

Mind Mapping Method as an Effective Tool for Teaching Database Course



Abdul Rehman Gilal, Ahmad Waqas, Aeshah Alsughayyir, Sajid Khan, Ahsanullah Abro, Mazni Omar

Abstract: Database system (DB) is one of the most important courses in computer science and software engineering disciplines. This course demands expertise in problem-analysis and problem-solving skills. Teaching problem-analysis and problem-solving skills is not an easy job. However, visual or mind mapped teaching methods are found effective during teaching such skills. Hence, the objective of this study is to measure the impact of mind mapping, one of the visual, method in teaching and learning DB course. The empirical data are collected by using experimental research approach. Total 68 students of 4th semester participated in the experiment from DB course offered in computer science and software engineering disciplines. All the students were exposed to descriptive teaching method and mind-mapped teaching method on the course topics. Based on the results, the mind-mapped teaching method is found effective in teaching and learning DB course. Additionally, girl students appeared more effective in yielding positive results than boy students during mind mapped taught classes. Finally, apart from fewer limitations, this study recommends certain future guidelines for better understanding and development in the very topic. For instance, age and culture based mind-mapped analysis may be considered for computer science and software engineering major courses as a future research.

Keywords: Database, Mind map, Teaching method, descriptive teaching, mind map teaching.

I. INTRODUCTION

Database system (DB) is one of the most important courses in computer science and software engineering disciplines. This subject includes requirements collection, design, development and validation phases [1]. At each level, students are supposed to interlink the learned concepts. It can also be considered that the success or the failure of DB would

be dependent on its phases [2]. For instance, design would create issues if the requirements are not gathered properly or development will surely have problems if the design is not well drawn [3]. Similarly, on the other hand, teaching database requires teachers and students to have a similar level of understanding at each phase. In other words, teaching DB requires to have a use of different teaching methods and strategies to ensure the student learning [4].

DB requires several skills for both learners and teachers. In terms of soft skills, DB course requires strong analytical and problem-solving skills to understand and find out the effective technological solution. It means that a DB student should be an innovative person in order to learn the concepts effectively. These required skills most often bring some challenges to teachers and students while learning the DB course. On the meantime, these difficulties or weaknesses in the DB subject may lead students 1) to gain less marks in the major courses and 2) to not be a good developer. It is said as several small mobile application development or web development applications are given to fresh graduates or developers. In most of the small or medium application development cases, clients do not hire independent DB developers. Hence, the developer is required to do both DB and programming jobs at the same time.

To analyze the problem correctly is a biggest challenge in software engineering courses [5]. One of the main causes of DB course learning difficulty is to learn the problem solutions from the abstractions. In simple words, teaching DB demands conversion of the problem's abstraction to reality for effective development like programming. The effective way to convert abstractions into reality is visualization [6]. Several authors [7]–[9] have also established a fact that visual learning is more effective method of teaching than descriptive or narrative. Shehla et al., [4] have also used one of the famous visual teaching methods (i.e., mind mapping) to trend programming students. They observed better learning results in mind map teaching method than descriptive or narrative method. At teaching level, DB and programming can be considered in the same cup of teaching method as both require several similar skills. For instance, like DB, for learning and teaching programming someone need skills like analytical, problem-solving and innovation skills. Therefore, this study also setup the objective to see the impact of mind map method on the student learning in DB courses. This study also considers the gender based learning style. Because, several past studies have claimed that boys and girl students are never at the same page of learning [10]–[19].

Revised Manuscript Received on March 30, 2020.

* Correspondence Author

Abdul Rehman Gilal*, Department of Computer Science, Sukkur IBA University, Pakistan. E-mail: a-rehman@iba-suk.edu.pk

Ahmad Waqas, Department of Computer Science, Sukkur IBA University, Pakistan. E-mail: ahmad.waqas@iba-suk.edu.pk

Aeshah Alsughayyir, Department of Computer Science, Taibah University, Kingdom of Saudi Arabia.

Sajid Khan, Department of Computer Science, Sukkur IBA University, Pakistan.

Ahsanullah Abro, Department of Computer Science, Sukkur IBA University, Pakistan.

Mazni Omar, School of computing, Universiti Utara Malaysia, Malaysia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Mind Mapping Method as an Effective Tool for Teaching Database Course

The forthcoming section presents the related studies which has applied similar method to improve or compare the results. The section after the related work discusses the methods that are carried out in this study to extract the results.

