INTERNATIONAL JOURNAL OF TEACHER EDUCATION RESEARCH STUDIES (IJTERS)
(Open Access, Double-Blind Peer Reviewed Journal)
ISSN Online: 3049-1614



Re-Engineering General Foundation Mathematics for STEM Readiness in Oman: A Curriculum Alignment and Comparative Readiness Analysis

Dheva Rajan S[1]*, Mini Punnolli[1], Asim Thabit Talib Almaamari[1], Madhan Narayanan[1]

[1]University of Technology and Applied Sciences Al Musannah, Sultanate of Oman

Article information

Received: 24th August 2026
Received in revised form: 2nd September 2026
Accepted: 25th September 2026
Available online: 18th October 2026

Volume: 3
Issue: 6
DOI: https://doi.org/10.63090/IJTERS/3049.1614.0065

Abstract

A basic mathematical foundation, as part of a knowledge-based educational framework aligned with Oman Vision 2040, could serve as the intellectual foundation for STEM development. The Mathematics course in the General Foundation Program (GFP) at the University of Technology and Applied Sciences (UTAS) is vital for students planning to pursue fields such as information technology, artificial intelligence, engineering, and data science. However, concerns remain significant as the program focuses on procedural skills and is less focused on analytical reasoning and modeling. The CDP has a digital math literacy component, but it is limited. None of the previous attempts to assess structured curriculum mapping has proven effective. Through structured curriculum mapping and a comparative readiness analysis, this study examines Course Learning Outcomes, Course Objectives, assessment plans, course delivery strategies, and proposed revisions aligned with a 10-dimensional STEM Readiness Framework. It also considers the spread of Bloom's taxonomy. The paper notes observed alignment gaps, graphically documents them, and benchmarks insights from Harvard University's mathematics pathways against policy recommendations. Results demonstrated around 70% agreement in content but also highlighted discrepancies between evaluation and instruction in two specific areas: modeling and decision-making under uncertainty, as well as digital exploration. Even though the same applies to the requirements for using general skills for knowledge, in the higher cognitive sphere, these limitations are even more severe. Proposed revisions include strengthened analytical and practical competencies, moving from bridge to cognitive enhancement. Advancing IT and engineering readiness, incorporating the IT cum technology-oriented concepts in mathematics, will help sustain existing STEM growth here.

Keywords:- Curriculum Mapping, STEM, Foundation Mathematics, 21st-Century Skills, Oman Vision 2040

I. INTRODUCTION

"Mathematics is a gateway and key to all sciences," by Bacon. Thanheiser (2023) has discussed what mathematics is in Mathematical Education and has presented strong arguments and explanations for mathematics as an "abstract body of knowledge", "contextual", and "verb". But (2023) concluded that one has to visualize the mathematics from all three. Countries that aspire to dominate artificial intelligence, advanced manufacturing, cybersecurity, and data-driven innovation must first have a solid mathematics base in higher education. Oman Vision 2040 lays out a clear national aspiration: economic diversification through a knowledge-based economy underpinned by technological competence, innovation capacity, and research excellence. The backbone of this transformation is a simple but mighty fact: mathematics is not just another subject; it's the cognitive architecture on which all advanced Science, Technology, Engineering, and Mathematics (STEM) fields are built. AI depends on probability and linear algebra. Statistical reasoning and modeling are the core of data science. Engineering requires abstraction, optimization, and systems thinking. These competencies are not characteristic as they are learned at an early age, so this is the stage when they must be fostered and built into a system that helps students navigate higher education, whether through a diploma or a bachelor's degree. But in too many of our foundation's programs, mathematics continues to be taught as a procedural endeavor, computation and formula application as much as performance on examinations, rather than reasoning, modeling, interpretation, and transferability. If it is to serve its intended role as a strategic gateway to advanced STEM learning, the General Foundation Program (GFP) must shift from content coverage to cognitive empowerment. Failing

to do so comes with significant risks: weak, superficial learning and diminished preparedness for emerging AI- and tech-enhanced programs.

1.1. Research Aim

This study evaluates and strengthens the structural, pedagogical, and cognitive alignment of GFP Mathematics with national and international STEM requirements. The study works through a comprehensive comparative curriculum alignment analysis across three major axes:

i. The existing institutional framework, as defined in the current Course delivery Plan (CDP), and this revised curriculum are a means of developing deeper skill articulation as well as increasing cognitive load.
ii. An international reference model to place the analysis in a global context (Harvard University (HU).
iii. To design, propose, and analyze a STEM readiness mathematical model.

It is not sufficient to merely critique our current framework; we need to re-engineer the foundations of mathematics as a tactical tool for STEM readiness. This study communicates this need by mapping desired learning outcomes, assessment criteria, and requisite skills to globally standardized mathematical competencies, thereby producing verifiable pathways that fortify cognitive foundations, maximize quantitative literacy, and enable a sustainable transition into advanced AI & STEM pathways. In that stream of thought, the paper does not present foundation mathematics as a necessary evil to be endured, but rather as the critical juncture at which the intellectual framework for a country's future STEM is built.

