European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

Analysing the interrelationship among enablers affecting student engagement in online higher education using Interpretive Structural Modelling (ISM) and MICMAC analysis

Dr. Shilpa Gaidhani
Assistant Professor, Balaji Institute of Management and Humaan Resource Development (BIMHRD), Sri Balaji University, Pune

Dr. G. Gopalakrishnan
Director, Balaji Institute of Management and Humaan Resource Development (BIMHRD), Sri Balaji University, Pune

Abstract

The Engagement of students is an essential factor in the effectiveness of online university education. This study uses Interpretative Structural Modeling (ISM) and matrixed impacts of Croisés multiplication appliquée á un classment (MICMAC) analysis to identify key enablers affecting Students' Engagement and exploring their interdependence. The findings emphasize institutional support, technological infrastructure and faculty training as basic drive forces that create involvement strategies, design and motivation of students. Psychological and social factors, perceived easy to use and flexibility have proven to be dependent variables affected by these drivers. The ISM framework revealed hierarchical relations between enablers, while MICMAC analysis has classified them based on the power and dependence strength. This research concludes that the structured online educational environment, robust technological support and targeted engagement strategies improve the results of students' participation and learning. Practical recommendations include strengthening institutional policies, improving the faculty training, implementing interactive courses' designs and providing psychological support to support inclusive and engaging ecosystem of online education.

Keywords: Student engagement, online education, ISM model, MICMAC analysis, institutional support, technological infrastructure

1. Introduction

The digital transformation of higher education has accelerated dramatically in recent years, particularly in response to the disruptions caused by the COVID-19 pandemic. As institutions rapidly transitioned to online platforms to ensure continuity in teaching and learning, online education emerged not only as an emergency response but also as a strategic long-term alternative to traditional modes of delivery (Dhawan, 2020; Adedoyin & Soykan, 2020). This shift has brought undeniable advantages such as increased flexibility, enhanced accessibility, and cost-effectiveness, thereby democratizing access to higher education for a wider range of learners (Bao, 2020; Bozkurt & Sharma, 2020).

Despite these benefits, maintaining high levels of student engagement in online environments remains a persistent and critical challenge. Unlike face-to-face learning, online education often lacks the immediacy of personal interaction, which can lead to feelings of isolation, reduced motivation, and decreased participation among students (Martin & Bolliger, 2018; Rasheed et al., 2020). Student engagement- defined as the level of interest, curiosity, and involvement that students show towards their learning process - is widely acknowledged as a key determinant of academic success and satisfaction (Fredricks, Blumenfeld, & Paris, 2004; Kahu, 2013).

A growing body of literature highlights that student engagement in online learning is not shaped by a single factor but rather by a complex network of interrelated enablers. These include institutional support mechanisms, availability and usability of technological infrastructure, faculty presence and responsiveness, quality of course design, and various psychological and motivational factors such as self-efficacy and perceived ease of use (Dixson, 2015; Sun et al., 2008; Banna et al., 2015). The effectiveness of online education, therefore, depends heavily on understanding how these factors interact and influence one another.

To address this complexity, advanced decision-making and modeling techniques are required to untangle the web of relationships among these enablers. **Interpretive Structural Modeling (ISM)** and **Matrice d'Impacts Croisés Multiplication Appliquée à un Classement (MICMAC)** analysis offer rigorous and structured methodologies for identifying and classifying such interdependencies. ISM helps in developing a multilevel hierarchical framework by structuring the interrelationships among variables, enabling a clearer understanding of direct and transitive influences among the factors (Warfield, 1974). MICMAC analysis complements ISM by classifying the factors based on their driving power and dependence, helping in the identification of key drivers and dependent variables (Godet, 1991; Sushil, 2005).

This research applies ISM and MICMAC analysis to systematically explore the enablers that affect student engagement in online higher education. The study aims to identify the most influential (driving) and most influenced (dependent) factors, mapping their structural interrelations to provide actionable insights. Through this methodological lens, the study contributes to the literature by offering a comprehensive and structured framework for understanding student engagement in digital education.

Furthermore, the findings of this research are intended to guide academic institutions and policymakers in designing strategic interventions to enhance engagement, reduce dropout rates, and improve student learning outcomes in online settings. By offering a data-driven perspective on the key enablers, this study serves as a critical resource for rethinking institutional strategies in the digital era and ensuring that the promise of online education is fulfilled not just in access, but in quality and impact.

2. Literature Review

2.1 Model PRISMA for a systematic Literature Review

Systematic Literature Overview (SLR) is a structured approach to the identification, evaluation and synthetization of existing research on a particular topic. It ensures transparency, reproducibility and accuracy in the selection and analysis of the relevant studies. In this overview, preferred reporting items for systematic reviews and meta-analysis (PRISMA) was used to increase literature accuracy.

The PRISMA model consists of four key phases: **identification, screening, eligibility and integration.** Initially, the relevant literature was identified by complete search in the Scopus database using predefined keywords and Boolean operators. Furthermore, duplicate records have been removed and the studies were proven on the basis of titles and abstracts. The eligibility criteria were used to assess the full -text cells with respect to their relevance, literature accuracy and classification criteria. Finally, the most important studies for qualitative and

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2 (2025)
http://eelet.org.uk

quantitative research were included. By analysing the PRISMA model, this systematic overview ensures a clear, unbiased and replicable approach to understand an existing knowledge set in the selected research domain.

