JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

INNOVATIVE INSTRUCTIONAL STRATEGIES FOR ADDRESSING MATHEMATICS PHOBIA IN SECONDARY EDUCATION

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Abstract: The issue of mathematics phobia still poses a challenge on the self-esteem, performance, and overall participation of the students in the subject especially in the secondary school-going world. In the current paper, the author examines the ways that innovative pedagogical practices can help turn mathematics education into an experience that inspires curiosity, develops resilience and builds emotional security. It relies on the recent academic and institutional literature to discuss nine interconnected strategies: Inquiry-Based Learning (IBL), Problem Based Learning (PBL), Flipped Classroom, Gamification, Collaborative Learning, Storytelling and Contextualization, Growth Mindset Pedagogy, Technology Integration, and Arts Integration. All of these strategies help deal with mathematics phobia on cognitive, affective, and social levels to make students perceive mathematics not as an abstract feeling of intimidation but as something creative and approachable, and human. The paper draws attention to the role of inquiry and problem-solving to foster autonomy and thinking, narrative and growth mindset as approaches to develop emotional strength, and technology, gamification, and the arts as techniques to engage and include. The integrative discussion emphasizes that there is a need to have coherent integrative instructional ecosystems in which such practices are synergistically used to foster confidence, collaboration and meaning through learning in mathematics. It is recommended to improve teacher professional development, reforms in assessment which are inclusive and system-wide support that appreciate well-being, as well as achievement. Finally, the mathematics phobia needs to be eradicated through the act of empathy, innovation, and humanisation of mathematics education that enable the learners to discover joy and identity in the subject.

Index Terms- Mathematics phobia, Innovative pedagogy, Inquiry-based learning, Growth mindset, Gamification, Arts integration

INTRODUCTION

Mathematics has been an essential subject in formal schooling, as the of basis of logical thinking, science, and technology. It also prepares students with critical and analytical thinking skills that are imperative to a more data-driven world. Nevertheless, in the case of many students, especially in the secondary school level, mathematics is not the source of empowerment and distress as well as avoidance. This is usually called mathematics phobia, experience as a debilitating fear of dealing with mathematical material that is usually intense and can severely compromise student confidence and performance despite decades of curriculum change and pedagogical discovery. International tests, including the Programme for International Student Assessment (PISA), show that a substantial percentage of adolescent's express anxiety, tension, or helplessness undermining the indication of mathematical assignments, and such emotional traits have a damaging relationship with level of accomplishment (Organisation for Economic Co-operation and Development [OECD], 2023). It is because of this trend that pedagogical strategies which take cognition and the affective aspects of learning mathematics are highly demanded.

Mathematics phobia which is also a similar term with mathematics anxiety is actually a complex of emotional, physiological, and cognitive reactions obstructing the ability of a person to interact positively with mathematical problems. The most common symptoms associated with this phobia that students are likely to report include panic, confusion, avoidance towards mathematical situations, and the latter triggers a self-reinforcing cycle of fear and poor performance (Weir, 2023). Moderate and significant negative correlations of mathematics anxiety with mathematics performance have always been statistically verified in meta-analytic studies at both age groups and cross-cultural settings (Barroso et al., 2021; Zhang et al., 2019). This implies that the issue goes beyond the dispositions of the individual to include systemic aspects in the teaching and learning environment that compound or mitigates these feelings. Being used to fear and anxiety towards mathematics makes them act as restriction to student involvement, less efficient working memory, and eventually prevent conceptual learning (Barroso et al., 2021).

This is an important sensitive phase that occurs during the secondary school days. This is the time where students learn to think, reason, and comprehend more intricate mathematical ideas, more complex and initial career choice choices are made. Research has shown that mathematics anxiety is likely to be heightened at this time because of increased academic expectations, a perception of greater student comparison, and formalization of assessment procedures (Zhang et al., 2019). In turn, it means that there is an urgent need to address interventions in the conduction of the affective climate in the mathematics classes on the secondary level. When not addressed, mathematics phobia may cause permanent avoidance of mathematics courses and other mathematics-related careers, thus cutting down the ability of students to engage in science, technology, engineering, and mathematics (STEM) disciplines; disciplines that are becoming crucial in global competitiveness and innovation.

