STANDARDS ON TEACHING MATHEMATICS THROUGH BLENDED MODALITY AMONG HIGHER EDUCATION INSTITUTIONS: AN EXPLORATORY FACTOR ANALYSIS

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ABSTRACT: *Teaching mathematics in higher education has always been a challenge for both the faculty members and the students. In this study, the researcher explored the development and validation of a model on the standards of teaching mathematics in higher education through blended modality. This aimed to develop an instrument and establish its reliability and validity. Exploratory sequential mixed method research was employed in this study, which started with qualitative data gathering and analysis followed by tentative data gathering and analysis. The data from the qualitative were the quotes taken from interviews of six faculty members, literature review, and archives. These quotes were transformed into a 40-item Likert scale questionnaire distributed for the quantitative part. A total of 795 respondents comprised of 640 students and 155 faculty members answered the survey. The results from the exploratory factor analysis revealed that 9 items had to be removed and there were 5 factors identified.*

Keywords: Blended learning; exploratory sequential mixed method; factor analysis; higher education; teaching mathematics

I. INTRODUCTION

Teaching mathematics in higher education has always been difficult since the students need a lot of activities and examples to understand the concepts. According to Wilkie [1], instructors' instructional techniques must be altered before students' learning in mathematics classes may be enhanced. Additionally, the pandemic disrupted classes at all levels. As a result, comprehensive virtual learning was imposed as a new teaching and learning option. It did not last long, though, as several nations quickly responded to the idea of allowing only laboratory classes for students to attend limited face-to-face classes.

The NCTM advised math teachers to concentrate on instructional strategies for efficient math teaching methods. While previous works described the obstacles to absence of face-to-face instruction in the context of pandemic, and although the association between learners' perceptions of themselves as mathematicians and the challenges they face in an online learning environment has also been studied there is still a dearth of published articles on the preparation [2].

According to the literature, there are many challenges that math teachers must overcome in order to implement online learning. These challenges include their preparation for managing applications for online learning, student access to online learning resources, obstacles to attaining education that requires mathematical thought, and restrictions on providing input to students [3, 4]. However, some of these teachers think that there are several advantages to online learning, such as encouraging students to independent learning, helping everyone become more ICT-savvy, letting students use more creativity in their tasks and when searching for references, and allowing the delivered content to be better stored [5].

Universities and colleges have already made some investments in their digital infrastructures to enable this setup over the past approximately two years that they have been in an online learning set-up [6]. The utilization of digital technology for learning in particular has been popular. The Philippines has not yet established any specific guidelines for the conduct of classes using a mixed modality, thus it is appropriate to investigate this given the current environment where teaching is not always required to happen in a fully physical setting. Despite the lack of face-to-face instruction, these standards will be used as criteria to assess the performance of mathematics teachers in tertiary education.

The researchers in this study were interested in how prepared, what obstacles they faced, and what mitigation strategies were used by the mathematics teachers at several higher education institutions when using a blended modality. The issue with this study would be how to teach mathematics at the SUCs in a way that allows for both online and in-person instruction, or both at once. Additionally, it aims to evaluate how the various teaching methods used by faculty members during the pandemic affected their students' learning. As a result, it would decide which specific criteria will be useful for offering such a blended modality.

Review of Related Literature

Blended Learning in Higher Education

Blended learning is an intelligent design strategy that integrates the efficacy of face-to-face and online learning to achieve significant educational objectives [7]. Through an online learning platform and traditional learning methods like interaction and participation, blended learning integrates innovation and technological advancement. The capacity of students to build a social presence in synchronous education tactics is one of the problems presented by this strategy, which has the potential to enhance students' learning and increase teaching and resource allocation efficiency [8]. According to research, social presence is crucial for student learning outcomes, engagement in the course, and community development [9].

According to Rahman et al. [7], the implementation of blended learning is reliant on some influences, including the availability of facilities and infrastructure for the Internet network, the educators' professional growth and progress in using ICTs, and the preparation of students for using computers and the internet.

And according to some latest researches, one of the most effective methods for increasing student engagement is via hybrid or blended course delivery [6, 10]. In fact, Brayson and Andres [11] predicted that for the upcoming academic years, the preponderance of experiences in online higher education will be founded on a blended instructional paradigm, which combines both virtual and physical classroom settings and interconnects synchronous and asynchronous learning. In a blended-oriented classroom, learner-centric techniques, teacher intervention, and considerable peer engagement and communication successfully combine both the conventional and the online delivery modalities.