Results are discussed in the section “Results and Discussion”. The last section concludes the results with certain future recommendations.

II. RELATED WORK

Human mind likes visual and graphical stuff. Information passed through images remains in the mind for a long time. Tony Buzan [20], founder of the mind mapping method, says that mind actually works with images and associations. In his book “How to Mind Map”, he explains that the Typed “orange” word does not appear in the mind if someone listen the word “orange”. In fact, orange image comes out in the mind. The author further explains that vitamin ‘C’ makes association with orange. Furthermore, the mind mapping process is divided into 4 main characteristics: The subject attention is crystallized in a central image, the main themes of the subject radiate from the central image as branches, branches comprise a key image or key word printed on an associated line, and the branches form a connected nodal structure [21]. The following Figure 1 summarizes the mind map of fruits with images and associations.

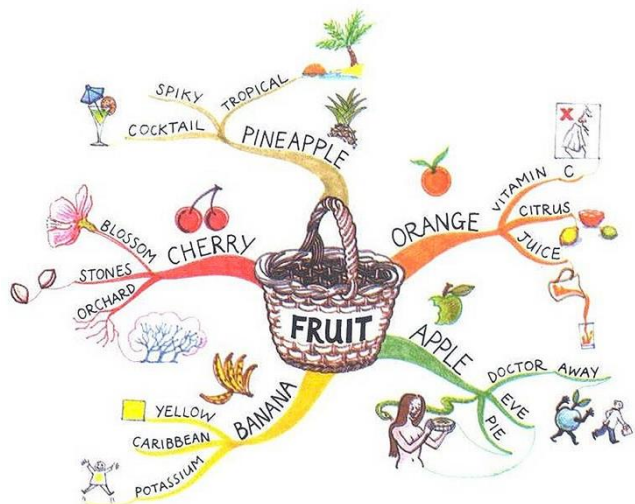


Fig. 1. Mind map of fruits [adopted from [20]].

Based on this mind processing way, several studies have been conducted on the mind mapping method to improve the performance of the mind related jobs. For instance, Lui et al., [21] performed experimental research approach to confirm the mind mapping effects on teaching and learning. Their initial comments are quite similar as in this study as they also started with the aim to check the impact of mind mapping effectiveness in teaching and learning. They studied experimental and quasi-experimental studies with twenty (20) menu items. In the results, they found that mind mapping has positive effect on teaching and learning. They further found that achievements, usage, country and subjects could bring a greater change in the results. In this study, we have also tried to see that how can DB subject teaching be influenced with mind mapping method. This study also adds gender variable for gaining detailed explanations.

Teaching programming is always a tough job for teachers. Several students considered programming is a toughest

subject. This all can be mapped with the way someone teaches and learns the programming. Shehla et al., [4] conducted experimental study to see whether mind mapping method can improve the students learning or not. They used brainstorming and conceptualization tools to train students’ problem analyzing capability to make them able to design effective solutions. Their focus was text and block-based programming environments. Shehla’s study involved a good number sample of 160 students from 2 universities. At the end, their results confirm that programming, either text-based or block-based, is an easy course for teaching and learning if mind map method is followed. This study also considers that problem analyzing is a critical job for designing effective solutions in the DB systems. Therefore, we also hope that teaching through mind mapping method can improve DB students’ problem analyses approach for effective solutions. The following section discusses the method by which the study experiments are designed and applied for checking the hypothesis.

III. METHOD

In order to measure the impact of mind mapping method, experimental approach is carried out in this study. Both teachers and students from department of Computer Science (CS) Sukkur IBA University were involved to perform the experiments. In summary, total 68 students from 2 sections (i.e., Section-A and Section-B from degree program (i.e., CS and Software Engineering) were enrolled in the DB course in the Fall-2019 semester. The course was offered in the 4th semester of degree program. Following Table 1 shows the class distribution based on section and gender parameters.