Pedagogy is one of the key factors linked to mathematics phobia and can be modified in relation to other contributors. Older traditional methods that are teacher-centered with rote memories, focusing on procedures, and high stakes assessment tend to uphold fear instead of iniquitous and knowledge. Compared to traditional pedagogies that focus on memorization and repetition, the student-centered approach to pedagogy that would allow exploration, collaboration, and meaning-making can establish psychologically safe learning conditions in which mistakes are seen as the opportunities to develop instead of a sign of incompetence (Ramirez et al., 2018). In fact, it has been found out that the instructions given by the teachers and the way in which the teacher personally feels about mathematics affect the emotional attitudes held by a student towards mathematics. Anxiety, or the perpetuation of strict performance expectations, on the part of the teachers can unintentionally become negative affect and instructors who practice empathic and flexible pedagogies have the potential to create resilience and confidence (Ramirez et al., 2018).

Treatment of mathematics phobia thus entails defining a new pedagogy using cognition and emotion to conceptualize the situation. The modern teaching theorists have been in favor of creative learner-based modalities of teaching where the involvement, pertinence and connection component into the teaching of math are merged. These are Inquiry-Based Learning (IBL), Problem-Based Learning (PBL), Flipped Classroom Model, Gamification, Collaborative Learning, Storytelling and Contextualization, Growth Mindset Pedagogy, Technology Integration and Arts Integration. Altogether, these strategies coincide with the overall movement in the direction of constructivist and humanistic education paradigms, in which learning is viewed as an active, social, and emotionally situated phenomena. Such pedagogies when applied in an effective way may help to demystify mathematics, which is then a student-friendly, enjoyable, and personally significant subject since students may otherwise turn off because of fear or frustration.

This paper is aimed on a conceptual and analytic point discussing how these innovative pedagogic practices could help in alleviating mathematics phobia among students in secondary schools. The paper does not involve any empirical data collection practise, and synthesizes available academic materials and learning experience to emphasize how both methods can positively influence the formation of the attitudes, confidence, and self-motivation to mathematics. In addition, it discusses how these strategies can be coordinated in the classroom events to make mathematics learning a curious, creative, and empowering space. By turning the paradigm of mathematics teaching into a giver-oriented and response-oriented approach, teachers will not only eliminate fear but also the feeling of ability and interest that is at the core of mathematical thinking.

UNDERSTANDING MATHEMATICS PHOBIA

Mathematics phobia is another form of emotional and cognitive obstacle to effective learning in the secondary school. Although it is frequently combined in meaning with mathematics anxiety, mathematics phobia is connotatively a stronger, unreasoned and crippling fear that will interfere with the ability of the learners to participate in mathematical tasks in a meaningful manner. This is not just a case of not liking maths, it is a whole response at an emotional level, which may be triggered by not liking maths at all and developing avoidance, lack of self-efficacy and even physical aversion. These fear-provoking reactions deceive the students in their attitude toward their own potential and weaken their readiness to keep trying in case of difficulties (Ashcraft and Moore, 2022).

Mathematics phobia can only be described as an affective disorder in that it has multifaceted nature in the sense that it involves emotional, cognitive and behavioural aspects. Student emotionally can feel tense or nervous or even panicked when exposing themselves to mathematical materials. Intrusive negative thoughts concerning possible failure or shame have a tendency to interfere with working memory and concentration, thus decreasing performance cognitively (Carey et al., 2016). This phobia is behavioural by nature as students may avoid classes, avoid tasks and in assignments, opt out positions that do not involve mathematics as much as possible. It is a triadic model consisting of emotional, cognitive, and behavioural components, and it can be expanded to the modern definition of math anxiety in the psychological literature (Dowker et al., 2016). Anxiety may be more situational and dependent on the level of difficulty, mathematics phobia is persistent, disseminated and less prone to change without deliberate attempts at pedagogic intervention.

