complete outline of each class that helps students identify the significance of the topics covered in the class. It enables a teacher to provide illustrative and interesting structured content in the classroom. In MSDP, teachers must upload topic-oriented lecture notes in the application earlier and deliver a 15-minute lecture from that lecture note during class time (see Fig.5). At the same time, students will be able to download pdf files of each topic-wise lecture note from online.

Fig. 5. Lecture Notes

Step: 5 Learning Maths through practical exercise:

The main purpose of the topic-wise presentation, video tutorial, and lecture notes is to give the students a clear conceptual understanding of mathematics. However, along with conceptual understanding, practical exercise helps students to gain cognitive capacities to solve more complex mathematical tasks. As a consequence, according to

the MSDP program students have to perform 45 minutes of practical exercises as per lecturer's instructions in every Maths class (see Fig.6). Students play an active role during practical exercises and perform tasks individually, in pairs, small or collaborative groups. In this way, MSDP ensures a student-centered collaborative mathematics learning environment.

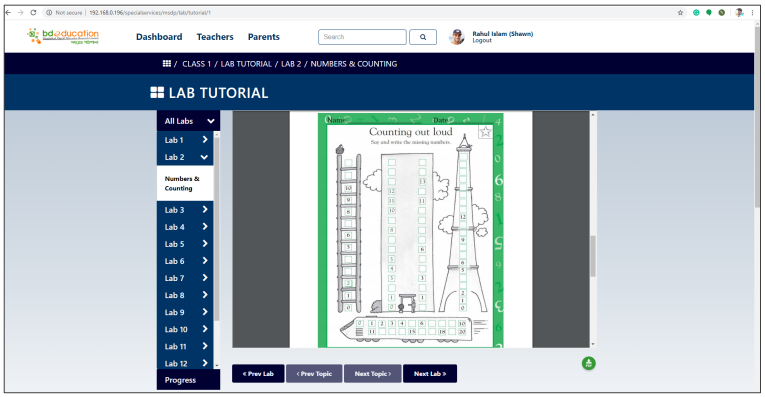

Fig. 6. Practical exercise (Lab tutorial)

Step: 6 Evaluation:

This is the final stage where students have to perform a test based on the previous stages. It allows the teacher to recognize the problems of students and to take the right action to solve the problem.

4 Effectiveness Evaluation of MSDP to Overcome Mathematics Anxiety

4.1 Participants and material

The effectiveness evaluation of the MSDP application involved 4 primary schools in Bangladesh where 200 students have participated from class 3 to class 5 (Mean age: 8.85, Range age: 7 – 11, Male: 127, Female: 73). There were two groups of students, namely the intervention group and the non-intervention group. Every group consisted of 100 students. MSDP application was used for the intervention group and the conventional learning approach was used for the students of the non-intervention group (Time period: 2 years). We followed a qualitative research approach to assess the efficiency of the MSDP application. Structured interviews (5 questions) and Likert Scale-based (4-point scale that allows the individual to say how much they agree/disagree with a specific statement) questionnaires (5 items) were used (see Table 1) to determine students' attitudes towards Maths.

Table 1. Qualitative data collection approach

Likert Scale-based Questionnaires	Interview Questionnaires
Q1. Do you feel unusual nervousness when doing or thinking about Maths?	Q1. Do you have fear in Maths?
Q2. Do you have visible signs of nervousness (sweaty palms, shaky hands, and so on)?	Q2. Do you feel panic during Maths test or when calling on to answer Maths related questions?
Q3. Do you suffer from fear of failure in Maths subjects?	Q3. In spite of having good preparation, do you feel lack of confidence during the Maths exam?
Q4. Do you think Maths tests are always more stressful than other tests?	Q4. Do have difficulties in remembering people's names or phone numbers?
Q5. Do you think your parents/teachers expect a lot from you especially in Maths?	Q5. How often do you have trouble finding words when you are talking to others?

4.2 Results and discussion

Table 2 provides the efficiency summary of the MSDP application. Findings clearly indicate that MSDP applications enable to create positive mathematical attitudes in students and help them overcome mathematical fears. Table 2 illustrates that students of the intervention group face comparatively less unusual nervousness, visible signs of nervousness, fear of failure, stressful feelings during Maths test rather than the non-intervention group. At the same time, 79% participants of the intervention group reported that they had not any anxiety in Maths. On the other hand, in the non-intervention group, 55% students reported they had not any anxiety in Maths. This indicates that the proposed ICT-based MSDP application can play an important role to prevent mathematics anxiety.