1.2. Research Questions

The current reality raises a pressing institutional and national question:

i. How can GFP be expanded to better prepare students for STEM to provide cognitive preparations for students toward pathways in AI, IT, and Engineering?
ii. How can the current Course Learning Outcomes (CLO) be presented to promote abstraction, modeling, and quantitative reasoning?
iii. How can the current assessment practices be enhanced to measure higher-order thinking or simply procedural accuracy?
iv. How can the offerings provide overarching inclusion of 21st-century skills that connect directly to STEM futures?

In the absence of systematic alignment, the foundation stage could function more like a remedial bridge than a strategic accelerator to prepare students for advanced STEM coursework.

II. REVIEW OF LITERATURE

The literature of this work is reviewed based on three categories:

i. Mathematics as a Gateway Discipline,
ii. 21st-Century Skills in STEM Education, and
iii. Curriculum Mapping as Policy Tool.

"Mathematics is the Queen of all Sciences," Carl Frederic Gauss (2023) have done work in their paper on how mathematics is a basis for STEM Education. Goos et al. (2023) has reviewed 5 years of papers between 2017 and 2022 with conceptual research and suggested to let the students understand how mathematics is a rich source for STEM education, using the associated STEM tasks. "Mathematics is the essential instrument of all physical resources" is a quote by Kant. Zeeshan (2024) has addressed the mathematical achievement gap among students from low-income or poor backgrounds and recommended Adaptive learning techniques for them. (2024) discussed enhancing Students' abilities and skills through STEM-integrated science learning in their work. Their results show that STEM implementation can be integrated with various learning models, such as PjBL, PBL, and Jigsaw. Integrating STEM with media content has proven effective in improving students' abilities and skills. Chen et al. (2023) revealed dispositions of 21st-Century skills in STEM programs and their changes over time through project-based learning in mathematics. Amelia & Santoso (2021) has done work on 21st century skills in project-based learning and integrated STEM in science subjects. AlAli (2024) also discussing the project-based approach, but as a core pedagogical approach. Herianto et al. (2024) has developed students' 21st-century skills through the STEM engineering design learning cycle model, points towards engineering.

Milner-Bolotin & Martinovic (2025) conveyed those creative approaches for 21st-century science, technology, engineering, and mathematics teacher education from theory to practice to policy. In the early stages (2009 to 2014), subjects in science, technology, engineering, and mathematics played a dominant role, and these subjects were considered the core of STEM education. Over time, science subjects such as computer science, the arts, physics, and environmental science were gradually incorporated into the STEM integration pathway, especially in the humanities and social sciences. (Zazkis & Herbst, 2018).

Tan & Kidman (2025) has done work on twenty-first century skills and STEM education, but it is purely based on the Chinese context. Widya et al. (2019) has done work on STEM education to meet the 21st-century demand, revealing that "Most teachers in developing countries know about STEM, have different understandings, but they do not understand how to integrate it into the learning process; teachers need training in adopting STEM." These statements conflict with the teachers' role-play. The organization runs on policies and procedures, and everyone in the organization follows them; hence, if the organization changes its methodology, only the teachers can. Dare et al. (2021) revealed in their findings that, "teachers have varying ideas related to the STEM disciplines within integrated STEM instruction, which could assist teacher educators in preparing high-quality professional development experiences." Research on STEM education, 21st-century skills, project-based learning, and interdisciplinary math thinking was found in the literature, but much of it examines pedagogy, teacher readiness, classroom

use of integrated materials (or broader STEM integration), not curriculum-level readiness. Research on math foundation programs as cognitive gateways for AI, IT, engineering, and data careers is scarce. A readiness model that combines curriculum mapping, Bloom's cognitive levels, assessment alignment, digital math literacy, and STEM transferability does not follow a structured framework. In particular, studies rarely connect Course Learning Outcomes, assessments, graduate attributes, and teaching strategies with STEM readiness at the foundational level. A solution is to use a 10-dimensional STEM Readiness Index approach, as done in this study, with curriculum mapping and a comparative readiness analysis of GFP Mathematics relative to STEM demands, which were missing from past efforts. In the above literature survey, it was observed that the STEM readiness model has not been benchmarked, and the current work addresses this gap. Thus, the gap is not that STEM readiness frameworks do not exist, but rather there is a lack of exemplified mathematics-specific foundation program SRI model with curriculum mapping, Bloom-level analysis, assessment alignment, and digital mathematical literacy and STEM transferability.