CAUSES OF MATHEMATICS PHOBIA

Mathematics phobia has historical origins that are multifaceted in nature and comprise of pedagogical, psychological, and sociocultural factors. Pedagogically, because of the variety of teaching methods that focus on speed, memorization, and accuracy rather than the comprehension of the concepts, fear can be unintentionally developed. The students tend to develop the observation that mathematics is the field of highly talented people and this oddity is strengthened by the teacher attitudes and classroom cultures that penalize the student instead of using the learning opportunities presented by the mistakes (Ramirez et al., 2018).

Individually, they have demonstrated that the vulnerability to math anxiety in terms of psychological factors is predicted by individual discrepancies in working memory, self-efficacy, and perfectionism (Carey et al., 2016). It is particularly vulnerable to learners whose academic self-concept is weak or who have had a history of failure. Parental and societal expectations are also an important factor socially. Fathers and mothers with anxiety regarding mathematics or an excessively strong focus on the final results of the study transfer these anxiety feelings to children, forming the trends of intergenerational math avoidance (Maloney et al., 2015). Sexism even exacerbates the problem since research has shown that girls tend to record a greater degree of mathematics anxiety despite the same level of performance, which is largely due to the cultural discourses which actively dishearten female participation in numbers (Gunderson et al., 2012).

Assessment culture is another important element. Such testing settings that are stakes-based and reward quickness and accuracy have the potential to induce performance anxiety and evaluative fear, and result in anxiety that compromises true knowledge. The outcome is a cyclical process where anxious learners perform poorly, and being poor results in affirming their belief that they are unable to do math, which starts avoidance behavior further (Ashcraft and Moore, 2022).

CONSEQUENCES OF MATHEMATICS PHOBIA

Mathematics phobia has much more lasting impacts than what can be seen in short-term classroom performance. It destroys confidence emotionally and contributes to the greater stress in the academic domain, and cognitively decreases working memory space which is a critical part of mathematical thinking (Carey et al., 2016). In the long term, the result of this is the increase in the disparity between potential and performance. Math phobia in the society restricts STEM occupation, which curtails diversity in the workforce and innovation capabilities in the future (OECD, 2023). Students with a history of math anxiety are less likely to have taken or declared more math classes and more likely to avoid university programs which demand quantitative skills (Barroso et al., 2021). There are especially worrying implications in an internationalized economy where mathematical literacy is the backbone of informed citizenship and marketability.

NEED FOR PEDAGOGICAL INNOVATION

On witnessing its extensive effects, mathematics phobia is more than a mere matter of remedials tutoring or test preparation because it necessitates the rethinking of the ways mathematics has been thought of and practiced. A way to recover the feeling of agency and curiosity in the students would be to provide them with pedagogical innovation. Inquiry-based learning, problem-based learning, and collaborative exploration are learner-centered techniques that create psychologically safe learning spaces and normalize learning struggle and celebrate learning discovery. Such pedagogies step around the sense of alienation and fear which typically come with standard teaching by refusing to treat errors as failures and by linking the abstract subject of mathematics to concrete situations in the real world (Boaler, 2022). Making mathematics instruction a non-elitist, affectively disposed, and non-objective activity is thus not only a pedagogical ideal, but it is also a moral obligation towards contributing to the establishment of equitable and lifelong access to the domain of quantitative reasoning.

INNOVATIVE PEDAGOGICAL PRACTICES FOR REDUCING MATHEMATICS PHOBIA

INQUIRY-BASED LEARNING (IBL)

Inquiry-Based Learning prefigures the inquiry of students as well as their arguments and investigations instead of teacher exposition. In mathematics, IBL encourages learners to observe patterns, make conjectures, put their ideas to the test, and polish the arguments; the same activities mathematicians engage in. A meta-analysis and systematic review of inquiry-based methods in STEM have demonstrated consistent benefits in the areas of engagement, higher-order thinking, and conceptual knowledge with instructional scaffolding on student inquiry (Antonio et al., 2024).