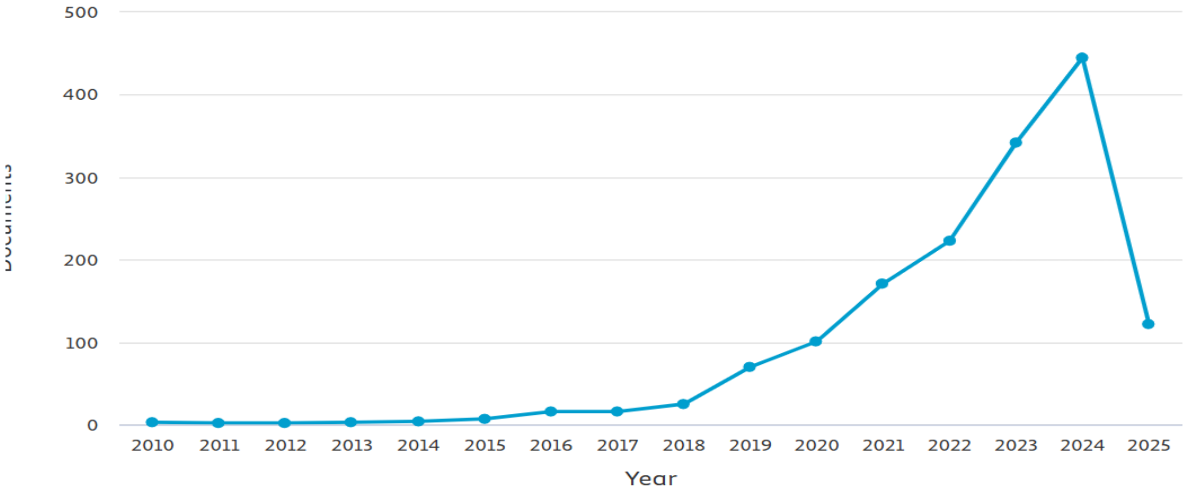

Figure 1 Documents by year (Scopus database)

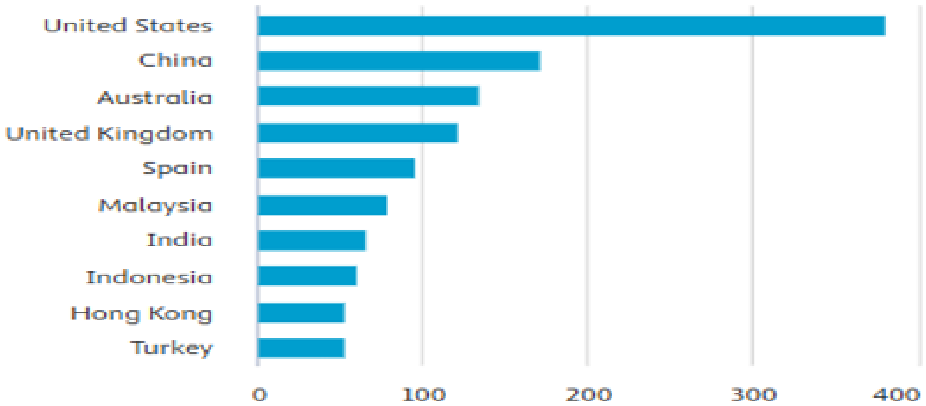

Figure 2 Documents by region/country (Scopus Database)