Shifting to Blended Courses and Programs

Over the past decade or more, higher education educational research has consistently demonstrated the value of blended learning formats [12]. In order to meet the expectations of a digital society, educational institutions must provide greater flexibility and individualization, allowing students to modify the learning process to their specific needs and life stages [13].

The majority of flexible learning initiatives focus on time- and space-flexible learning components, which are presently accomplished primarily through the use of new technologies and executed didactically in an online or blended learning environment [14]. In response to the COVID-19 pandemic, a number of institutions have considered substituting a portion or all of their classroom instruction with an online learning environment [15, 16]. Only if face-to-face classroom time can be supplanted with more adaptable learning conditions without a decline in student performance will universities be able to offer and expand these learning formats with any degree of long-term success [17].

Patterns of Online Learning

According to Singh and Thurman [18], online learning is the process of acquiring knowledge in synchronous as well as asynchronous situations while utilizing a variety of internet-accessible devices, including a laptop and a mobile device. Students may communicate with the instructor and other students while learning anywhere (autonomously). In online learning, students have the option of interacting with materials in a variety of formats, including audio, video, documents, and others [19]. Various programs that use the internet both inside and outside of the classroom make up online learning. It may be utilized to promote communication between instructors and students as well as access to instructional materials. According to Yen et al. [20], learning may be done wholly online or in conjunction with face-to-face contact.

II. Methods

Research Design

The research employed an exploratory sequential mixed method design. This particular research design is a mixed-methods design that starts with the collection and analysis of qualitative data before translating qualitative results into a statistically tested technique or instrument, according to Creswell and Plano Clark [21]. The first phase was a qualitative investigation of the teaching and learning in the context of limited blended teaching modality of mathematics classes for the tertiary education. From this preliminary investigation, the qualitative results were utilized to create a framework in terms of the standards on how to properly deliver blended classes. The rationale of this study was to utilize an exploratory sequential mixed method research design in order to develop an instrument and determine its generalizability to the teachers' practices and behaviors in employing the blended modality.

Sampling

For the qualitative part of the study, six faculty members were identified through purposive sampling. Purposive sampling is used because it better matches the sample to the goals and objectives of the research, increasing the study's rigor and the reliability of the data and findings [22]. And for the quantitative part, quota sampling was employed since there has to be at least 200 for the exploratory factor analysis [23]. Given that the quantitative portion of this research includes faculty members and students, quota sampling is undoubtedly a way to increase the sample size for specific subpopulations [24] with the assumption that there are no rules prescribing how these quotas should be fulfilled.

Participants

For this particular scholarly investigation, only the students and faculty members in a State University or State College within the Davao Region for the second semester of the academic year 2022-2023 were considered as participants. For the qualitative part, six faculty members who were employing a blended modality of teaching.

For the quantitative parts, students who were officially enrolled in SUCs took Bachelor of Science in Mathematics, Bachelor of Secondary Education major in Mathematics, and Bachelor of Science in Civil Engineering. These programs were identified since they had more mathematics subjects offered. Moreover, the faculty members in included on this study were the regular, contract of service, and part-time instructors and professors who were teaching mathematics subjects in the field of Mathematics Education, Pure/Applied Mathematics, and Allied fields such as Engineering, Information Technology, and Computer Science. This did not include faculty members who did not teach mathematics subjects. It did not also consider faculty members who are on study leave, or those who were no longer teaching in the college or university.

Data Gathering

The collection of the data was first started with the submission to the Research Ethics Committee at the Davao Oriental State University. After the ethical clearance was given, a letter is sent to the State Universities and Colleges (SUCs) in Region XI, asking the permission from the University Presidents for the conduct of the study. When the letter was approved, the researcher immediately conducted the interview for the qualitative phase. Before the conduct of each interview, the researcher explained the research protocols to the interviewee, following the ethical standards. Meanwhile, a literature review and document archiving were also done. The quotes from the interview, literature review, and archives were used to develop the instrument. This instrument was then subsequently employed for the conduct of the quantitative phase which involved exploratory factor analysis and confirmatory factor analysis. The results of the factor analyses were then presented in tables and discussed accordingly.