Table- I: Students Distribution based on Section and Gender

Section	Boys	Girls	Total
Section-A	20	15	35
Section-B	17	16	33

To initiate the experiments, the theory and lab teachers were trained with Tony Buzan mind mapping method’s guidelines. The teachers were given method against each topic to teach to both sections: descriptive-teaching method or mind-mapped teaching method. Only one thing was controlled that the method of topic was not descriptive to both sections at the same time. For instance, topic “Integrity Constraints” was taught with descriptive-teaching method to Section-A and with mind-mapped teaching method to Section-B. It was planned to control the threats to validity and also to measure whether the learning is by chance or by method change. Both sections were given almost equal opportunity to experience both methods. At the each topic end, students were given a class quiz to assess their learning. The quizzes were conducted right after the topic finished. It was planned to measure the classroom learning. The following Figure 2 presents the example of teaching material DB course through mind mapping presentation method. Appendix-A presents the methods against each topic followed in the both sections.



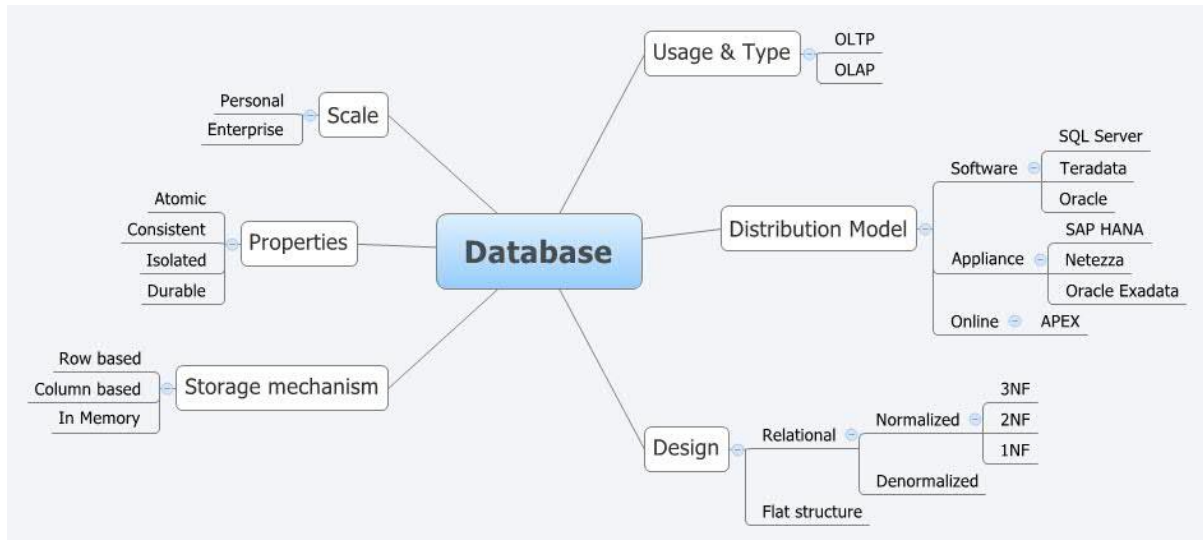


Fig. 2. Example of teaching mind mapped based presentation slide

IV. RESULTS AND DISCUSSION

The results are articulated and discussed into two segments: method based discussion and gender based discussion. The first segment basically covers the main part of the objective to see general impact of teaching and learning methods. However, the second segment is kept with the intention to see how the detailed implications occur on the results if the gender variable is involved. This can be considered the limitation of the study as it involves only gender variable to measure the diverting impacts of learning. But on the other hand, this way had helped us to ignite some useful future directions.

As mentioned earlier, the students were enrolled into two sections. Based on the descriptive results, students from both sections learnt better in mind mapping method (MM). The descriptive method (DM) students' results are not as effective as in MM. The average difference between the both methods is 13% and above. The figure 3 displays the side-by-side comparison of both methods in the both students' sections.

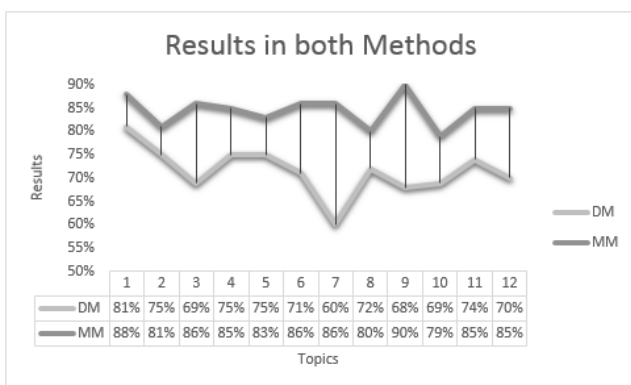


Fig. 3. Side by side comparison of both methods in both sections

During analyzing further, it is observed that students obtained average 72% in the DM approach. On the other hand, the same students obtained 85% during MM approach. Moreover, from the experiments, the difference in the results is found negligible during teaching some topics. For instance, topic number 1, 2, 5 and 8 difference is not found more than 8%. This could have happened due to two reasons: the topics