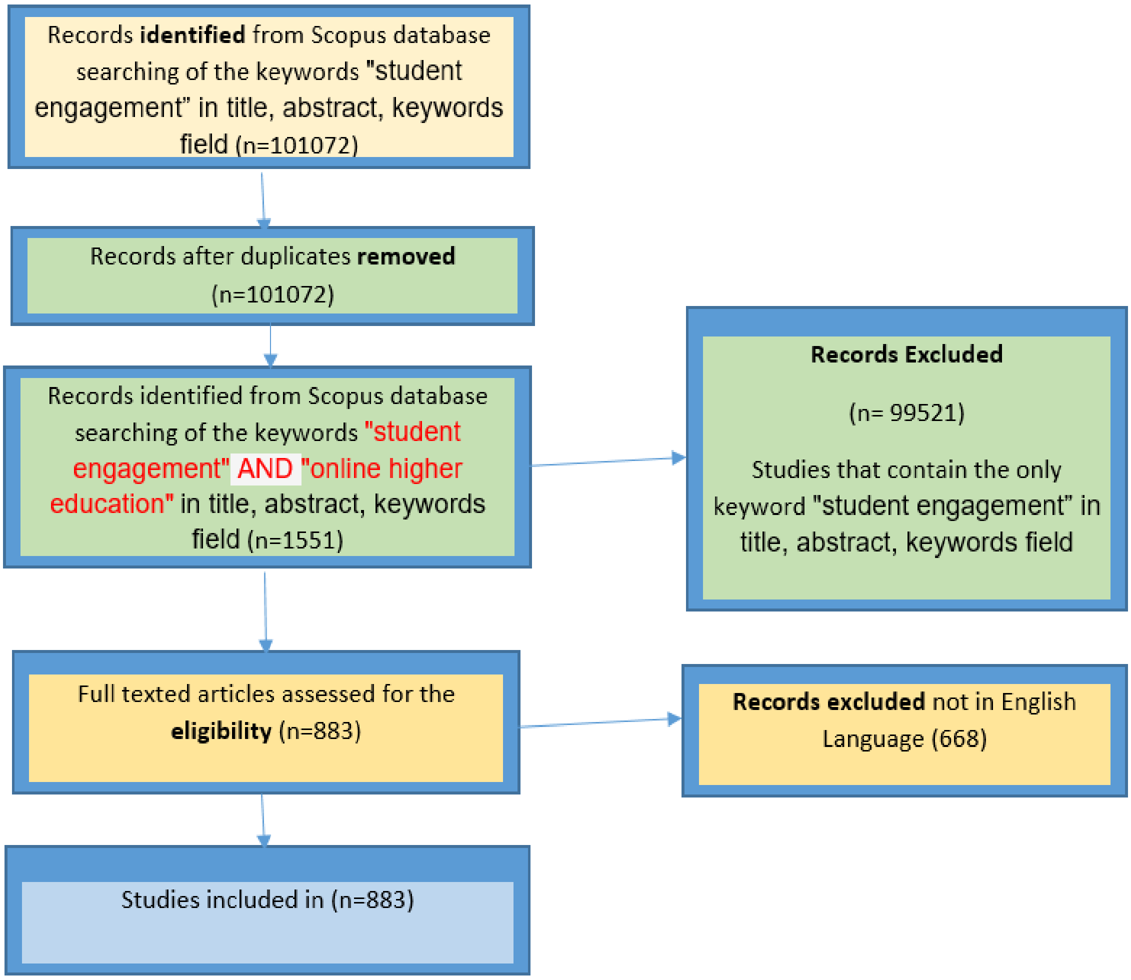

Figure 3 PRISMA model for Literature Selection

The systematic literature review identified several key enablers that influence the effectiveness of online education and digital learning environments. These enablers were categorized based on recurring themes in prior research and theoretical frameworks.

1. **Institutional Support**

Institutional support plays a crucial role in ensuring the successful implementation of digital learning. Universities that provide adequate policies, funding, and administrative assistance enable faculty and students to adapt effectively to online learning. (Teixeira and Mota, 2020)

2. **Technological Infrastructure**

The availability of reliable internet connectivity, learning management systems, and digital tools significantly influences the adoption and effectiveness of e-learning platforms. Studies highlight that institutions with strong IT support can improve both faculty and student experiences in online learning environments.

3. **Faculty Support and Training**

Faculty readiness and continuous training in digital pedagogy are essential for the effective delivery of online courses. Research suggests that institutions offering structured training programs lead to better engagement and teaching effectiveness.

4. **Course Design and Content Quality**

Well-structured courses with engaging content, interactive elements, and clear learning outcomes enhance student learning experiences. Studies emphasize that high-quality course design improves retention and student satisfaction.

5. **Student Motivation and Self-Regulation**

Self-motivation and the ability to regulate one's learning are key determinants of success in online education. Literature suggests that self-regulated learners tend to perform better and engage more actively in digital learning environments.

6. **Collaborative Learning Environment**

Online learning platforms that facilitate collaboration through discussion forums, group activities, and peer interactions contribute to better knowledge retention and learner satisfaction

7. **Engagement Strategies**

Student engagement is a critical factor for the success of digital education. Research highlights that gamification, interactive assessments, and multimedia resources significantly improve student participation.

8. **Assessment and Feedback Mechanisms**

Effective assessment methods, including formative and summative assessments, along with timely feedback, play a vital role in online education. Studies suggest that feedback mechanisms enhance learning outcomes and student performance.

9. **Psychological and Social Factors**

The psychological well-being of students, including factors like stress, isolation, and social support, influences their engagement and success in online education. Literature indicates that universities addressing these aspects create more inclusive learning environments.

10. **Perceived Ease of Use and Usefulness**

According to the Technology Acceptance Model (TAM), perceived ease of use and perceived usefulness significantly influence the adoption of digital learning tools. Studies confirm that user-friendly platforms encourage more students to engage in online learning.

11. **Flexibility and Accessibility**

One of the primary advantages of online learning is flexibility in terms of time and location. Research suggests that students with access to flexible learning options show higher course completion rates and satisfaction.

3. Research Methodology

3.1 Research Design

This study adopts an exploratory research design, using Interpretive Structural Modeling (ISM) and MICMAC (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) analysis to identify and analyze the interrelationships among key enablers affecting **student engagement in online higher education**

3.2 Identification of Key Enablers/Variables

A thorough review of literature and expert consultation were used to identify the initial list of enablers. Semi-structured interviews were conducted with 15 domain experts, including academicians and industry professionals, to validate and finalize the enablers.

The given enablers are:

1. Institutional Support (IS)
2. Technological Infrastructure (TI)
3. Faculty Support and Training (FST)
4. Course Design and Content Quality (CD)
5. Student Motivation and Self-Regulation (SM)
6. Collaborative Learning Environment (CLE)
7. Engagement Strategies (ES)
8. Assessment and Feedback Mechanisms (AFM)
9. Psychological and Social Factors (PSF)
10. Perceived Ease of Use and Usefulness (PEU)
11. Flexibility and Accessibility (FA)

3.3 Development of Structural Self-Interaction Matrix (SSIM)

The finalized enablers were subjected to pairwise comparison to determine the contextual relationships among them. Experts were asked to define the direction of influence between each pair using the following symbols:

- V: Enabler **i** influences **j**
- A: Enabler **j** influences **i**
- X: Mutual influence
- O: No influence

The SSIM is constructed by evaluating the relationships between each pair of enablers.

Table 1 Structural Self-Interaction Matrix (SSIM)

	IS	**TI**	**FST**	**CD**	**SM**	**CLE**	**ES**	**AFM**	**PSF**	**PEU**	**FA**
IS	-	V	V	V	O	O	O	O	O	O	O
TI		-	V	V	O	O	O	O	O	V	V
FST			-	V	V	V	V	A	A	A	O
CD				-	V	V	V	V	A	V	A
SM					-	X	X	A	A	A	A
CLE						-	X	A	A	A	A
ES							-	A	A	A	A
AFM								-	A	A	A
PSF									-	X	X
PEU										-	X

FA											-

3.4 Reachability Matrix

The SSIM was converted into a binary Reachability Matrix by replacing the symbols (V, A, X, O) with 1s and 0s, based on predefined rules. The matrix was then checked for transitivity- a fundamental assumption of ISM.