The IBL way of minimizing mathematics phobia is mostly more affective and cognitive. To begin with, questioning restates mathematics as a discovery science rather than a litmus test of talent; this lessens the point of assessment that sends anxiety. Second, IBL can restore working memory resources that would otherwise be prevalent in worry (scaffolded conjecturing and low stakes sharing) by enabling the process of sense-making and providing opportunities to achieve gradual success (Barroso et al., 2020). By allowing students to reframe the concept of struggle as not threatening but productive, these changes towards autonomy, curiosity, and mastery support students to achieve mastery.

Classroom example: An algebra unit in the secondary level opens with a mystery (e.g. a progression of numerical shapes). Groups of students formulate hypotheses, experiment with them with numerical and graphical means, and prove or refute hypotheses. The purpose of the teacher is not to correct mistakes, but to pose probing questions, give specific cues and applaud the new reasoning.

Practical implications: IBL needs to be heavily scaffolded (question prompts, entry-level tasks) and processally scored (explain reasoning, reflect on strategy). Teachers may need professional learning to design inquiry sequences and to manage time. Where teachers lack time, short micros-inquiry tasks (10–20 minutes) can still yield affective benefits by normalizing questioning and low-stakes error.

PROBLEM-BASED LEARNING (PBL)

Problem-Based Learning presents students with authentic, often multidisciplinary problems that require mathematical tools to analyse and solve. In contrast to standard exercises, PBL problems are ill structured and reflect the complexity of the real world; learners have to define subproblems and choose mathematical models and repetitions to find solutions. PBL studies in mathematics and other areas have positive effects on motivation and learning transfer and perceived relevance of mathematics, which is a very important property, and this feature is closely associated with lowered avoidance and anxiety (Kho, 2024; Diego-Mantecón et al., 2021).

Reducing phobia mechanisms such as relevance (makes math meaningful), collaborative problem solving (lowers threats associated with shared responsibility), normalizing productive struggle (iterative problem solving reframes failed first attempts as progress made), and productive struggle as normal (iterative problem solving reframes failed first attempt as progress made) have been proposed. When students observe the usefulness of mathematics in finding a solution to a problem they are interested in, the emotional valence of the subject usually becomes useful as opposed to threatening. In addition, the presence of working memory and a shared cognitive burden is maintained through working in groups or using scaffold rubrics.

Classroom example: A unit on statistics frames a local community question (e.g., analyzing water usage patterns). Students gather publicly available data (or use pre-prepared datasets), design surveys, perform analyses, and present recommendations. Assessment values argumentation, modelling choices, and iterative refinement.

Practical implications: PBL requires thoughtful design (authenticity vs. curricular goals), resources on lifelong learning, and rubrics that are process and reasoning-focused. Scaffolding of metacognitive reflection should be done in a way that students are taught to keep a check on the frustration level and reframe it as a part of the problem-solving process.

FLIPPED CLASSROOM

The Flipped Classroom reverses the established order with the students initially experiencing content (excluding books, long videos, readings, simulations) outside of the classroom before allotting classroom time to valuable practice, problem solving and formative feedback. Recent empirical research in mathematics education demonstrates that guided implementation of the flipped model has the potential to boost engagement and decrease the level of anxiety by allowing students to control pacing and spending classroom time on supportive and interactive tasks (Staddon et al., 2022; Egara-Okaro et al., 2024).

Math phobia is reduced by flipping in various ways. New content demystified in the pre-reading materials de-intellectualizes the new material and eliminates the fear of being lost the moment one steps into a lesson; students are able to put on hold, re-view and go into a lesson with a partial understanding. The classroom time is transformed into the space of collaborative sense-making and scaffolding of the teacher when all questions are normalized, and immediate corrective feedback eliminates the development of anxieties. Differentiation support can also be achieved by the use of this model because teachers are able to provide specific sets of problems to small groups depending on readiness.