Table 2. Research findings

Approach	Questions	Intervention group				Non-intervention group			
		Very often	***Sometimes***	***Rarely***	***Never***	***Very often***	***Sometimes***	***Rarely***	***Never***
Questionnaires	Q1	**9%**	40%	30%	21%	**18%**	46%	21%	15%
	Q2	16%	**18%**	18%	48%	16%	**25%**	20%	39%
	Q3	**20%**	22%	28%	30%	**26%**	28%	22%	24%
	Q4	**16%**	14%	31%	39%	**27%**	21%	33%	30%
	Q5	48%	38%	5%	9%	48%	38%	7%	7%
Interview	***Descriptive Analysis***								
	Q1	**79%** of respondents of respondents of intervention group and **55%** respondents of non- intervention group reported that they had no fear in Maths.							
	Q2	**54%** of respondents of intervention group and **66**% respondents of non- intervention group reported that they feel panic during Maths related questions/tests.							
	Q3	**48%** of respondents of intervention group and **57**% respondents of non- intervention group reported that in spite of having good preparation, they feel a lack of confidence during math exams.							
	Q4	**26%** of respondents of intervention group and **27**% respondents of non- intervention group reported that they face difficulties in remembering people's names or phone numbers.							
	Q5	**37%** of respondents of intervention group and **39**% respondents of non- intervention group reported they face trouble finding words when they are talking to others.							

5 Conclusion

Mathematics knowledge and skills are required in students' future careers and throughout their lifetime. Accordingly, whatever elements that can hinder students' math learning need to be addressed effectively, otherwise the consequence will be a failure. Reform is needed in conventional teaching-learning systems in such a way that students socialize and engage in the math learning process. Producing positive thinking, building support groups, building effective assessment strategies, minimizing the component of the competition, students' self-motivation, teacher's support and classroom structure are strategies that reduce student's level of math anxiety. In that case, ICT can play a vital role. The present study has introduced such a tool (ICT based MSDP application) that helps students motivate themselves to learn mathematics. As well as, it creates a significant positive attitude towards mathematics in students that helps them overcome the mathematics anxiety. Therefore, based on the overall findings, teachers and authorities of the schools are highly recommended to use ICT in the classroom for a better teaching-learning environment.

6 Acknowledgement

The authors wish to thank the school authorities, students and teachers for their support and co-operation.

7 References

[1] A. Dowker, A. Sarkar and C. Looi, "Mathematics Anxiety: What Have We Learned in 60 Years?", Frontiers in Psychology, vol. 7, 2016. Available: 10.3389/fpsyg.2016.00508 [Accessed 25 February 2020]. https://doi.org/10.3389/fpsyg.2016.00508

[2] Sokolowski H and Ansari D (2017) Who Is Afraid of Math? What Is Math Anxiety? And What Can You Do about It?. Front. Young Minds. 5:57. https://doi.org/10.3389/frym.2017.00057

[3] P. M. and K. S. Z., "Mathematics Anxiety and Its Relationship with the Achievement of Secondary Students in Malaysia", International Journal of Social Science and Humanity, vol. 6, no. 2, pp. 119-122, 2016.

[4] Mangi, S., & Hussain, S. "Analysis of Mathematics Anxiety among B.Ed. students: A Case Study", International Journal of Academic Research in Business and Social Sciences, 8(1), 100–116, 2018.

[5] M. Bekdemir, "The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students", Educational Studies in Mathematics, vol. 75, no. 3, pp. 311-328, 2010. https://doi.org/10.1007/s10649-010-9260-7

[6] Dr. R. Das, G. C. Das "Math Anxiety: The Poor Problem Solving Factor in School Mathematics", International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013.

[7] L. Pradana, O. Sholikhah, S. Maharani and M. Kholid, "Virtual Mathematics Kits (VMK): Connecting Digital Media to Mathematical Literacy", International Journal of Emerging

Technologies in Learning (iJET), vol. 15, no. 03, p. 234, 2020. Available: https://doi.org/10.3991/ijet.v15i03.11674[Accessed 25 February 2020].

[8] N. Baya'a and W. Daher, "Mathematics Teachers' Readiness to Integrate ICT in the Classroom", International Journal of Emerging Technologies in Learning (iJET), vol. 8, no. 1, pp. 46-52, 2013. Available: http://dx.doi.org/10.3991/ijet.v8i1.2386[Accessed 25 February 2020].

[9] A. Drigas and G. Kokkalia, "ICTs in Kindergarten", International Journal of Emerging Technologies in Learning (iJET), vol. 9, no. 2, pp. 52-58, 2014. Available: [Accessed 25 February 2020]. https://doi.org/10.3991/ijet.v9i2.3278

[10] J. AB, "Self-regulated learning: Intelligence quotient and mathematical disposition", Journal of Physics: Conference Series, vol. 1422, p. 012020, 2020. Available: https://doi.org/10.1088/1742-6596/1422/1/012020 [Accessed 16 February 2020].