Data Analysis

In the qualitative phase, the researcher employed a semi-structured interview approach to the case study. This also included the conduct of document analysis and literature review on the various challenges and opportunities of the mathematics faculty members on the implementation of blended learning modality. The five steps in qualitative data analysis as prescribed by Dye [25]. Table 1 presents the demographic profile of the participants.

Table 1. Demographic Profile of the Participants

Participants	Academic Ranks	Subjects Taught	Online Platform Used	Length of Service
P1	Instructor I	Mathematics in the Modern World (MMW); Statistics	Google Classroom; LMS	4 years
P2	Instructor I	MMW; Calculus	Google Classroom; LMS	3 years
P3	Associate Professor I	Calculus; Topology	Google Classroom; LMS	13 years
P4	Senior Lecturer	MMW; Statistics; Trigonometry	Google Classroom; LMS	3 years
P5	Assistant Professor III	Discrete Mathematics	Google Classroom; LMS	10 years
P6	Instructor I	MMW; Mathematical Modelling	Google Classroom; LMS	7 years

For the quantitative part, there were 150 students and 70 faculty members who were surveyed. These data were tallied and analyzed through exploratory factor analysis (EFA). All the assumptions of EFA were followed in order to come with the factors which were considered as the standards or criteria in effective blended teaching.

III. RESULTS AND DISCUSSION

Data from the interview were organized and categorized according to the general questions and sub-questions. This was done by combining the transcript of interviews into one. The data from the literature review were also arranged and categorized and into their relevance.

There was a total of 40 items in the instrument which underwent validation from the experts. Significant contributions such as the improvements of the sample, the enhancement of the directions, and the restatements of the items were made after the validation.

After the validation from the experts, the instrument was distributed to 70 faculty members and 150 students. The data were then tallied and analyzed through an exploratory factor analysis. According to Shrestha [26], there are three main processes in factor analysis: a) evaluating the adequacy of the data, b) factor extraction, and c) factor rotation and interpretation.

Assessment of the Suitability of the Data

The outcomes of the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test are shown in Table 2. KMO statistics have a value of 0.955 > 0.6, which shows that the sample is sufficient and the factor analysis is suitable for the data. To determine if the correlation matrix is enough, one might apply Bartlett's test of sphericity. At $p<0.001$, Bartlett's test of sphericity is very significant, indicating that at least some of the variables in the correlation matrix have substantial relationships.

Table 2. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

KMO Measure of Sampling Adequacy.		.955
Bartlett's Test of Sphericity	Approx. Chi-Square	8603.590
	df	780
	Sig.	0.000

Here, the test result is 8603.590, and the significance level is less than 0.001. Therefore, it is ruled out that the correlation matrix is an identity matrix. The variables are not orthogonal, to be precise. Given the significant value of 0.05, a factor analysis would be appropriate for the given data set.

KMO is a test specifically used to determine how strong the partial correlation between the variables is. Most researchers now believe that a KMO of at least 0.80 is sufficient for factor analysis to start, although values closer to 1.0 are considered ideal and values less than 0.5 are undesirable [27].

Factor Extraction

Table 3. Eigenvalues and Total Variance Explained

	Initial Eigenvalues		
Factor	Total	% of Variance	Cumulative %
1	22.960	57.401	57.401
2	1.556	3.889	61.290
3	1.383	3.458	64.748
4	1.186	2.965	67.712
5	1.069	2.672	70.384

Shown in Table 3 is the total variance explained. This displays the Eigenvalues, the percent of the variance, and the cumulative percentage. There are 5 factors having Eigenvalues greater than 1 and these extracted factors accounted for a combined 70.38% of the total variance, which then implies that there will be 5 factors that would be formed. The portion of the total variance explained by a factor is indicated by its eigenvalue.

Table 4. Summary for Factors on the Standard for Teaching Mathematics in Higher Education through Blended Modality after Exploratory Factor Analysis