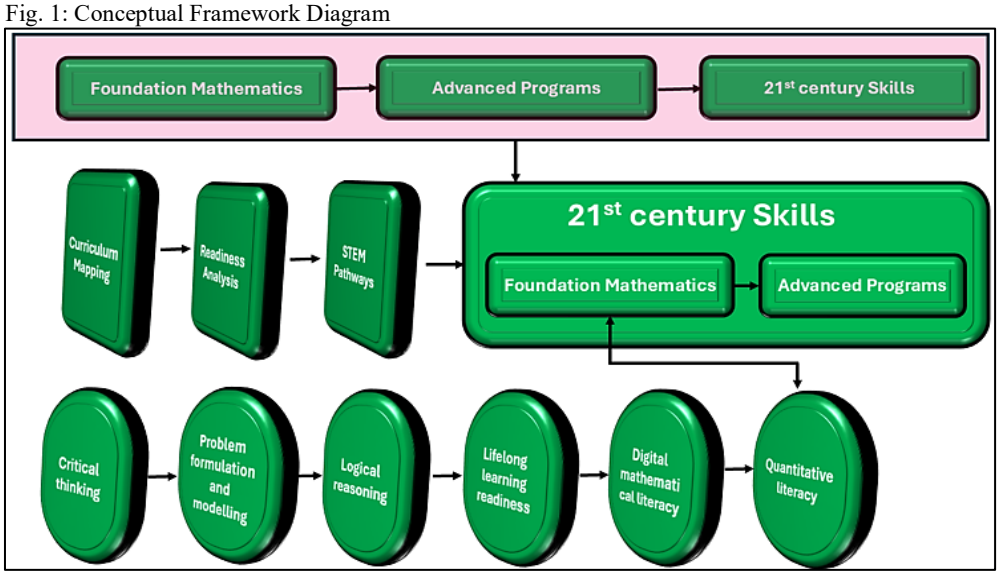
III. METHODOLOGY

This study adopts structured curriculum mapping and comparative alignment design. The data sources for the analysis of the framework consist of

i. Course delivery plan and course description, course outcomes, assessment plan, teaching and learning strategies, and graduate attributes
ii. Institutional alignments
iii. The international benchmark curriculum with Harvard Foundation Mathematics

In *stage 1*, each CLO, assessment component, and instructional activity was extracted and tabulated into a curriculum analysis matrix. Here, HU is chosen for benchmarking and as a convenience sampling method. In *stage 2*, Bloom's Taxonomy classification has been performed. For instance, "Compute probability of simple events" is categorized under "Apply". When multiple actions appeared in a CLO, the dominant cognitive demand was classification. The frequency distribution of the Bloom levels was then converted to percentage representation to compare the current and proposed curriculum structures. In *stage 3*, the STEM Readiness Index (SRI) dimension mapping has been developed. Each dimension was operationalized using observable curriculum indicators. The SRI dimensions are given like reasoning (justify and interpret), modelling (formulate), and statistical depth (Probability, variability). In *Stage 4*, Scoring has been performed with 0 not present, 1 implicit or minimal, 2 explicit but limited, and 3 for central and interpretative. The dimension percentage has been calculated using (total of observed scores / (3*number of relevant CLSs))*100. The weighted score has been calculated using the weighting model. *Stage 5* has been discussing comparative alignment analysis, such as exposure to linear algebra, proof-based reasoning, modelling orientation, etc. The purpose of the benchmarking was not curriculum equivalence but the identification of structural gaps relevant to STEM preparedness.
The Conceptual Framework Diagram is given in Fig 1.

Fig. 1: Conceptual Framework Diagram



The four-axis mapping dimension has been considered in this mapping.

i. CLO depth (Bloom's level),
ii. Skill Integration (21st Century Skill Alignment),
iii. Assessment Type (Procedural Vs Reasoning), and
iv. STEM Transferability (Relevance to AI/IT/STEM).

The proposed work here is document-based, rule-based, and systematically operationalized. Operational scoring transparency and triangulation strengthens this empirical work.

3.1. Stem Readiness Projection Model

The purpose of this STEM readiness projection model is to map the foundation level of skill strength to advanced STEM Stability. A conceptual regression model is introduced to strengthen the modeling exposure that correlates with the reduced fragility in AI-based courses. Here, we are not providing empirical data but rather a conceptual modeling discussion with the 10-Dimensional STEM Readiness Score (SRS_{10}), using Reasoning (R%), Modeling (M%), ASF%, SPD%, FGT%, CDL%, FQL%, DMU%, ACU%, STR%. This explains how foundation skills influence the future STEM stability. The weight model is given by

$$SRS_{10} = \frac{1}{10}(R + M + ASF + SPD + FGT + CDL + FQL + DMU + ACU + STR) \quad (1)$$

An iterative approach was taken across CLOs, assessments, and teaching strategies to improve consistency. SRI scoring decisions and Bloom classifications were based on clear operational indicators, with minimal reliance on interpretive judgment. This cross-verification decreased the inconsistencies in alignment judgments across different curriculum components. Table 1 gives us the sample scoring matrix.

Table 1. Sample Scoring Matrix

CLO	R	M	ASF	SPD	FGT	CDL	FQL	DMU	ACU	STR
Translate worded problems into mathematical expressions and model simple real-life problems	2	3	2	0	1	0	1	1	1	2
Use appropriate software to interpret equations and graphs	2	1	1	0	3	3	0	1	1	3

3.2. Proposed weighted STEM Readiness Score Formula

The proposed weighted STEM Readiness Score formula converts the conceptual framework formula into a measurable index.

$$\text{SRS} = \text{w}_1(\text{Reasoning}) + \text{w}_2(\text{Modelling}) + \text{w}_3(\text{Statistical Depth}) + \text{w}_4(\text{Digital Literacy}) \quad (2)$$

Where w_i These are the associated weights to be determined and dynamic, based on STEM readiness.

3.3. STEM Transferability

The STEM Readiness Index (SRI) - 10-Dimensional Framework has been developed to assess STEM transferability, with a minimum of three CLO indicators.