By converting **V, A, X, O** into **1s and 0s**, we create a **binary reachability matrix**. This matrix is then modified using transitivity rules.

Table 2 Reachability Matrix

	IS	TI	FST	CD	SM	CLE	ES	AFM	PSF	PEU	FA
IS	-	1	1	1	0	0	0	0	0	0	0
TI		-	1	1	0	0	0	0	0	1	1
FST			-	1	1	1	1	1	1	1	0
CD				-	1	1	1	1	1	1	1
SM					-	0	0	1	1	1	1
CLE						-	0	1	1	1	1
ES							-	1	1	1	1
AFM								-	1	1	1
PSF									-	0	0
PEU										-	0
FA											-

To modify this matrix using transitivity rules, we will apply **Warshall's Algorithm** (also known as the **Floyd-Warshall Algorithm for reachability**). This ensures that if **A → B** and **B → C**, then **A → C** must also be updated to 1.

Table 3 Initial Binary Matrix

	IS	TI	FST	CD	SM	CLE	ES	AFM	PSF	PEU	FA
IS	1	1	1	1	0	0	0	0	0	0	0
TI	0	1	1	1	0	0	0	0	0	1	1
FST	0	0	1	1	1	1	1	1	1	1	0
CD	0	0	0	1	1	1	1	1	1	1	1
SM	0	0	0	0	1	0	0	1	1	1	1
CLE	0	0	0	0	0	1	0	1	1	1	1
ES	0	0	0	0	0	0	1	1	1	1	1
AFM	0	0	0	0	0	0	0	1	1	1	1
PSF	0	0	0	0	0	0	0	0	1	0	0
PEU	0	0	0	0	0	0	0	0	0	1	0
FA	0	0	0	0	0	0	0	0	0	0	1

Apply Transitivity Rules

If **A → B** and **B → C**, then update **A → C** to **1**.

Key Changes:

- **IS** should inherit all reachable nodes from **TI** and **FST**.
- **TI** should inherit all reachable nodes from **FST**.

- **FST** should inherit all reachable nodes from **CD** and beyond.
- **PSF, PEU, and FA** inherit no new reachability.

Table 4 Final Transitive Closure Matrix

	IS	TI	FST	CD	SM	CLE	ES	AFM	PSF	PEU	FA
IS	1	1	1	1	1	1	1	1	1	1	1
TI	0	1	1	1	1	1	1	1	1	1	1
FST	0	0	1	1	1	1	1	1	1	1	1
CD	0	0	0	1	1	1	1	1	1	1	1
SM	0	0	0	0	1	1	1	1	1	1	1
CLE	0	0	0	0	0	1	1	1	1	1	1
ES	0	0	0	0	0	0	1	1	1	1	1
AFM	0	0	0	0	0	0	0	1	1	1	1
PSF	0	0	0	0	0	0	0	0	1	0	0
PEU	0	0	0	0	0	0	0	0	0	1	0
FA	0	0	0	0	0	0	0	0	0	0	1

3.5 Level Partitioning

The reachability matrix was used to determine the reachability and antecedent sets for each enabler. Iterative level partitioning was carried out to identify different levels in the hierarchy, where the top-level elements have no elements above them in terms of influence.
We will first determine the **Reachability Set (R)** and **Antecedent Set (A)** for each element.

Table 5 Reachability and Antecedent Sets

Element	**Reachability set (R)**	**Antecedent Set (A)**	**Intersection (R ∩ A)**
IS	IS,TI,FST,CD	IS	IS
TI	TI,FST,CD,PEU,FA	IS, TI	TI
FST	FST, CD, SM, CLE, ES, AFM, PSF, PEU	IS, TI, FST	FST
CD	CD,SM,CLE,ES,AFM,PSF,PEU,FA	IS,TI,FST,CD	CD
SM	SM,AFM,PSF,PEU,FA	FST,CD,SM	SM
CLE	CLE,AFM,PSF,PEU,FA	FST,CD,CLE	CLE
ES	ES,AFM,PSF,PEU,FA	FST,CD,ES	ES
AFM	AFM,PSF,PEU,FA	FST,CD,SM,CLE,ES, AFM	AFM
PSF	PSF	FST, CD, SM, CLE, ES, AFM, PSF	PSF
PEU	PEU	TI, FST, CD, SM, CLE, ES, AFM, PEU	PEU
FA	FA	TI, CD, SM, CLE, ES, AFM, FA	FA

The elements where **R = R** ∩ **A** will be placed at the **top level** in the hierarchy.

In the first iteration, **PSF, PEU, FA** form Level 1.

Identify Hierarchical Levels

Through successive iterations, we classify the enablers into hierarchical levels based on their dependencies and driving power.

Table 6 Hierarchical Levels

Iteration	**Top-Level Elements (R ∩ A)**
1st Level	PSF, PEU,FA
2nd Level	AFM
3rd Level	SM,CLE,ES
4th Level	CD
5th Level	FST
6th Level	TI
7th level	IS

3.6 ISM-Based Model Development

Based on the level partitions, a directed graph (digraph) was developed to represent the hierarchical structure. Based on dependencies and hierarchical structuring, a **final ISM model** is drawn where:

- **IS (Institutional Support)** is the foundational driver.
- **Technological Infrastructure (TI)** depends on institutional support.
- **Faculty Support & Training (FST)** is driven by both.
- **Course Design (CD)** is influenced by FST.
- **Student Motivation (SM), Collaborative Learning (CLE), and Engagement Strategies (ES)** depend on course design.
- **Assessment & Feedback Mechanisms (AFM)** support SM, CLE, and ES.
- **Psychological & Social Factors (PSF), Perceived Ease of Use (PEU), and Flexibility & Accessibility (FA)** depend on AFM.