	Factors	Factor Loading	Cron-bach's Alpha
	Factor 1: *Teaching Management*		.923
Q17	Keeps precise records of students' performance and submits them on time.	.537	
Q18	Develops plans for preserving and organizing online learning resources, such as documents, links, and other resources.	.623	
Q20	Combines judiciously the offline and online activities to provide students control over their learning.	.656	
Q23	Prepares activities that are organized in an understandable style for both online and in-person class learning.	.542	
Q24	Uses both online and offline assessment data to assist students in monitoring their own learning progress.	.627	
Q30	Administers performance-based assessments in both an offline and online format.	.660	
Q31	Manages the class where students could work at their own speed to achieve mastery.	.574	
Q34	Demonstrates consideration for the students' ability to pay attention and comprehend the material presented.	.563	
	Factor 2: *Communicating and Feedbacking*		.912
Q21	Demonstrates mastery in the subject-matter by providing explanations that go beyond those found in the required textbook.	.638	
Q22	Designs exercises for classes that combine online and in-person components to aid students in gaining critical life skills.	.587	
Q25	Provides quality of feedback to the students for their online and face-to-face performance.	.555	
Q26	Provides timely and constructive feedback to students using a variety of channels (text, audio, video, etc.).	.674	
Q27	Communicates properly the grading policy to the students.	.546	
Q29	Orients the students of the online components (Learning Management System, resources, and online course arrangement).	.522	
Q39	Regularly arrives on time for class, is presentable, and is ready to handle any tasks that may be given.	.554	
	Factor 3: *Facilitating of Learning*		.887
Q3	Maintains a proper student-teacher interaction through online and in-person.	.601	
Q5	Offers students with several opportunity to voice their opinions regarding the efficacy of face-to-face and online teaching methods.	.569	
Q19	Provides a precise procedure for switching between offline and online learning sessions.	.646	
Q33	Configures the classroom space as needed to support the planned in-person and online classroom-based activities.	.584	
Q35	Enhances students' self-esteem and/or properly recognizes their accomplishments and potential.	.511	
Q38	Assumes responsibilities as a coach, resource person, interrogator, integrator, and arbitrator to encourage pupils to contribute to their knowledge and comprehension of the relevant ideas.	.549	
	Factor 4: *Student Monitoring*		.863
Q4	Ensures that students are comfortable communicating with them through online and face-to-face classes.	.521	
Q7	Establishes rules for how students should ask for assistance while using internet technologies for studying.	.623	
Q8	Develops appropriate procedures for managing and submitting student-created work online.	.725	
Q9	Monitors and records the activities in the online and face-to-face.	.534	
Q10	Provides a proper monitoring of students' engagement (e.g., how long they spend working, how often they log in, how often they use the site, etc.).	.572	
Q40	protects the internet privacy of students by establishing technology use agreements for the exchange of student data.	.529	
	Factor 5: *Accessibility of Materials*		.839
Q12	Ensures that the course module contents are accessible to the students.	.534	
Q13	Uploads and shares materials, tasks, quiz, and tests through blended learning.	.599	
Q14	Ensures that all students have the opportunity to engage in online learning activities.	.658	
Q16	Ensures that the recordings, power point presentations, and other resources are made accessible by the students at the electronic learning management system.	.507	

The number of initial unrotated components to be extracted is determined using eigenvalues, sometimes referred to as Kaiser's criteria. Each factor's eigenvalues show the variation that is explained by that particular linear components, with coefficient values less than 0.5 being suppressed [28]. By using all of the variances in the variables, the variables are analyzed into a set of smaller linear combinations in this procedure. However, a mathematical model is used to estimate factor analysis, and merely shared variance is examined. This analysis also advised that eigenvalues should be taken into account when making decisions regarding the factors.

Factor Rotation and Interpretation

Presented in Table 4 is the summary for factors on the standard for teaching mathematics in higher education through blended modality after exploratory factor analysis where questions were grouped and compressed according to the factor loadings. In this table, Q1, Q2, Q6, Q11, Q15, Q28, Q32, Q36, and Q37 had no factor loading, which implied that their factor loadings were below 0.5. The criterion for item elimination required that items with comparable loadings on two variables and loadings lower than 0.5 be removed as suggested on the studies conducted by Maskey, Fei, and Nguyen [29].

The summary for factors in this table shows that the first factor has 8 items whose factor loadings range from .573 to .674 with a Cronbach's alpha of .923; the second factor has 7 items with factor loadings of .522-.674 with a Cronbach's alpha of .912; factor three has 6 with factor loadings of .511-.646 with a Cronbach's alpha of .887; factor four has 6 items whose factor loadings range is .521-.725 with a Cronbach's alpha of .863; and, factor five has 4 items with factor loadings of .507-.658 and a Cronbach's alpha of .839.