- Logical & Analytical Reasoning (R) discusses the evidence of higher-order thinking: justify, interpret, analyze, evaluate, explain, prove, and validate conclusions. The CLO indicators can include interpreting solutions, justifying methods, evaluating outcomes, and decision-making language.
- Mathematical Modeling (M) that discusses the ability to translate real-world problems into mathematical structures and interpret solutions contextually. The CLO indicators can include formulating equations, solving real-world problems, applying mathematics to context, and interpreting graphs.
- Algebraic & Symbolic Fluency (ASF) discusses the competence in manipulating algebraic structures symbolically and structurally. The CLO indicators can include factorization, simplification, polynomial manipulation, and functional transformations.
- Statistical & Probabilistic Depth (SPD) discusses the depth of engagement with uncertainty, combinatorics, distributions, and inference. The CLO indicators can include Probability reasoning, permutations and combinations, variability concepts, and statistical interpretation.
- Functional & Graphical Thinking (FGT) discusses the understanding of relationships between variables and interpreting graphical behavior. The CLO indicators can include graph plotting, function identification, trend analysis, and pattern recognition.
- Computational & Digital Literacy (CDL) discusses the explicit integration of software tools and computational reasoning. The CLO Indicators can include Excel, GeoGebra, Desmos, simulation tools, and logical spreadsheet functions.
- Financial & Quantitative Literacy (FQL) discusses the application of mathematics to economic and financial contexts. The CLO indicators can include profit/loss, interest, and practical decision metrics.
- Decision-Making Under Uncertainty (DMU) discusses the ability to evaluate risk and simulate logical outcomes. The CLO indicators can include logical functions, validation, simulation-based reasoning, and contextual interpretation.
- Abstraction & Conceptual Understanding (ACU) discusses the ability to understand definitions, properties, and theoretical relationships. The CLO indicators can include defining real numbers, understanding identities, and conceptual properties.
- STEM Transferability & Interdisciplinary Readiness (STR) discusses the relevance to AI, IT, and engineering pathways. The CLO indicators can include functions linked to modeling, statistical reasoning for data science, computational logic, and analytical reasoning.

Scoring Rubric (0–3) is proposed for each CLO, and each dimension has a score between 0 and 3, meaning that not present, minor/implicit, explicit, and central cum interpretive. The normalized dimension score formula to provide a 0-100 scale for each dimension is given by, if there are n CLOs, then the dimension percentage is given by:

$$\text{Dimension\%} = \frac{\sum_{i=1}^{N} \text{Score_i}}{3n} \times 100. \quad (3)$$

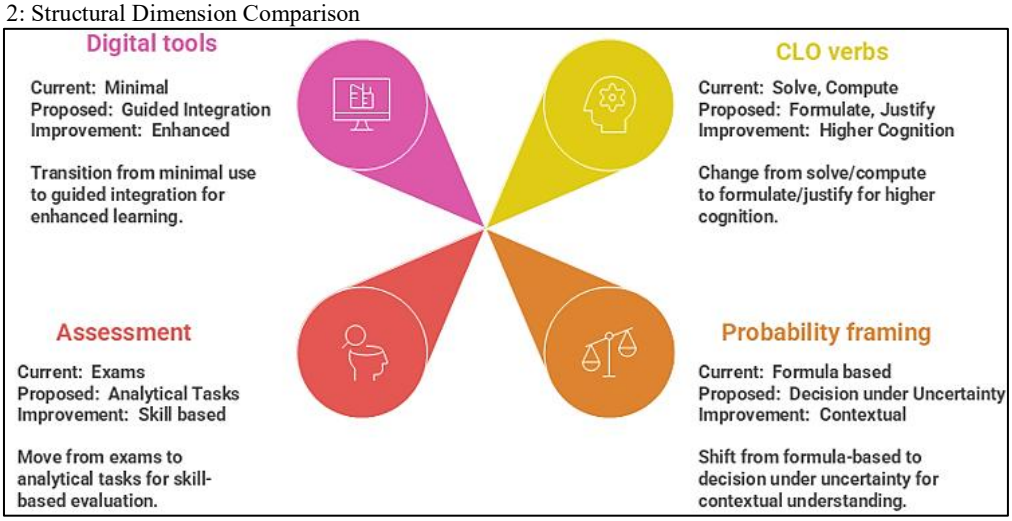
3.3.1. Stem Readiness Projection Model

The weight model is given by

$$\text{SRS}_{10} = \frac{1}{10}(\text{R} + \text{M} + \text{ASF} + \text{SPD} + \text{FGT} + \text{CDL} + \text{FQL} + \text{DMU} + \text{ACU} + \text{STR}) \quad (4)$$

STEM-Strategic Weighted Model based on an assumed Policy can be considered as, R = 0.15 ,M = 0.15, SPD = 0.15, CDL = 0.10, ASF = 0.10, FGT = 0.10, FQL = 0.05, DMU = 0.10, ACU = 0.05, TR =0.05, and SRS_{10} become $SRS_{10} = \sum w_i D_i$.. These values can be modified based on the proposal's curriculum weightage. Hence, in this study, current CLOs are likely strong in ACU and ASF, moderate in FGT, and weak in CDL, FQL, and DMU. Proposed CLOs are likely to be strong in CDL, strong in FQL, strong in modeling, moderate in reasoning, and weaker in SPD (probability depth reduced). The Structural Dimension Comparison is shown in Fig 2.