are theoretical, and topic had already involved visual learning somehow. As topic number 1 and 2 are theoretical which, may be, students are familiar earlier with topics. However, topic number 5 and 8 are related to Entity-Relationship (ER) models that are already involving visual teaching methods. Table 2 shows the obtained results and difference against each topic obtained results and difference against each topic.

Table- II: Obtained results and difference against each topic

Topics	Topic Title	Descriptive Method	Mind mapping Method	Difference
1	Introduction to DBMS	81%	88%	7%
2	Introduction to the Relational Model	75%	81%	6%
3	Relational Algebra	69%	86%	17%
4	Set Operations	75%	85%	10%
5	Database Design using E-R Model	75%	83%	8%
6	Reducing E-R Diagrams to Relational Schemas	71%	86%	15%
7	Enhanced ER design	60%	86%	26%
8	Relational Database Design	72%	80%	8%
9	Decomposition Using Multivalued Dependencies	68%	90%	22%
10	Semistructured-Data	69%	79%	10%
11	The form of an XML Schema	74%	85%	11%
12	Transaction Management	70%	85%	15%

The remaining topics' average results difference is 15% and above in the mind mapping method. Based on the vertical difference, at Sukkur IBA University, one thing is clearly claimed that students enjoy mind mapping teaching methodology more than descriptive methods.

Mind Mapping Method as an Effective Tool for Teaching Database Course

In order to learn detailed results, as mentioned earlier, this study classified MM results based on the gender variable. In the general view, girl students performed better during MM learning classes. The Figure 4 below displays the result categorized based on gender variable.

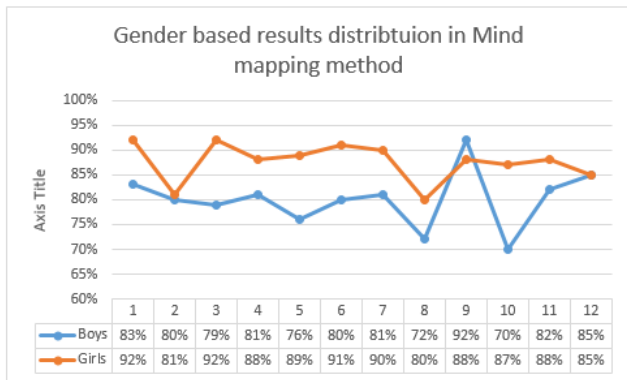


Fig. 4. Gender based result distribution in Mind Mapping Method

The girl students obtained average 88% in the MM learnt classes. On the other hand, boys of the class managed 80% of average results. Though the difference is not much high in both types of students; but girls managed to obtain better results in 9 topics than boys. Lastly, only one-time boy group of students got higher average marks than girls. These results can be interpreted with the general cultural perception here in Pakistan that girls are good with images and visualization.

V. CONCLUSION

Based on the results, this study has found certain factors to promote the mind map method for teaching database system course. The method is found interesting among computer science and software engineering students. The study participants obtained significantly better results during the mind mapped teaching method than the descriptive teaching method. This study is not free from several limitations but can be considered as a gentle startup. For instance, the study is based on the smaller sample size from only one country. It is recommended that the future studies may be carried out on the larger scale to design a designated method for the course. Moreover, this approach is not only suitable for database system course but may be explored and experienced in all the computer science and software engineering major courses. Similarly, this study involved gender based results differences and eventually that appeared to be a significant impacting variable. It is, therefore, age, culture and different class settings can also be research for making wider claims.