This result showed that out of the original 40-item instrument, 9 items were deleted since their factor loadings were less than the threshold of 0.5. Moreover, the remaining 31 items were regrouped according to their rotated factor matrix wherein each component was identified based on the suppressed factor loadings. The first factor is labeled as teaching management. This teaching management is an essential factor for effective blended teaching. Instructors need to create a well-structured course design that integrates online and in-person components seamlessly. The second factor is named communication and feedback. Also, effective communication and feedback are considered indispensable for blended teaching since the faculty members need to establish clear communication channels with students, both online and in-person. Next, the third factor is referred to as facilitating of learning. This implies that there is a need for the faculty members to create a supportive learning environment that fosters engagement and collaboration, both online and in person. Furthermore, factor 4 is marked as student monitoring. In this student monitoring, each faculty member has to keep track of student progress and provide timely support and guidance when necessary. This requires the use of tools and technologies that facilitate tracking and monitoring of student performance. Lastly, factor 5 is labeled as the accessibility of materials. This connotes that faculty members have to ensure that all course materials are easily accessible to students, regardless of their location or learning mode. This includes providing online access to course materials, such as lecture notes, videos, and other resources.

IV. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the use of exploratory factor analysis can provide valuable insights into the design and implementation of blended modality in higher education. Based on the research conducted, several important findings have been identified.

Exploratory factor analysis can be used to identify the underlying factors that contribute to effective blended learning. This includes factors such as technology use, student engagement, and instructional design. By identifying these factors, institutions can develop more effective blended learning strategies that are aligned with the needs and expectations of their students. This approach can be particularly useful for institutions that are just beginning to implement blended learning or that are looking to improve their existing strategies.

It is as concluded that the factors identified in this study can be an effective approach for higher education institutions that seek to provide a comprehensive and engaging learning experience for students for the blended modality. By focusing on teaching management, communication and feedback, facilitation of learning, student monitoring, and accessibility of materials, tertiary institutions can create a supportive and engaging learning environment that meets the needs of all students.

Also, it is recommended for the faculty members in the tertiary education teaching mathematics to provide an emphasis on teaching management, communication and feedback, facilitation of learning, student monitoring, and accessibility of materials, in order to properly implement blended modality in teaching and learning. Students are likewise advised to maximize their learning for them to successfully navigate blended learning environments and achieve their academic goals. And lastly, it is suggested that future researchers to conduct confirmatory factor analysis for these factors, and similarly conduct these through multiple linear regression analysis or structural equation modeling in order to determine it applicability in a different setting.

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REFERENCES

[1] Wilkie, K. J. (2019). The challenge of changing teaching: investigating the interplay of external and internal influences during professional learning with secondary mathematics teachers. *Journal of Mathematics Teacher Education*, ***22***(1).

[2] Bringula, R., Reguyal, J. J., Tan, D. D., & Ulfa, S. (2021). Mathematics self-concept and challenges of learners in an online learning environment during COVID-19 pandemic. *Smart Learning Environments*, ***8***(1), 1-23.

[3] Mailizar, Almanthari, A., Maulina, S., & Bruce, S. (2020). Secondary School Mathematics Teachers' Views on E-learning Implementation Barriers during the COVID-19 Pandemic: The Case of Indonesia. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(7).

[4] Bhagat, S., & Kim, D. J. (2020). Higher Education Amidst COVID-19: Challenges and Silver Lining. *Information Systems Management, 37*(4).

[5] Fakhrunisa, F., & Prabawanto, S. (2020). Online Learning in COVID-19 Pandemic: An Investigation of Mathematics Teachers' Perception. *4th International Conference on Education and E-Learning*, 207–213.

[6] Pregowska, A., Masztalerz, K., Garlińska, M., & Osial, M. (2021). A worldwide journey through distance education—from the post office to virtual, augmented and mixed realities, and education during the COVID-19 pandemic. *Education Sciences*, ***11***(3), 118.

[7] Rahman, K., Wahid, A., Afandi, I., Bali, M. M. E. I., & Hakim, L. (2019, June). Effectiveness of Teams Teaching-Hybrid Learning (TTHL) in Higher Education. In *WESTECH 2018: Proceedings of 1st Workshop on Environmental Science, Society, and Technology, WESTECH 2018, December 8th, 2018, Medan, Indonesia* (p. 263). European Alliance for Innovation.

[8] Gleason, B., & Greenhow, C. (2017). Hybrid education: The potential of teaching and learning with robot-mediated communication. *Online learning journal*, ***21***(4).