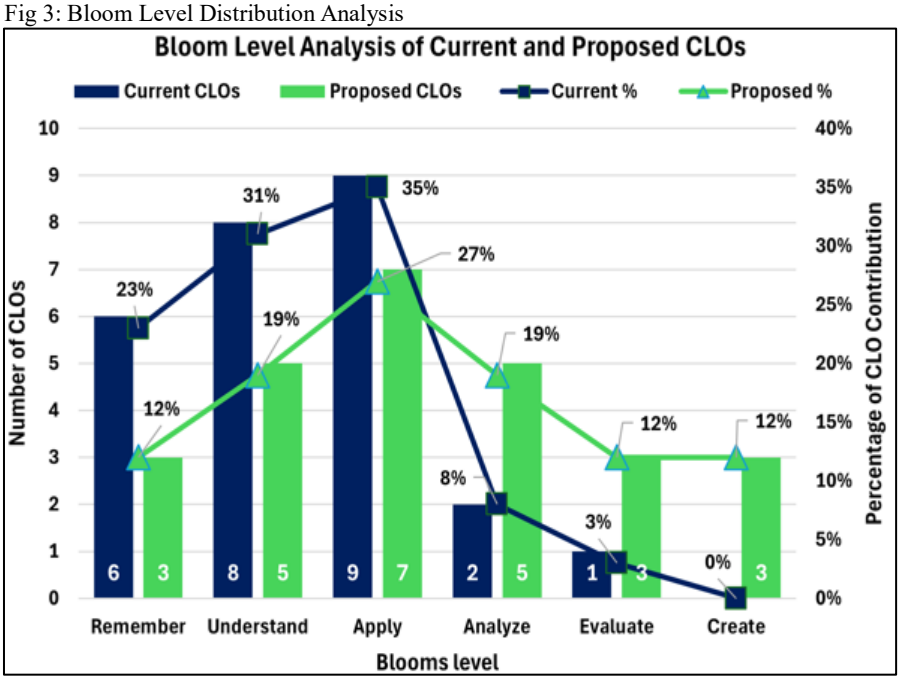
Fig. 2: Structural Dimension Comparison



IV. RESULTS AND DISCUSSION

The alignment quantification is provided in this section. While the proposed CLO framework significantly enhances applied and analytical dimensions, it narrows the breadth of mathematical exposure and reduces theoretical depth in trigonometry and probability. Therefore, the reform must balance cognitive elevation with conceptual robustness. The CLO depth is analyzed using Bloom's level distribution analysis for the current CDP vs. the proposed CDP. Fig 3 presents the distribution of Bloom Levels.

Fig 3: Bloom Level Distribution Analysis



In the existing curriculum, 54% of CLOs are remembered and understood using Bloom's taxonomy, and only 11% involve higher-order cognition (analyze and evaluate). This indicates the current methodology is highly procedural and descriptive. This 11% is inadequate for STEM in the 21st century and needs to be aligned with Oman Vision 2040, as proposed. It interpreted that at least 56% were devoted to applying, but also originated 33%, movement towards contextual and analytical learning with a better real-world leap. In the current GA, it is under communication skills, with moderate strength, as communication is general. It is currently explicit in English; it needs explicit quantitative communication emphasis. It must include mathematical communication, interpretation & explanation to align with 21st-century skills.

In Teamwork and Leadership, the current strength is partial, as the evidence supporting teamwork-based evaluation in the math assessment structure is limited. It has to be through collaborative problem-solving and cross-disciplinary integration.

In Discipline, Knowledge, and Skills, the current alignment is high and is strongly embedded in algebra, functions, trigonometry, and statistics. Quantitative literacy, logical reasoning, and abstract thinking concepts can be incorporated.

In Creativity and Innovation, the current alignment is moderate. Creativity is implicit but not explicitly assessed through open-ended modeling tasks. It has to be with innovation, cognitive flexibility, and mathematical modeling.

In Entrepreneurial Skills, it is limited to direct application to business or real-world quantitative scenarios. Quantitative decision-making, risk awareness, and applied modeling can be incorporated.

In Lifelong Learning, it is moderate; self-study elements are present, but the articulation of metacognitive skills is weak. Self-regulated learning, reflective thinking, and adaptability can be incorporated.

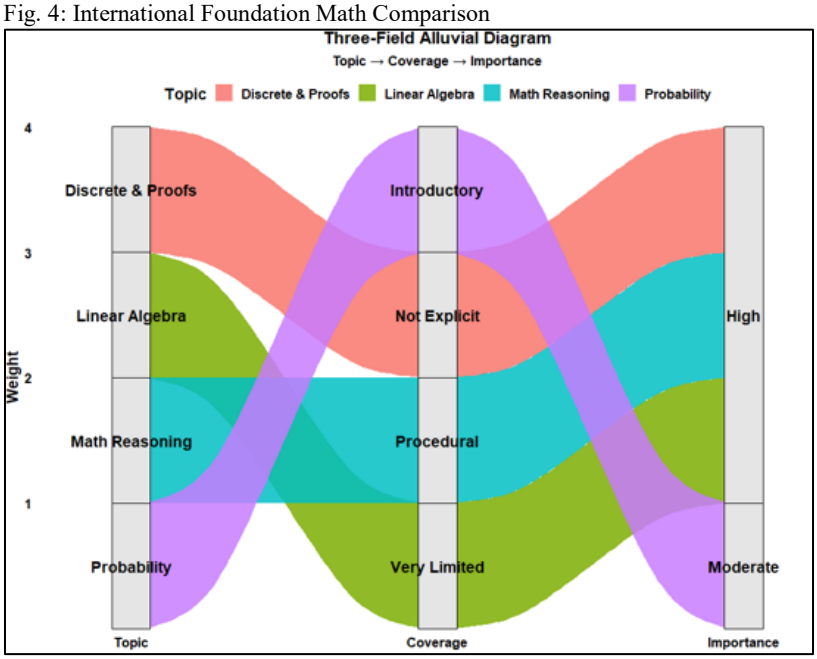
In Technical and Digital Competency, the current alignment is moderate as GeoGebra/Desmos is used. Even though the depth of exploration and analytical work can be strengthened. Digital competency is mostly missing, particularly in mathematics, and it relies on procedural rather than reasoning. Digital and mathematical literacy, as well as visualization literacy, can be enhanced. The scores of skill dimensions are as follows: Communication (2), Teamwork (1), Discipline Knowledge (3), Creativity (2), Entrepreneurial (1), Lifelong Learning (2), Technical & Digital competency (3), and critical thinking (3), leading to a total of 17 out of 24. The overall curriculum alignment percentage has been calculated by