REFERENCES

- H. F. Korth and A. Silberschatz, "Database system concepts," *McGraw-Hill Comput. Sci. Ser. ; McGraw-Hill Ser. Syst.*, 1991.
- A. A. Imam, S. Basri, R. Ahmad, and A. R. Gilal, "Data synchronization model for heterogeneous mobile databases and server-side database," *Int. J. Adv. Comput. Sci. Appl.*, vol. 9, no. 1, 2018.
- J. Jaafar, A. R. Gilal, M. Omar, S. Basri, I. Abdul Aziz, and M. H. Hasan, "A Rough-Fuzzy Inference System for Selecting Team Leader for Software Development Teams," in *Advances in Intelligent Systems and Computing*, vol. 661, Springer, Cham, 2017, pp. 304–314.
- S. Gul, M. Asif, W. Ahmad, and U. Ahmad, "Teaching programming: A mind map based methodology to improve learning outcomes," in *2017 International Conference on Information and Communication*

- Technologies, ICICT 2017*, 2018.
- M. N. Ismail, N. A. Ngah, and I. N. Umar, "Instructional strategy in the teaching of computer programming: A need assessment analyses," *Turkish Online J. Educ. Technol.*, 2010.
- S. Khan, D.-H. Lee, M. A. Khan, A. R. Gilal, and G. Mujtaba, "Efficient Edge-Based Image Interpolation Method Using Neighboring Slope Information," *IEEE Access*, vol. 7, pp. 133539–133548, 2019.
- R. Felder and L. Silverman, "Learning and Teaching Styles in Engineering Education.," *Eng. Educ.*, 1988.
- J. K. Knight and W. B. Wood, "Teaching more by lecturing less," *Cell Biol. Educ.*, 2005.
- R. Berk, "Multimedia teaching with video clips: TV, movies, YouTube, and mtvU in the college classroom.," *Int. J. Technol. Teach. Learn.*, 2009.
- A. R. Gilal, J. Jaafar, M. Omar, S. Basri, and A. Waqas, "A Rule-Based Model for Software Development Team Composition: Team Leader Role with Personality Types and Gender Classification," *Inf. Softw. Technol.*, vol. 74, pp. 105–113, 2016.
- A. R. Gilal, J. Jaafar, S. Basri, M. Omar, and A. Abro, "Impact of software team composition methodology on the personality preferences of Malaysian students," in *2016 3rd International Conference on Computer and Information Sciences (ICCOINS)*, 2016, pp. 454–458.
- A. R. Gilal, J. Jaafar, S. Basri, M. Omar, and M. Z. Tunio, "Making programmer suitable for team-leader: Software team composition based on personality types," in *2015 International Symposium on Mathematical Sciences and Computing Research, iSMSC 2015 - Proceedings*, 2016.
- A. R. Gilal, J. Jaafar, L. F. Capretz, M. Omar, S. Basri, and I. A. Aziz, "Finding an effective classification technique to develop a software team composition model," *J. Softw. Evol. Process*, vol. 30, no. 1, pp. 1–12, 2018.
- M. Z. Tunio, H. Luo, C. Wang, F. Zhao, A. R. Gilal, and W. Shao, "Task Assignment Model for crowdsourcing software development: TAM," *J. Inf. Process. Syst.*, 2018.
- A. R. Gilal, M. Omar, and K. I. Sharif, "DISCOVERING PERSONALITY TYPES AND DIVERSITY BASED ON SOFTWARE TEAM ROLES," in *International Conference on Computing and Informatics, ICOCI 2013*, 2013, pp. 259–264.
- A. R. Gilal, J. Jaafar, M. Omar, S. Basri, and I. Din, "Balancing the Personality of Programmer: Software Development Team Composition.," *Malaysian J. Comput. Sci.*, vol. 29, no. 2, pp. 145–155, 2016.
- A. R. Gilal, M. Omar, and K. I. Sharif, "A Rule-Based Approach For Discovering Effective Software Team Composition," *J. Inf. Commun. Technol.*, vol. 13, pp. 1–20, 2014.
- M. Z. Tunio *et al.*, "Impact of Personality on Task Selection in Crowdsourcing Software Development: A Sorting Approach," *IEEE Access*, 2017.
- A. R. Gila, J. Jaafa, M. Omar, and M. Z. Tunio, "Impact of personality and gender diversity on software development teams' performance," *I4CT 2014 - 1st Int. Conf. Comput. Commun. Control Technol. Proc.*, no. I4ct, pp. 261–265, 2014.
- T. Buzan and B. Buzan, *The mind map book*. Pearson Education, 2006.
- Y. Liu, G. Zhao, G. Ma, and Y. Bo, "The Effect of Mind Mapping on Teaching and Learning : A Meta-Analysis," *Stand. J. Educ. Essay*, 2014.