Classroom example: As part of a unit on trigonometry, students are requested to watch short screencast lessons on the concepts of unit circles as homework. They do problem stations in the classroom, which are structured, with each having a different point of entry and with the facilitator prompts; the teacher is there to coach them instead of give lectures.

Practical implication: The issue of equity is also relevant because the students without proper devices or the network should have access to school computers or other resources. Cognitive principles should be followed in the video design (rupted segments, worked examples). Importantly, the presence of accountability structures (low-stakes quizzes or reflective tasks) promotes the preparation before the class, without having punitive contexts.

GAMIFICATION

Gamification incorporates the features of a game (goals, points, levels, narrative quests) into the instruction without transforming the curriculum into an entertainment product. Educational gamification reviews describe the positive effect on motivation, persistence, and affect, especially when the review depicts a scenario of disengaged students (Ratinho et al., 2023; Zainuddin, 2020). Gamified activities in mathematics may replace mindless practice with a series of challenges with hooks for incremental gains and development of a feeling of skill.

Gamification lowers the phobia by redefining failure, as well as constructing successive, attainable challenges. Learners will have more incentives to fight through early difficulty when errors result in in-game feedback, new attempts, and visible progress (levels or badges). Connectedness can be encouraged with social features (leaderboards that are carefully designed to focus on personal best or team points) and not crippling competition. Also, gamification tends to implement narrative and feedback; two design attributes that reduce anxiety and keep the audience engaged.

Classroom example: a semester-long math quest, in which students can receive badges to achieve mastery of groups of skills (algebraic manipulation, problem modelling). There are collaborative boss-problems, which can only be solved through teamwork and cumulative knowledge; defeat in a boss incurs an arranged contemplation and further training as opposed to embarrassment before others.

Practical implications: Intrinsic value (mastery, autonomy) needs to be supported with game mechanics, but designers should not over rely resort to extrinsic rewards. Gradually scaffold competition and make sure that badges are indicative of purposeful learning.

COLLABORATIVE LEARNING

Collaborative learning structured peer interaction for shared problem solving; has a long evidence base showing benefits for achievement, reasoning, and positive attitudes (Kyndt et al., 2013; Ridwan et al., 2022). Structures such as cooperative ones (jigsaw, think-pair-share, reciprocal teaching) make students explain, justify, and criticize solutions; these activities strengthen conceptual knowledge and share cognitive load.

Collaborative learning reduces phobia by creating social support and normalizing uncertainty. When peers articulate reasoning, they demystify mathematics language; seeing classmates struggle and recover produces normative expectations that struggle is typical and surmountable. Peer explanations often use more accessible language, which reduces the fear of incomprehension and the shame associated with asking basic questions. Also, shared responsibility helps decrease spotlight effect which multiplies anxiety in the process of cold-call answering.

Classroom example: In geometry, students work in mixed-ability trios where each member is responsible for one aspect of a proof (diagram reasoning, algebraic manipulation, written justification). Groups take turns and each student exercises several ways of explanation.

Practical suggestions: Collaborative learning needs some meticulous groupings strategies, distinct roles, and measures of accountability (individual reflection records or brief individual quizzes) to facilitate an equal part. Teachers' ought to educate teamwork skills in a direct manner (active listening, turn taking, constructive critique).

STORYTELLING & CONTEXTUALIZATION

Having mathematics within the context of stories and purposeful situations makes the abstract concepts more human and closer to the students' real-life contexts. Math classes are a good place to use digital and analog storytelling to enhance interest and retention of concepts related to the narrative structure (Nigro, 2022). Culturally relevant problems are story contexts, historical vignettes or narrative data situations that convert decontextualized symbols into situational understanding tools in mathematics that students are interested in.

Storytelling can be used to overcome phobia because emotional framing of mathematics by students brought over to narratives incites curiosity and empathy, which reduce threat appraisal. Cognitive indexing is also aided by the contextualization since students can remember mathematical procedures more easily when there is a memorable situation. Notably, stories allow a variety of entry points into a problem (visual, verbal, quantitative), and students with varying strengths can make their contributions, and fear of failure by any of the modalities diminishes.