$$\left(\frac{\text{sum of the scores of all dimensions}}{3}\text{*total Number of dimensions evaluated}\right)\text{*}100 = \left(\frac{17}{24}\right)\text{*}100 = 70.83\%$$

The current CDP demonstrates approximately 70% structural alignment with contemporary 21st-century skill expectations. However, alignment remains stronger at the cognitive-content level than at the pedagogical and assessment levels. Teamwork & Leadership are present in the attribute list. But not strongly embedded in the design of mathematics assessment.

Mostly, the assessment deals with individual written tests with the gap type "Assessment-level". In entrepreneurial skills, there is a weak connection to quantitative decision-making, applied modeling, and risk analysis contexts, with the gap type "Application-level". In digital competency, GeoGebra & Desmos are used. But mostly demonstrative, not exploratory or investigative, with the Gap Type "Pedagogical depth". In Creativity & Innovation, procedural dominance in exams with few open-ended modeling tasks has the gap type "Task-design". The HU foundation components are compared with our current CDP components, and the results are presented in Fig. 4, International Foundation Math Comparison.

Fig. 4: International Foundation Math Comparison

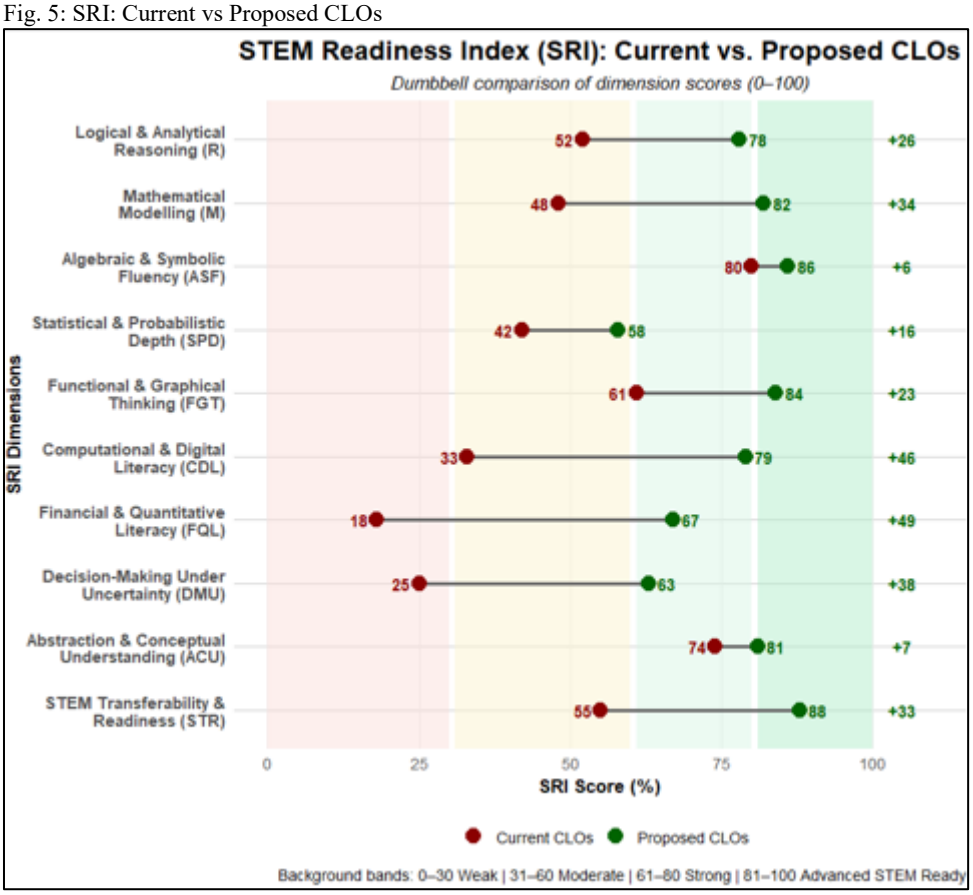


The topics of the HU foundation components are compared with the current CDP under the domain categories: Linear Algebra, Discrete and Proofs, Probability depth, and mathematical reasoning.

