II. REVIEW OF LITERATURE

To promote a greater understanding of the research problem, it becomes essential to ensure the evidence of unnecessary duplication and to demonstrate the relationship between the complete exposure of the research study and the topic under investigation. Hence, the investigator reviewed various research studies related to the research title "**Predictive Models of Multiple Intelligence, Learning Style and Teaching Pedagogy for the Academic Achievement of School Children.**" The literature thus collected was collated in appropriate heads as specified below:

A. **Concept and factors influencing Academic Achievement (AA)**
B. **Genesis, concept and theoretical framework of Multiple Intelligence (MI)**
C. **Genesis, concept and theoretical framework of Learning Style (LS)**
D. **Genesis, concept and theoretical framework of Teaching Pedagogy (TP)**
E. **Interrelationship between Multiple Intelligence (MI), Learning Style (LS), Teaching Pedagogy (TP), and Academic Achievement (AA)**
F. **Conceptual framework of the study**

A. CONCEPT AND FACTORS INFLUENCING ACADEMIC ACHIEVEMENT (AA)

Academic Achievement (AA) has become an educational yardstick. It describes academic outcomes that indicate the extent to which a student has achieved their learning goals. AA is often measured through examinations or continuous assessments. Success in it is defined as AA. In other words, engagement in educationally purposeful activities, satisfaction in learning, acquisition of desired knowledge, skills and competencies, persistence and attainment of educational outcomes, etc., are all referred to as AA.

Bolt (2011) defined AA in the Encyclopedia of Child Behaviour and Development as the progress made towards acquiring educational skills, materials, and knowledge, usually spanning various disciplines. It refers to achievement in academic settings rather than general knowledge acquisition in non-academic settings. Unlike typical forms of achievement, AA is usually viewed without a definitive endpoint. Instead, the concept is understood as a spectrum along which one can "achieve" specific skills and knowledge, possibly further developing those skills and increasing knowledge's depth, breadth, and specificity. AA

revolves around the central goal of improving the educational knowledge of the students (Welsh et al., 2001).

Steinmayr et al. (2014) stated that AA represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university. School systems primarily define cognitive goals that apply across multiple subject areas (e.g., critical thinking) or include acquiring knowledge and understanding in a specific intellectual domain (e.g., numeracy, literacy, science, history). Therefore, AA should be considered to be a multifaceted construct that comprises different domains of learning. It is a fact that the student's AA, which is one of the most basic and indispensable aims of education institutions, is also an expectation of society. Therefore, when education systems set their goals and objectives, they consider AA alongside several competencies. Achievement is the progress toward attaining one's goals. In other words, achievement can be expressed as progress toward attaining the goals individuals or institutions determine. Regarding students, achievement means reaching the objectives framed in the curriculum (Kazazoglu, 2013).

Academic Achievement occupies a significant place in education and the learning process. It has become an index of a child's future in this highly competitive world. It has been one of the most important goals of the educational process. AA is a crucial mechanism through which adolescents learn about their talents, abilities, and competencies, essential in developing career aspirations. One of the most important outcomes of any educational setup is the achievement of the students. Depending on the level of achievement, individuals are characterised as high achievers, average achievers, or low achievers (Illahi & Khandai, 2015).

As AA is extensive and covers a wide variety of educational outcomes, the definition of AA depends on the indicators used to measure it. Among the many criteria that indicate AA, there are very general indicators such as procedural and declarative knowledge acquired in an educational system, more curricular-based criteria such as grades or performance on an educational achievement test, and cumulative indicators of academic achievement such as educational degrees and certificates. All criteria have in common that they represent intellectual endeavours and thus, more or less, mirror the intellectual capacity of a person (Haines & Mueller, 2013).

The exploration of AA has led to numerous empirical studies and fundamental progress, such as the development of the first intelligence test by Binet and Simon. Introductory textbooks such as Woolfolk 2007 provide theoretical and empirical insight into the determinants of AA and its assessment. However, as AA achievement is a broad topic, several textbooks have focused mainly on selected aspects of AA, such as enhancing AA or specific predictors of AA. A thorough, short, and informative overview of AA is provided in Spinath (2012). Spinath emphasises the importance of AA concerning different perspectives (such as for individuals and societies, as well as psychological and educational research). Walberg 1986, as cited by Steinmayr et al. (2014), is an early synthesis of existing research on the educational effects of the time. However, it still influences current research, such as investigations of AA predictors in some large-scale AA assessment studies. It also highlights the relevance of research syntheses (such as reviews and meta-analyses) as an initial point for improving educational processes. A work by Hattie et al. (2009) provides an overview of the empirical findings on AA by distinguishing between individual, home, and scholastic determinants of AA according to theoretical assumptions.