[9] Bali, M. M. E. I. (2017). Model interaksi sosial dalam mengelaborasi keterampilan sosial. *Pedagogik: Jurnal Pendidikan*, ***4***(2).

[10] Gamage, K. A., Gamage, A., & Dehideniya, S. C. (2022). Online and Hybrid Teaching and Learning: Enhance Effective Student Engagement and Experience. *Education Sciences*, ***12***(10), 651.

[11] Bryson, J. R., & Andres, L. (2020). Covid-19 and rapid adoption and improvisation of online teaching: curating resources for extensive versus intensive online learning experiences. *Journal of Geography in Higher Education*, ***44***(4), 608-623.

[12] Beatty, B. J. (2019). Hybrid-flexible course design. *Implementing student-directed hybrid classes. Provo, Utah: EdTech Books*

[13] Barnett, R. (2014). Conditions of Flexibility: Securing a More Responsive Higher Education System. *Higher Education Academy*.

[14] Andrade, M. S., & Alden-Rivers, B. (2019). Developing a framework for sustainable growth of flexible learning opportunities. *Higher Education Pedagogies*, ***4***(1), 1-16.

[15] Peters, M. A., Rizvi, F., McCulloch, G., Gibbs, P., Gorur, R., Hong, M., ... & Misiaszek, L. (2022). Reimagining the new pedagogical possibilities for universities post-Covid-19: An EPAT Collective Project. *Educational Philosophy and Theory*, ***54***(6), 717-760.

[16] Saichaie, K. (2020). Blended, flipped, and hybrid learning: Definitions, developments, and directions. *New Directions for Teaching and Learning*, ***2020***(164), 95-104.

[17] Müller Werder, C., Stahl, M., Alder, M., & Müller, M. (2018). Learning effectiveness and students' perceptions in a flexible learning course. *European Journal of Open, Distance and E-Learning*, ***21***(2), 44-52.

[18] Singh, V., & Thurman, A. (2019). How many ways can we define online learning? A systematic literature review of definitions of online learning (1988-2018). *American Journal of Distance Education*, ***33***(4), 289-306.

[19] Huang, R. H., Liu, D. J., Tlili, A., Yang, J. F., & Wang, H. H. (2020). Handbook on facilitating flexible learning during educational disruption: The Chinese experience in maintaining undisrupted learning in COVID-19 outbreak. *Beijing: Smart Learning Institute of Beijing Normal University*, *46*.

[20] Yen, S. C., Lo, Y., Lee, A., & Enriquez, J. (2018). Learning online, offline, and in-between: comparing student academic outcomes and course satisfaction in face-to-face, online, and blended teaching modalities. *Education and Information Technologies*, ***23***(5), 2141-2153.

[21] Creswell, J. W., & Plano Clark, V. L. (2018). Designing and Conducting Mixed Methods Research (3rd ed.). *Thousand Oaks, CA: SAGE*.

[22] Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing*, ***25***(8), 652-661.

[23] Knekta, E., Runyon, C., & Eddy, S. (2019). One size doesn't fit all: Using factor analysis to gather validity evidence when using surveys in your research. *CBE—Life Sciences Education*, ***18***(1).

[24] Iliyasu, R., & Etikan, I. (2021). Comparison of quota sampling and stratified random sampling. *Biom. Biostat. Int. J. Rev*, ***10***, 24-27.

[25] Dye, T. (2021). *Qualitative data analysis: Step-by-step guide (Manual vs. automatic).* Thematic.

[26] Shrestha, N. (2021). Factor analysis as a tool for survey analysis. *American Journal of Applied Mathematics and Statistics*, ***9***(1), 4-11.

[27] Taherdoost, H. A. M. E. D., Sahibuddin, S., & Jalaliyoon, N. E. D. A. (2022). Exploratory factor analysis; concepts and theory. *Advances in applied and pure mathematics*, ***27***, 375-382.

[28] Iantovics, L. B., Rotar, C., & Morar, F. (2019). Survey on establishing the optimal number of factors in exploratory factor analysis applied to data mining. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *9*(2), e1294.

[29] Maskey, R., Fei, J., & Nguyen, H. O. (2018). Use of exploratory factor analysis in maritime research. *The Asian journal of shipping and logistics*, ***34***(2), 91-111.