Fig. 4 depicts a three-field alluvial diagram relating major domains of mathematics, their current alignment, and their importance for STEM readiness. The left field indicates the identified mathematical domains (Discrete & Proofs, Linear Algebra, Mathematical Reasoning, and Probability), the middle field indicates their level of representation in the current GFP Mathematics curriculum (Introductory, Procedural, Very Limited, and Not Explicit), and the right field indicates their relative

importance for future STEM pathways. The flow widths generally reflect the conceptual importance and transferability of each domain toward AI, IT, engineering, and data-oriented domains, from an overall perspective. The diagram indicates that Discrete & Proof-Based Reasoning and Linear Algebra are considered highly important in STEM, but they are either underrepresented or not explicitly noted in the curriculum at this time. Instead, mathematical reasoning is mostly procedural rather than analytic, and probability is introduced largely at a computational level with little inferential depth. Fig 5: Dumbbell comparison shows the STEM Readiness Index: Current vs. Proposed CLOs. Fig 5 presents SRI: Current vs Proposed CLOs. Even though in Fig. 5 the algebraic and symbolic representations show a very slight improvement from 80 to 86, this has already been incorporated into mathematical modelling (M) in a different way. Hence, such an increment shows a significant improvement in the proposed CLOs.

Fig. 5: SRI: Current vs Proposed CLOs



The 'dumbbell' shows the move from a procedural current CLO structure to a stronger STEM gravity proposed CLO framework. Financial/Quantitative literacy, computational and digital literacy, decision-making under uncertainty, modeling, and STEM transferability are all big winners; applied readiness, digital readiness, and applied interdisciplinary preparedness. But algebraic and symbolic fluency shows a slight decline, indicating that some curriculum reform is needed to equip students at all levels, not just higher, with the "new" STEM skills. The current computer-based platform (CDP) consists of software such as GeoGebra and Desmos, while the framework includes a stronger emphasis on digital math literacy and STEM transferability.

4.1. Limitations

The international benchmarking component used only Harvard University as a convenience sampling model due to the availability of publicly accessible documents. The current work adopts structured curriculum mapping and policy analysis approaches, but does not include empirical learner performance data or STEM progression analysis. The current analysis is limited to only GFP mathematics and may not be applicable to the post-foundation mathematics.

4.2. Suggestions and Recommendations

Spreadsheet-based modeling with mathematics is not yet available. Logical functions & decision modeling can be incorporated. The explicit real-world interpretation sector is Weak at present, and we suggested it is strong. Data summarization, especially with practical tools, is currently basic, but we suggest contextualizing it. Simulation-based reasoning is lacking in the current CLOs; we suggest it could be incorporated. Explicit modeling, simulation-based reasoning, increased quantitative communication skills, and reforming assessment techniques are suggested. If we are doing so, the current skill domain can be strengthened. The Skill Domain Coverage for the current and Proposed CDP is given in Table 2.

Table 2. Skill Domain Coverage

Sl. No.	Skill Domain	Current Coverage	Proposed Coverage
1	Mathematical Modelling	Moderate	Strong

2	Computational Thinking	Minimal	Moderate-Strong
3	Digital Literacy	Very limited	Explicit
4	Financial Numeracy	None	Introduce
5	Decision Analytics	None	Introduce

While the proposed CLO framework significantly enhances applied and analytical dimensions, it narrows the breadth of mathematical exposure and reduces theoretical depth in trigonometry and probability. The integration of IT skills into mathematics is suggested. It is suggested to focus on measurable objectives, real-world scenarios, and computing skills. As standalone IT is already in the school curriculum, it is suggested that it be incorporated into English and Math. A separate chapter or part, called Research skills, is suggested for each chapter. In this, the students will frame the research questions rather than search for answers. Use of the library and research databases such as ProQuest, MEDLINE, Scopus, and Clarivate is suggested. A special assignment may focus on collecting the data from the available databases. Therefore, the reform must balance cognitive elevation with conceptual robustness. This works only with structured curriculum mapping and official documents such as CLOs, assessments, graduate attributes, and teaching strategies, using either student-level data or statistical testing. Predefined Bloom-level indicators for each and rubric-based criteria of SRI were used throughout mapping, minimizing bias. It was based on evidence found within the curriculum. Aspects of their impact potentially include policy analysis and alignment to curriculum, not the evaluation of learner performance. In the future, the current work might leverage large-scale empirical validation across multiple frameworks, reliability analysis in conjunction with student data, and predictive statistical modeling of STEM outcomes.