Classroom example: Introduce the value of linear functions using the story of a small-business owner that is keeping a financial record on the growth of revenue and expenditure, learners are modeling break-even points, scenario predictions, and creating suggestions on the pricing models.

Practical considerations: It may need a lot of time to develop authentic stories. Teachers' ought to match stories in the standards of the curriculum and the job in the story, scaffold instructions both to a variety of learners. Existence based on cultural stories facilitates relevance and inclusion.

GROWTH MINDSET PEDAGOGY

Growth mindset pedagogy teaches students that intelligence and mathematical ability develop through effort, strategy, and feedback (Dweck). Large-scale interventions and meta-reviews show that mindset messages and supports can improve persistence and, in some contexts, achievement specially for students facing academic adversity (Yeager et al., 2019; Dong et al., 2023). Importantly, growth-oriented climates change how students interpret mistakes (as information rather than proof of fixed inability), a shift which is critical in reducing phobic reactions.

Mechanisms for reducing phobia include altering attributions (failure into strategy gap), increasing willingness to take on challenges, and creating norms that praise process over innate talent. Combined with concrete strategies (error analysis routines, reflective journal, teacher language scripts), growth mindset pedagogy does not provide empty platitudes, but instead, it operationalizes the aspect of resilience-building.

Classroom example: The teacher conducts the assessments and based on them, structures the error analysis sessions during which students recognize sources of misconceptions, suggest changes in the strategies, and develop small growth objectives. The teacher models growth language ("You haven't mastered this *yet*") and training in study strategies.

Practical considerations: Mindset messages alone are insufficient; they must pair with supports (effective instruction, feedback systems). There are known boundary conditions where the effects are strongest for students facing obstacles and so interventions should be targeted and accompanied by structural support.

TECHNOLOGY INTEGRATION

The abstract structures can be made visible using technology dynamic geometry software, adaptive practice platforms, simulations, and virtual manipulatives to give quick and immediate feedback. Research shows that well-placed technology contributes to the conceptual learning and interaction especially where the tools can allow exploration, but not just drill (Schukajlow et al., 2023). Interactive visualizations can also ease the cognitive load associated with providing representations (graphs, linked algebraic forms) that assist students to formulate mental representations with reduced anxiety.

The use of technology minimizes phobia it does so by visualization, instant feedback and experimentation being safe. For example, dynamic geometry environments let students manipulate constructions and immediately see invariant properties, turning static proofs into exploratory play. Adaptive systems can give individualized practice at the correct difficulty level, minimizing repeated failure and maintaining flow. When implemented with teacher facilitation, technology becomes a partner that amplifies agency and reduces the fear of public error.

Classroom: The student learns transformations of functions with GeoGebra applets sliders Real-time update graphs; the students are asked how changing the parameters of the shapes will change their shape and how they think these changes will work before they are proven to be true.

Real-life implications: There has to be a solution to digital disparity and inequity in access. The ability to choose and arrange high quality tools by teachers is also a crucial factor; technology must be pedagogically guided instead of gadget-centered.

ARTS INTEGRATION

Arts Integration (also known as part of STEAM models) relies on artistic creation such as visual art, music, drama, movement to comprehend mathematical concepts. There are systematic reviews of STEAM/arts-integration, which propose a positive impact on the engagement, social-emotional learning, and student confidence, but their outcomes are mixed, and the quality depends on whether the integration is authentic or a tokenistic addition (2023; Weyer et al., 2022). Tasks that mathematics students solve and create together with artwork (e.g., tessellations design, rhythm patterns related to modular arithmetic) prompt students to be creative and multi-modal in their responses.

Arts integration alleviates phobia as it implies focus on being right but instead of being right, it should focus on exploration and aesthetic judgment. Tasks done in arts are open to a variety of solutions and appreciate process and so the error is not as threatening. Besides, the availability of the arts experiences could increase student feelings of competence and belonging, which negatives avoidance. In providing non-verbal modes of the expression of mathematical concepts, arts open up alternative ways of thinking to students who otherwise might suffer an anxiety-induced block in the strictly symbolic environment.