However, Spinath (2012) points out that it is more appropriate to speak of "predictors" instead of determinants of AA because the mostly cross-sectional nature of the underlying research does not allow causal conclusions. Large-scale scholastic achievement assessments provide an overview of the current state of research on AA, as these studies have investigated established predictors of AA on an international level. Furthermore, these studies, for the first time, have enabled nations to compare their educational systems with other nations and to evaluate them on this basis. However, it should be mentioned critically that this approach may somewhat overestimate the practical significance of differences between the countries. Moreover, the studies have increased the amount of attention paid to the role of family background and the educational system in individual performance development. The quality of teaching, in particular, has been emphasised as a predictor of student achievement. Altogether, there are valuable cross-sectional studies investigating many predictors of AA. Following this, Richardson et al. (2012) have stated that a further focus on educational research has to be placed on tertiary educational research.

Academic performance, also known as AA, results from education that measures how well a student, instructor, or institution has met its educational objectives. Academic achievement is frequently assessed through exams or ongoing evaluation. Still, there is yet to

be a consensus on the optimal testing methods or whether components of procedural knowledge like skills or declarative information like facts are most crucial. According to educational viewpoints, academic accomplishment results from the teaching and learning process (Kumar & Phogat, 2020).

According to Harb and Shaarawin (2006), two factors affect student AA. These are internal and external classroom factors. Internal classroom factors include student competence, class schedules, class size, textbooks, class test results, learning or school facilities, school or class environment, the complexity of course materials, the teacher's role in the class, the technology used in the class, and exam systems. External ones include extracurricular activities, family problems, financial problems, social problems, and other problems.

Even more elaborately, AA was described as a complex web of factors that involve personal, academic, organisational, pedagogical, and social dimensions (Alyahyan & Dustegor, 2020; Lema et al., 2023) and found to interact with and influence each other (York et al., 2015). These predictors are essential, as they provide insights into an individual's potential for academic performance and success in education settings.

Accordingly, Alyahyan and Dustegor (2020) and Rooij et al. (2018) categorised predictors of AA into two parts: non-cognitive and cognitive predictors. The cognitive predictors are (1) socio-economic factors (SES), which explain 9–23% of the variance of AA (Musso et al., 2020; Hernández et al., 2021; (2) learning strategies (Alhadabi & Karpinski, 2020; Farruggia et al., 2018; Musso et al., 2020; Ribeiro et al., 2019, which explain 16–26% of the variance of AA (Aydin et al., 2019; Baulke et al., 2018; and (3) motivational factors, such as goal orientation and self-efficacy (Alban & Mauricio, 2019; Behr et al., 2020; Bowles & Brindle, 2017; Ndoye et al., 2020; Rump et al., 2017; Vanthournout et al.,2012) which explain 9–20% of the variance of AA (Alhadabi & Karpinski, 2020; Azila-Gbettor et al., 2023; Ndoye et al., 2020; Rump et al., 2017). However, numerous studies indicated that the motivational factors either had a negative effect (Baulke et al., 2018) or were non-significant (Alban & Mauricio, 2019; Li & Wong, 2019).

The most commonly studied cognitive predictors are (1) grade point average (GPA) (Li & Wong, 2019; Naaman & Hind, 2021; Van Herpen et al., 2020) provided they are used

as an indicator of AA, not as an outcome variable; (2) prior academic achievement measured by grades and standardised tests (Richardson et al., 2012; Wes-trick et al., 2021), such as school-leaving or college admission exam results, which primarily assess aptitude in areas such as mathematics, reading, and writing, explaining 17–25% of its variance (Musso et al., 2020; Pinxten et al., 2015; Westrick et al., 2021); and (3) cognitive abilities, including measures of intelligence, reasoning, critical thinking and problem-solving, twenty-first-century skills (Molnár et al., 2021; Pastén, 2021; York et al., 2015; Zlatkin-Troitschanskaia et al., 2015).

With the categorisation of AA predictors as cognitive and non-cognitive factors, the studies about the Indian School Educational system were collated, and the findings are presented below:

Praveen and Shafeeq (2019) conducted a study to find out the effect of family environment on AA of senior secondary school students. A total of 605 senior secondary school students from districts of Uttar Pradesh have participated. The contribution of the predictor variable (family environment) on AA was found to be low but significant. Further, it also revealed that the family environment explained a 4.1% variation in AA.

Komal and Sarikas (2019) in their study to identify the effect and correlation of home environment and AA of 9th-class students. The sample consisted of 120 students, divided into 60 girls and 60 boys, chosen from the school of Kota city. A random sampling method was used to collect the data from the students. The home environment scale was used to see the home environment level in each student, and AA was analysed through the student's exam results. A positive relation was found between the home environment and the student's AA.