V. CONCLUSION

The current work is to realign the few remaining curricula with Oman Vision 2040, reduce STEM Attrition Risk, and prepare the youth for AI & Data Science. In this study of General Foundation Mathematics, we regard it as a form of strategic thinking in the cognitive infrastructure; it is not simply a bridge between vocational and high-school mathematics. This framework evaluates the GFP Mathematics CDP through curriculum mapping, Bloom's taxonomy referencing, graduate attribute positioning, and course learning outcome-based SRI scoring. This SRI scoring has aided in identifying critical information that indicates positive gaps in divided reasoning, modeling, digital literacy, or higher-order cognitive skills. The proposed work compares the curriculum to that of other institutions, specifically benchmarking against Harvard's math pathways, including exposure to linear algebra, probability, and discrete math, as well as proof-based reasoning and preparation for STEM. The research also elaborates a 10-dimensional rubric, scored and weighted 10-point STEM Readiness Index SRI. SRI measures the extent to which foundation mathematics supports readiness for AI, IT, engineering, and other advanced STEM fields. Cognitive preparations for pathways in AI, IT, and Engineering, ways to present current CLO to promote abstraction, modeling, and quantitative reasoning, enhancements to current assessment practices to measure higher-order thinking, and the overarching inclusion of 21st-century skills that connect directly to STEM futures were discussed in this work. The ten-dimensional STEM Readiness framework knits together CLOs, assessment practices, pedagogy, and international benchmarks. The main success of current education theories is the 70% structural alignment with 21st-century STEM competencies. However, there is insufficient attention to knowledge of application and mainly mechanical skill training. At the same time, one can see an imbalance in development (Bloom's taxonomy). Analysis, evaluation, and creation are currently underemphasized. Mathematical modeling, statistical inference, and digital literacy in school practices all create barriers to entry. As a category, the teaching of college mathematics has deficiencies in proof-based reasoning, discrete mathematics, and early exposure to linear algebra. However, digital tools are largely demonstrations with no room for experimentation - other than learning for learning's sake. The result indicates that instructors can shift the curriculum design orientation towards cognition, grounded in modeling, abstraction, and real-world problem-solving. It also asks for assessment paradigms that reflect higher-order thinking, as well as designs in digital exploration and interdisciplinary applications that will aid its transmission to STEM transfer markets. Future work might include empirical validation of this framework, tracking STEM development, and building models for adaptive learning. Future studies of this framework include multiple institutional comparisons and empirical statistical modeling to strengthen external validity.

DECLARATION

Ethical Statement

The analysis included only documents used in officially approved course delivery plans, learning outcomes, assessment structures, and academic frameworks. As no human participants, personal data, or student records were involved, formal ethical clearance was not appropriate. The study focused on curriculum evaluation and included both academic and policy-oriented organizations, ensuring institutional integrity.

REFERENCES

AlAli, R. (2024). Enhancing 21st century skills through integrated STEM education using project-oriented problem-based learning. GeoJournal of Tourism and Geosites, 53(2), 421–430. https://doi.org/10.30892/gtg.53205-1217

Amelia, R., & Santoso, S. T. P. (2021). 21 century skills in project based learning integrated STEM on science subject: A systematic literature review. International Conference on Engineering, Technology and Social Science (ICONETOS 2020). https://doi.org/10.2991/assehr.k.210421.085

Chen, S.-K., Yang, Y.-T. C., Lin, C., & Lin, S. S. J. (2023). Dispositions of 21st-century skills in STEM programs and their changes over time. International Journal of Science and Mathematics Education, 21(4), 1363–1380. https://doi.org/10.1007/s10763-022-10288-0

Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. Education Sciences, 11(11), 737. https://doi.org/10.3390/educsci11110737

Goos, M., Carreira, S., & Namukasa, I. K. (2023). Mathematics and interdisciplinary STEM education: Recent developments and future directions. ZDM–Mathematics Education, 55(7), 1199–1217. https://doi.org/10.1007/s11858-023-01533-z

Herianto, Ikhsan, J., & Purwastuti, L. A. (2024). Developing student 21st-century skills through STEM engineering design learning cycle (STEM-EDELCY) model. The Journal of Educational Research, 117(3), 137–150. https://doi.org/10.1080/00220671.2024.2346659

Milner-Bolotin, M., & Martinovic, D. (2025). Creative approaches for 21st-century science, technology, engineering, and mathematics teacher education: From theory to practice to policy. Future in Educational Research, 3(1), 5–12. https://doi.org/10.1002/fer3.70

Ningtyas, P. K., Widarti, H. R., Parlan, P., Rahayu, S., & Dasna, I. W. (2024). Enhancing students' abilities and skills through science learning integrated STEM: A systematic literature review. International Journal of Education in Mathematics, Science and Technology, 12(5), 1161–1181. https://doi.org/10.46328/ijemst.4292

Tan, H., & Kidman, G. (2025). Twenty-first century skills and STEM education: A review of literature. In G. Kidman, H. Tan, R. Gesthuizen, & D. D. Mangao, Knowledge generation in STEM and STEAM education (pp. 127–173). Springer Nature Switzerland. https://doi.org/10.1007/978-3-032-03247-8_5

Thanheiser, E. (2023). What is the mathematics in mathematics education? The Journal of Mathematical Behavior, 70, 101033. https://doi.org/10.1016/j.jmathb.2023.101033

Widya, Rifandi, R., & Laila Rahmi, Y. (2019). STEM education to fulfil the 21st century demand: A literature review. Journal of Physics: Conference Series, 1317(1), 012208. https://doi.org/10.1088/1742-6596/1317/1/012208

Zazkis, R., & Herbst, P. (Eds.). (2018). Scripting approaches in mathematics education: Mathematical dialogues in research and practice. Springer International Publishing. https://doi.org/10.1007/978-3-319-62692-5

Zeeshan, S. (2024). Bridging the mathematics achievement gap: Innovative approaches to teaching mathematics in underserved communities. International Journal of Mathematics and Statistics Studies, 12(5), 1–10. https://doi.org/10.37745/ijmss.13/vol12n5110