Classroom case: A unit on symmetry in geometry ends with a project-based assignment in which students design a piece of textile or a mural, with mathematical constraints of reflection and orders of rotation being applied to the composition; evaluation should consider mathematical explanation and reflection on design.

Pragmatics: STEAM work demands that teachers work together across departments and take time to integrate their planning. Assessment must reflect their mathematical as well as their arts reasoning; the assessment through professional development may assist teachers in creating the real interdisciplinary tasks.

DISCUSSION

The problem of mathematics phobia is something that has been experienced over time and restricts the level of confidence and participation by a student. It is not merely a mental problem, but an emotional and societal experience that is influenced by the classroom culture and ideas on aptitude (Barroso et al., 2021). All the innovative pedagogical practices discussed in this paper provide a multi-dimensional framework to address such an issue by fostering a culture of curiosity, resilience, and belonging in mathematics learning.

Problem-Based and Inquiry-Based Learning makes the classroom a community of discovery, in which errors are not perceived as failures but as an extension of the discovery process (Diego-Mantecon et al., 2021). This is also facilitated by the Flipped Classroom as the students are given the opportunity to learn both individually and through problem solving as a group, as well as through one-on-one attention during the classroom time (Staddon, 2022). Such changes to the teacher-centered towards the learner-centered approach facilitate autonomy and psychological safety as one of the major factors in minimizing math anxiety (Yeager et al., 2019).

With this cognitive emphasis, the Growth Mindset Pedagogy and Storytelling are used to make mathematics more humanized, busting the myth about math talent and relating concepts to life (Dong et al., 2023; Nigro, 2022). Teamwork, motivation, and feeling of shared success can be facilitated in Collaborative Learning and Gamification and enhance the social aspect (Kyndt et al., 2013; Ratinho and Martins, 2023). By the time students gain more experience with mathematics, Technology and Arts Integration expands their experience into visualization, creativity, and aesthetic pleasure and generates less fear and more engagement (Weyer and Dell'Erba, 2022).

These approaches alone do not create true transformation, but synergy and teacher support should be sustained. When pedagogy, assessment, and professional learning in schools are joined on a principle of inclusiveness and curiosity, mathematics to be no longer a cause of fear but an option to empowerment. Incorporating inquisitiveness, creativity, and empathy, the teachers can make students realize mathematics as a form of expression, as a human endeavour, and themselves as mathematical thinkers.

CONCLUSION

Mathematics phobia has been recorded as one of the most chronic challenges of academic performance and self-efficacy in students in the secondary schools. It has more foundations than the abstractness of the subject to emotional, pedagogical, and sociocultural levels (Barroso et al., 2021). In this paper we have discussed that innovative, student-centered pedagogies as Inquiry-Based Learning, Problem-Based Learning, Flipped Classroom, Gamification, Collaborative Learning, Storytelling, Growth Mindset Pedagogy, Technology Integration and Arts Integration are sustainable solutions to reducing mathematics phobia and advance holistic learning.

One of the primary findings of this synthesis is that not one of the pedagogies is complete on its own. Their incorporation into coherent instructional ecosystems that embrace curiosity, collaboration, and creativity in addition to rigor brings effective transformation. Professional development to empower teachers with skills and confidence to execute such strategies in an effective manner should therefore be given priority by the educators and policymakers. The system of assessment also needs to be changed to promote reasoning, reflections, and innovations instead of memorization of information. On the institutional level, schools are supposed to assist in a positive environment that would attribute equally importance to experimentation and emotional health as to achievement.

It goes without saying, that there is more than pedagogy in the mathematics phobia reduction, it involves empathy, innovation, and alignment of the whole system. With mathematics being meaningful, creative and collaborative, anxiety is overtaken with agency. To restructure mathematics education and place human-centered, integrated, and integrated methods can empower students to not only learn mathematics and learn to delight in it and identify with it.

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