The structure of relationships as follows:

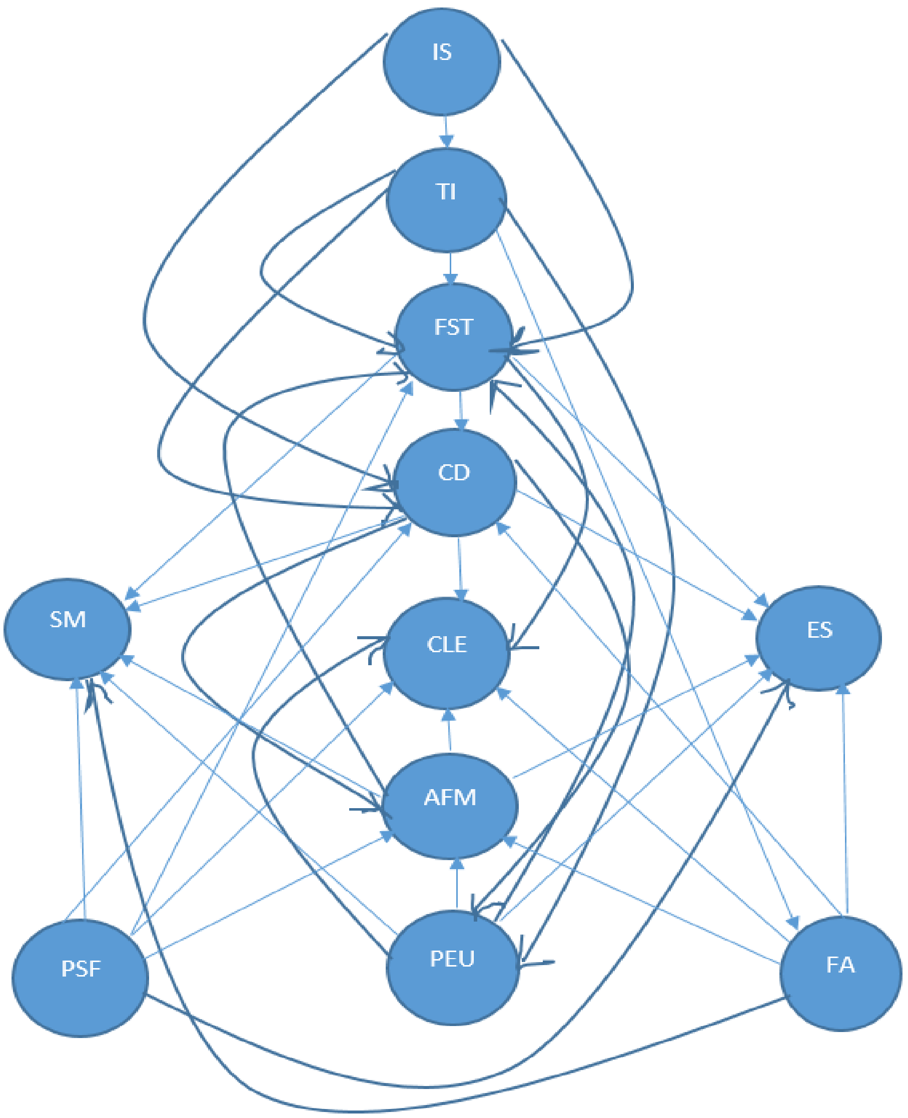

Figure 4 ISM Model for student engagement in Online Higher Education

Here is the ISM model representing the hierarchical structure of enablers for student engagement in online higher education. The foundational enablers (Institutional Support and Technological Infrastructure) are at the base, while dependent enablers (Psychological & Social Factors, Perceived Ease of Use) are at the top.

3.4 MICMAC Analysis for Classification

MICMAC analysis was carried out to classify the enablers based on their driving and dependence powers. The final reachability matrix was used to calculate the driving power (number of enablers it influences) and dependence power (number of enablers it is influenced by). Enablers were then categorized into four clusters:

- Autonomous (weak driver, weak dependence)
- Dependent (weak driver, strong dependence)
- Linkage (strong driver, strong dependence)
- Independent (strong driver, weak dependence)

3.4.1 Driving and Dependence Power

- **Driving Power** = Number of 1s in the row (i.e., how many elements this factor influences)
- **Dependence Power** = Number of 1s in the column (i.e., how many elements influence this factor)

Let’s compute this from the matrix:

Table 7 Driving and Dependence Power

Enabler	Driving Power (Row Total)	Dependence Power (Column Total)
IS	11	1
TI	10	2
FST	9	3
CD	8	4
SM	7	4
CLE	6	4
ES	5	4
AFM	4	6
PSF	1	8
PEU	1	8
FA	1	7

3.4.2 MICMAC Classification

Using the driving and dependence powers, we can place each enabler into one of the following **four clusters**:

Table 8 MICMAC Classification

Cluster	Criteria	Enablers
Autonomous	Low driving, low dependence	*(None in this case)*
Dependent	Low driving, high dependence	**PSF, PEU, FA**
Linkage	High driving, high dependence	**AFM**
Independent	High driving, low dependence	**IS, TI, FST, CD, SM, CLE, ES**