8 Authors

Jashodhan Saha received his BSc (Hons) in Mathematics in 1996 from University of Dhaka, Bangladesh and completed an MSc in Applied Mathematics in 1997 from the same Institution. He also received MBA degree (major in Finance) in 2009 from United International University, Dhaka, Bangladesh. He has been serving as the Managing Director of Bangladesh Digital Education Research Limited, Dhaka since 2016. Mr Saha is the founder director of Solver Institute of Mathematical Skill Development Program which was established in 2015. He was also a faculty member of United International University, Dhaka from October 2005 to October 2015. He is a Life Time Member of Bangladesh Mathematical Society and Award Leader of the Duke of Edinburgh's Award Foundation. Mr Saha is an author of several journal and conference articles on Heat and Mass Transfer, the impact of service climate and job satisfaction. His research interest includes Education Management in general and Mathematical Anxiety in particular.

Suman Ahmmed has completed his B.Sc. Engineering degree from the Department of Computer Science and Engineering (CSE), Bangladesh University of Engineering and Technology (BUET) in 1997. He also completed his M.Sc. Engineering degree from the same department and Institution. He participated as one of the founder initiators for establishing the United International University (UIU), Dhaka (www.uiu.ac.bd), as a Founder Trustee, financed by United Group (www.united.com.bd). Mr Suman joined as an Assistant Professor in the department of CSE from 2003. In addition to his academic responsibilities, he also served as Director of Students Affairs of UIU from 2005 – 2016. Afterwards he joined as the Director of Center for Development of IT Professionals (CDIP), UIU (www.cdip.uiu.ac.bd). In addition to his University career he started another Research based Digital Education System provider company, Bangladesh Digital Education Research Ltd. (www.bdeducation.org.bd), supported by United Trust (www.unitedtrust.org.bd), a social welfare wing of United Group, from year 2017, as the Chairman. As a Chairman of bdeducation, he is also contributing as a Board member of five different Schools and Colleges Managing Committee.

Maruf Ahmed Tamal is an associate researcher of the Bangladesh Digital Education Research Ltd.,Gulshan 1, Dhaka, Bangladesh. He received his B.Sc. degree in Computer Science and Engineering from Daffodil International University, Dhaka, Bangladesh, in 2019. His primary area of expertise is machine learning and data mining based knowledge discovery. He also pursues interests in ICT based Pedagogy.

Karim Mohammed Rezaul was awarded a PhD degree in Computing and Communications Technology from North East Wales Institute (NEWI) of Higher Education (presently Glyndŵr University), University of Wales, UK in October 2007. He received his BSc degree in the field of Naval Architecture and Marine Engineering from Bangladesh University of Engineering and Technology (BUET), Dhaka in 1998 and, MSc degree in Marine Technology from Norwegian University of Science and Technology (NTNU), Trondheim, Norway in 2001. Presently, he is a Visiting Professor of Computing & Communications Technology at Wrexham Glyndwr University, UK and Adjunct Professor in Management at IPE Management School Paris, France. He is also a Professor of Computer Science & Engineering (CSE) at Sonargaon University (SU), Dhaka, Bangladesh. Since 2002, Prof. Karim has been working as an Academic advisor and Programme director at various International colleges and universities in UK and Bangladesh.

Prof. Karim is an author of a numerous Scientific and Business articles (Scholarly & Refereed publications) which include book, book chapters, journals and International conference poceedings. He is an editor of several international journals and member of the Technical Program Committee (TPC) of multiple International conferences. His research interests include IS Design and Development; ICT-based Pedagogy; Internet of Things (IoT); Artificial Intelligence (AI); Fractals and Nanotechnology; Networking - Traffic Engineering, Quality of Service (QoS) Control, Traffic modelling & simulation etc.; Distributed DBMS; Information Security; Business Intelligence; E-Business/E-commerce; ICT Project Management; Computing.

Mohammad Ali is a Coordinator and Researcher of the Bangladesh Digital Education Research Ltd. Gulshan 1, Dhaka, Bangladesh. His primary areas of expertise are Human-Computer Interaction (HCI), Augmented & Virtual Reality (AR/VR) and Internet of Things (IoT). He also pursues interests in ICT based Pedagogy.

Article submitted 2020-03-09. Resubmitted 2020-04-06. Final acceptance 2020-04-07. Final version published as submitted by the authors.