APPENDIX-A

TOPICS	TOPIC TITLE	SECTION-A	SECTION-B
1	Introduction to DBMS	DM	MM
2	Introduction to the Relational Model	MM	DM
3	Relational Algebra	DM	MM
4	Set Operations	MM	DM
5	Database Design using E-R Model	DM	MM

6	Reducing E-R Diagrams to Relational Schemas	MM	DM
7	Enhanced ER design	DM	MM
8	Relational Database Design	MM	DM
9	Decomposition Using Multivalued Dependencies	DM	MM
10	Semistructured-Data	MM	DM
11	The form of an XML Schema	DM	MM
12	Transaction Management	MM	DM

Note: Descriptive-teaching method (DM) and Mindmap-teaching Method (MM)

various engineering and ICT courses to undergraduate students. His research interest includes design science, development of engineering and computer science applications, and User Experience (UX) evaluation of systems, products and services.



Mazni Omar is a senior lecturer at the School of Computing, College of Arts and Sciences, Universiti Utara Malaysia. She holds PhD in Information Technology and Quantitative Sciences from Universiti Teknologi MARA, Malaysia. Her main research focuses are agile software development, empirical software engineering, software quality and data mining.

AUTHORS PROFILE



Abdul Rehman Gilal, is a faculty member of Computer Science department at Sukkur IBA University, Pakistan. He has earned Doctor of Philosophy (Ph.D.) in Information Technology from Universiti Teknologi Petronas (UTP), Malaysia. He has been mainly researching in the field of software project management for finding the effective methods of composing software development teams. Based on his research publication track record, he has contributed in the areas of human factor in software development, complex networks, databases and data mining, programming and cloud computing.



Ahmad Waqas, is an Associate Professor in the Department of Computer Science. He Completed his Ph.D. at International Islamic University Malaysia. His teaching and research interests include Distributed Systems, Cloud Computing, Network Design, Security and Management, Algorithms and Data Structures and Theoretical computer science. Dr. Ahmad Waqas has published numerous research articles in renowned journals and conferences proceedings including WOS, Scopus, and IEEE. He is the Chief Editor of Sukkur IBA Journal of Computing and Mathematical Sciences (SJCMS). He also organized the 2017 International Conference on Computing and Mathematical Sciences and served as General Co-Chair. He has been serving as Editorial Board Member, Program Committee Member and Technical Program Committee Member of many journals and international conferences.

Aeshah Alsughayyir, has received the B.E. degree in Computer Science from Taibah University, Madina, KSA, and the MSc. and Ph.D. degrees in Computer Science and Optimisation Algorithms respectively from the University of Leicester, Leicester, the United Kingdom. In 2013, she joined the Department of Computer Science, Taibah University, as a Lecturer, and in 2018 became an assistant professor. Her general interest is to dedicate her scientific knowledge to help the society and improve education. Her current research interests include areas of scheduling algorithms, Energy aware algorithms in cloud computing, parallel computing, solving problems using machine learning techniques, natural language processing, and quantum computing.



Sajid Khan, was born in Sukkur, Pakistan, in 1988. He received the B. S. degree in Telecom Engineering from the FAST-NUCES University, Pakistan, in 2011 and M. S leading to Ph. D. degree in Electronics and Communication Engineering from Hanyang University, Ansan, South Korea in 2017. From 2011 to 2012, he was a Software Engineer at Gameview Studios, Pakistan. Since 2017, he has been as Assistant Professor with the Computer Science Department, Sukkur IBA University, Sukkur, Pakistan. His research interest include image denoising, edge detection, interpolation, deinterlacing, fingerprint detection and biomedical image processing.



Dr. Ahsanullah Abro works as an assistant professor in department of computer science (CS), Sukkur IBA University. MSc IT (by research) from Universiti Teknologi PETRONAS (UTP), Malaysia (2011). Dr. Abro has received PhD from UTP, Malaysia. Previously, He has worked as Research Associate and Assistant Professor in Public Institutes of higher learning and participated in various academic activities and research projects. He teaches