3.4.3 Final MICMAC Data Table

Table 9 Final MICMAC Data Table

Enabler	Driving Power	Dependence Power	MICMAC Category
IS	11	1	Independent
TI	10	2	Independent
FST	9	3	Independent

CD	8	4	Independent
SM	7	4	Independent
CLE	6	4	Independent
ES	5	4	Independent
AFM	4	6	Linkage
PSF	1	8	Dependent
PEU	1	8	Dependent
FA	1	7	Dependent

3.4.4 MICMAC diagram (scatter plot)

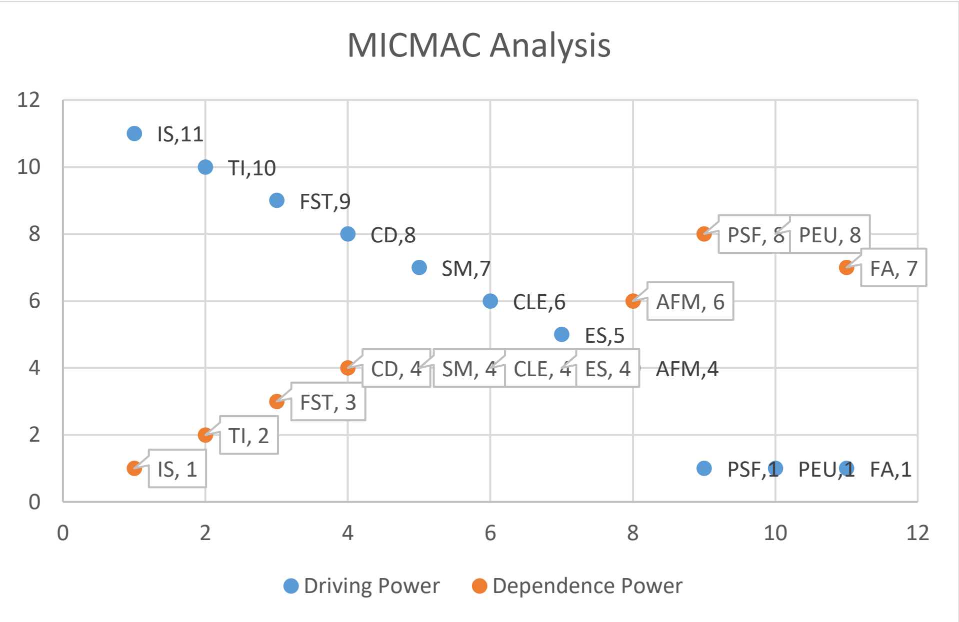

Figure 5 MICMAC Analysis

Interpretation:

1. Independent Variables (High Driving, Low Dependence)

These enablers strongly influence the system but are not easily influenced by others.

- **IS** (Institutional Support)
- **TI** (Technological Infrastructure)
- **FST** (Faculty support & Training)
- **CD** (Course Design)
- **SM** (Student Motivation)
- **CLE** (Collaborative learning)
- **ES** (Engagement Strategies)

These should be the primary focus for policymakers or managers as they drive other enablers.

2. Linkage Variables (High Driving, High Dependence)

Highly dynamic and unstable- changes in these affect others and are also affected easily.

- **AFM (Assessment &feedback mechanism)**

Needs careful monitoring and constant alignment.

3. Dependent Variables (Low Driving, High Dependence)

These are outcomes influenced by other enablers.

- **PSF** (Psychological & social factors)

- **PEU** (Perceived Ease of Use)
- **FA** (Flexibility and Accessibility)

They reflect the system's effectiveness- their improvement depends on strengthening independent variables.

3.5 Discussion

The analysis of factors influencing student engagement in online higher education using Interpretive Structural Modeling (ISM) and Matriced' Impacts Croisés Multiplication Appliquée à un Classement (MICMAC) has revealed critical insights into the hierarchical structure and interdependencies among key enablers.

1. **Key Findings from ISM Analysis:**

- Institutional support and technological infrastructure emerged as foundational enablers with high driving power, influencing other factors such as faculty support, course design, and engagement strategies.
- Faculty support and training, coupled with well-structured course design, directly impact student motivation, self-regulation, and engagement strategies.
- Psychological and social factors, perceived ease of use, and flexibility and accessibility exhibit higher dependence on other enablers, highlighting their role as outcomes rather than direct drivers of engagement.

2. **Key Findings from MICMAC Analysis:**

- Factors such as institutional support, technological infrastructure, and faculty training possess strong driving power and are classified as independent variables.
- Student motivation, engagement strategies, and assessment and feedback mechanisms act as linkage variables, indicating their influence on both driving and dependent factors.
- Psychological and social factors, perceived ease of use, and flexibility and accessibility are highly dependent on other factors, suggesting they can be improved by enhancing the fundamental enablers.

3. **Interrelationships Among Factors:**

- A structured online learning environment supported by institutional policies and technological readiness facilitates effective faculty engagement, which in turn enhances course design and student motivation.
- Engagement strategies and collaborative learning environments bridge the gap between instructional delivery and student participation, ensuring sustained engagement.
- The role of psychological and social support cannot be underestimated, as it significantly impacts students' ability to adapt to online learning.

3.6 Recommendations

1. **Strengthening Institutional Support and Technological Infrastructure:**

- Universities should invest in robust digital infrastructure, ensuring seamless access to learning management systems and online resources.
- Policies should be designed to provide financial and technical support to both faculty and students, minimizing barriers to engagement.

2. **Enhancing Faculty Training and Course Design:**

- Continuous professional development programs should be implemented to equip educators with digital teaching skills.
- Course design should incorporate interactive and multimedia-based content to promote active learning.

3. **Implementing Effective Engagement Strategies:**

- Gamification, real-time feedback, and collaborative learning activities should be integrated to enhance student participation.
- Personalized learning pathways should be developed to cater to diverse student needs and learning preferences.

4. **Improving Psychological and Social Support Mechanisms:**

- Universities should establish virtual support systems, including peer mentoring and counseling services, to address students' emotional well-being.
- Regular check-ins and engagement analytics can help identify students at risk of disengagement, enabling proactive intervention.

5. **Optimizing Assessment and Feedback Mechanisms:**

- Formative assessments should be incorporated to provide ongoing feedback and improve student performance.
- AI-driven analytics can be leveraged to track student engagement patterns and offer personalized learning recommendations.

3.7 Conclusion

This study highlights the critical interdependencies among various enablers affecting student engagement in online higher education. Institutional support, technological infrastructure, and faculty training serve as fundamental drivers that shape the effectiveness of course design, engagement strategies, and psychological well-being. The ISM and MICMAC analyses provide a structured understanding of these relationships, offering valuable insights for educators and policymakers.

To enhance student engagement, higher education institutions must adopt a holistic approach, integrating technological advancements with pedagogical innovations and robust support mechanisms. By implementing targeted strategies, universities can foster an inclusive and engaging online learning environment, ultimately improving student learning outcomes and academic success. Future research can explore the longitudinal impact of these enablers on student engagement and retention in online education.

3.8 Glossary

1. **Student Engagement** – The level of interest, motivation, and participation demonstrated by students in their learning process.
2. **Interpretive Structural Modeling (ISM)** – A methodology used to identify and structure relationships among complex variables within a system.
3. **Matriced' Impacts Croisés Multiplication Appliquée à un Classement (MICMAC)** – A technique used to analyze the driving and dependence power of various factors in a system.
4. **Institutional Support** – Policies, resources, and assistance provided by universities to enhance student learning and engagement.
5. **Technological Infrastructure** – The digital tools, platforms, and systems that support online learning and student interaction.
6. **Faculty Support and Training** – Programs and initiatives aimed at enhancing the digital teaching skills and instructional methods of educators.

7. **Course Design** – The process of structuring online learning materials, activities, and assessments to optimize student learning outcomes.
8. **Engagement Strategies** – Techniques used to encourage active participation and involvement of students in online education.
9. **Psychological and Social Factors** – Emotional, cognitive, and social influences that impact student motivation and learning behavior.
10. **Perceived Ease of Use** – The extent to which students find digital learning platforms user-friendly and accessible.
11. **Flexibility and Accessibility** – The ability of students to access learning resources and adapt to different learning environments based on their needs.
12. **Formative Assessments** – Ongoing evaluations used to provide feedback and guide students toward improvement during the learning process.
13. **AI-driven Analytics** – The use of artificial intelligence to track student engagement patterns and provide personalized learning recommendations.

References

1. Adedoyin, O. B., & Soykan, E. (2020), COVID-19 pandemic and online learning: The challenges and opportunities, *Interactive Learning Environments*, 1–13.
2. Al Issa, H., Omar, M. M. S., & Çelebi, A. (2024), Higher education student engagement with online learning: The role of perceived value and academic entitlement, *Higher Education, Skills and Work-Based Learning*, 14(3), 545–561.
3. Al-Zahrani, A. M., & Alasmari, T. (2023), Learning analytics for data-driven decision-making: Enhancing instructional personalization and student engagement in online higher education, *International Journal of Online Pedagogy and Course Design*, 13(1), 1–18.
4. Aldosari, A. M., Alramthi, S. M., & Eid, H. F. (2022), Improving social presence in online higher education: Using live virtual classroom to confront learning challenges during COVID-19 pandemic, *Frontiers in Psychology*, 13, 994403.
5. Banna, J., Lin, M. F. G., Stewart, M., & Fialkowski, M. K. (2015), Interaction matters: Strategies to promote engaged learning in an online introductory nutrition course, *MERLOT Journal of Online Learning and Teaching*, 11(2), 249–261.
6. Bao, W. (2020), COVID-19 and online teaching in higher education: A case study of Peking University, *Human Behavior and Emerging Technologies*, 2(2), 113–115.
7. Bozkurt, A., & Sharma, R. C. (2020), Emergency remote teaching in a time of global crisis due to CoronaVirus pandemic, *Asian Journal of Distance Education*, 15(1), 1–6.
8. Cespón, M. T., & Toyos, P. B. (2025), An example of gamification for pre-service teachers in online higher education: Methods, tools, and purpose, *Digital Education Review*, 46(1), 14–13.
9. Cohen, J., & Donaldson, K. (2021), The impact of learning design interventions on student satisfaction in an online higher education environment, *International Journal of Technologies in Learning*, 28(1), 45–58.
10. Dhawan, S. (2020), Online learning: A panacea in the time of COVID-19 crisis, *Journal of Educational Technology Systems*, 49(1), 5–22.
11. Dixson, M. D. (2015), Measuring student engagement in the online course: The Online Student Engagement Scale (OSE), *Online Learning*, 19(4), 1–15.
12. Eaton, G., & Cates, S. (2023), Is utilization of university-sponsored social media associated with increased social integration and retention among online students? An examination of social media as a moderator of student retention, *Journal of College Student Retention: Research, Theory and Practice*, 25(1), 24–50.

13. Fedock, B. C., McCartney, M., & Neeley, D. (2019), Online adjunct higher education teachers' perceptions of using social media sites as instructional approaches, *Journal of Research in Innovative Teaching and Learning*, 12(3), 222–235.
14. Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004), School engagement: Potential of the concept, state of the evidence, *Review of Educational Research*, 74(1), 59–109.
15. Gedik, N., Uça Güneş, E. P., Beylik, A., Çabuk, A., & Tiraş, E. (2023), Portable lightboard use in online higher education, *Open Praxis*, 15(2), 162–174.
16. Godet, M. (1991), Actors in forecasting and modelling, *Futures*, 23(4), 355–376.
17. Greenhow, C., & Galvin, S. (2020), Teaching with social media: Evidence-based strategies for making remote higher education less remote, *Information and Learning Science*, 121(August), 513–524.
18. Händel, M., Bedenlier, S., Kopp, B., Gläser-Zikuda, M., Kammerl, R., & Ziegler, A. (2022), The webcam and student engagement in synchronous online learning: Visually or verbally? *Education and Information Technologies*, 27(7), 10405–10428.
19. Johar, N. A., Kew, S. N., Tasir, Z., & Koh, E. (2023), Learning analytics on student engagement to enhance students' learning performance: A systematic review. *Sustainability (Switzerland)*, 15(10), 7849.
20. Kahu, E. R. (2013), Framing student engagement in higher education. *Studies in Higher Education*, 38(5), 758–773.
21. Kanasa, H. (2016), Establishing and maintaining rapport in an online, higher education setting, *Student Engagement and Educational Rapport in Higher Education*, 67, 85–18.
22. Lee, J., & Kim, D. (2024), From awareness to empowerment: Self-determination theory-informed learning analytics dashboards to enhance student engagement in asynchronous online courses, *Journal of Computing in Higher Education*.
23. Letchworth, N. C., Koltonski, S., & Sheriff, L. K. (2024), Academic coaches and student success in higher education, *American Journal of Distance Education*, 38(4), 418–427.
24. Maphoto, K. B. (2024), Perceptions and innovations of academics in an open distance e-learning institution, *Online Journal of Communication and Media Technologies*, 14(2), e202429.
25. Martin, F., & Bolliger, D. U. (2018), Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, 22(1), 205–222.
26. Mihai, M., Albert, C. N., Mihai, V. C., & Dumitras, D. E. (2022). Emotional and social engagement in the English language classroom for higher education students in the COVID-19 online context. *Sustainability (Switzerland)*, 14(8), 4527.
27. Nicoll, S., Douglas, K., & Brinton, C. (2022), Giving feedback on feedback: An assessment of grader feedback construction on student performance, *ACM International Conference Proceeding Series*, 239-249.
28. Noguera, I., Guerrero-Roldán, A.-E., & Masó, R. (2018), Collaborative agile learning in online environments: Strategies for improving team regulation and project management. *Computers and Education*, 116, 110–129.
29. Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023), Integration of artificial intelligence performance prediction and learning analytics to improve student learning in an online engineering course, *International Journal of Educational Technology in Higher Education*, 20(1), 4.
30. Payne, A. L., Stone, C., & Bennett, R. (2023), Conceptualizing and building trust to enhance the engagement and achievement of under-served students, *Journal of Continuing Higher Education*, 71(2), 134–151.

31. Peters, M., & Romero, M. (2019), Lifelong learning ecologies in online higher education: Students' engagement in the continuum between formal and informal learning, *British Journal of Educational Technology*, 50(4), 1729–1743.
32. Pietersen, D. (2023), Perspectives on dialogue and care in teaching, learning relationships in an ever-changing online higher education landscape, *Perspectives in Education*, 41(2), 134–150.
33. Plak, S., van Klaveren, C., & Cornelisz, I. (2023), Raising student engagement using digital nudges tailored to students' motivation and perceived ability levels, *British Journal of Educational Technology*, 54(2), 554–580.
34. Qiu, R. G. (2019), A systemic approach to leveraging student engagement in collaborative learning to improve online engineering education, *International Journal of Technology Enhanced Learning*, 11(1), 1–19.
35. Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020), Challenges in the online component of blended learning: A systematic review, *Computers & Education*, 144, 103701.
36. Roque-Hernández, R. V., Díaz-Roldán, J. L., López-Mendoza, A., & Salazar-Hernández, R. (2023), Instructor presence, interactive tools, student engagement, and satisfaction in online education during the COVID-19 Mexican lockdown, *Interactive Learning Environments*, 31(5), 2841–2854.
37. Shehzad, N., & Charles, T. (2023), Exploring the impact of instructor social presence on student engagement in online higher education, *Contemporary Educational Technology*, 15(4), ep484.
38. Soleimani, F., Lee, J., & Yilmaz Soylu, M. (2024), Analyzing learners' engagement in a micromasters program compared to a non-degree MOOC, *Journal of Research on Technology in Education*, 56(3), 233–247.
39. Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008), What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction, *Computers & Education*, 50(4), 1183–1202.
40. Sushil. (2005), Interpretive structural modeling (ISM): A tool for strategic decision making. *Global Journal of Flexible Systems Management*, 6(2), 9-16.
41. Tereshko, L. M., Weiss, M. J., Cross, S., & Neang, L. (2024), Culturally diverse student engagement in online higher education: A review. *Journal of Behavioral Education*.
42. Warfield, J. N. (1974), Developing interconnection matrices in structural modelling, *IEEE Transactions on Systems, Man, and Cybernetics*, 4(1), 51-81.
43. Yang, N., & Ghislandi, P. (2024), Quality teaching and learning in a fully online large university class: A mixed-methods study on students' behavioral, emotional, and cognitive engagement, *Higher Education*, 88(4), 1353–1379.