Prathap (2019) aimed to determine the relationship between family environment, home adjustment, and AA among middle adolescents. One hundred seventy middle adolescent students were selected from the Chennai district, and a purposive sampling technique was used. There was a significant relationship between family environment dimensions and AA of middle adolescents at the level of $p<0.05$. Similarly, a significant association existed between AA and socio-demographic variables of age, socio-economic status, and education of middle adolescents at the level of $p<0.05$.

Farkhanda and Ehtesham (2013) examined the effects on the AA of higher secondary school students of Lucknow city. The sample encompassed 102 males and 98 females aged 15 to 19 from five higher secondary schools in Lucknow city, Uttar Pradesh (India). The total marks obtained by the students in the previous class were the achievement criteria. This study showed that gender does not influence achievement in science at the higher secondary school level.

Alordiah et al.'s (2015) study investigated the influence of gender, school location, and socioeconomic status (SES) on students' AA in mathematics. The study was an ex-post factor design in which the variables were neither manipulated nor controlled. The stratified random sampling approach was used to collect the sample of 1900 students such that the study's variables were considered. The study results showed that male students performed better than female students, urban students performed better than rural students, and students of parents with high SES performed better than students of parents with low SES.

Andrabi and Jabeen's (2018) study analysed the relationship between AA and socio-economic status among secondary-level students. A total of 564 tribal and non-tribal students were selected from two districts of Kashmir by stratified random sampling technique. The Socioeconomic Status Scale (SESS) was administered to assess SES. Correlation and regression analysis reported a significant relationship between AA and socio-economic status in tribal and non-tribal students. The gender-wise comparison also showed a significant relationship between the variables.

Kumari et al. (2017) study compared the effects of family factors contributing to the high AA of private residential school children and rural government school children. Children from private residential schools and rural government schools in IX and X classes with the highest ranks (first 3-4 ranks) in the previous year were collected. The total sample comprised 240 children, 120 from each set, 60 from the IX class, and 60 from the X class. The investigator developed an Interview schedule for the children to know their perceptions about family contributing factors. The study concluded that children of private residential schools and rural government schools were average and similar in their perceptions regarding parental contributions to their AA. High parental aspirations and expectations helped increase achievement in both groups but were comparatively high in private residential school children.

Kaur and Prajapati (2022), in the study titled “Academic Achievement about Cognitive Ability among Secondary School Students,” found that the mean score of students with integrated style of cognitive ability was higher. Hence, an emphasis was placed on teachers using appropriate teaching materials and methods and tuning their teaching according to student's abilities to help them succeed academically.

Prabha and Dhanalakshmi (2022) studied the significant relationship between cognitive ability and AA of higher secondary school students in the Salem district of Tamil Nadu. A simple random sampling method was used. 250 higher secondary school students from different types of schools, such as government, government-aided, and private, were considered. The study showed a significant relationship between cognitive ability and AA in higher secondary school students.

Selvakumar and Sivakumar (2019) revealed the impact of cognitive ability on AA of higher secondary students. The results revealed no significant difference in cognitive ability between male and female higher secondary students. However, there was a significant difference between male and female higher secondary students in their AA, and a significant relationship existed between cognitive ability and AA of higher secondary students.

The above-coded studies indicate that cognitive and no-cognitive factors predict AA in school students. However, studies of the Indian school educational system are scarce. However, among the many factors that influence AA, non-cognitive factors, namely age, gender, parental education, occupation, and the surroundings of the respondents do play a significant role. Among the cognitive factors, Indian studies have considered only cognitive ability as a concern. The Learning style, which has established a critical role in AA among foreign studies, was not dealt with in the Indian Scenario. However, very few teacher-related factors, like the methods and materials used for teaching, are significant in a few studies and not significant in others. It has to be accepted that no studies conducted had the Samacheer Kalvi (the Unified Education system of Tamil Nadu) as the curricular framework under study. With all these inputs, the investigator aimed to analyse the influence of non-cognitive and cognitive factors on AA school students and suggest a framework for a better AA specific to every subject of study.

B. GENESIS, CONCEPT AND THEORETICAL FRAMEWORK OF MULTIPLE INTELLIGENCE (MI)

The famous Greek philosopher Aristotle made the first reference to something close to the idea of intelligence, but he called it "reason," which happened two thousand three hundred years ago. According to Aristotle, the ‘reason’ was humans' ability to reign in their passion. In other words, it is the ability to resist the urge of one’s instincts. He also considered that this ability separates human beings from animals. Come the 1600s, thinkers still described ‘reason’ as the "all or none" ability, but 200 years later, with Charles Darwin behind the pen, the notion that there may be degrees to this "reason" arose, and he called it "mental powers." To Darwin, the reason could be broken down into gradations and said that several people have more, and a few have less. When the physiologist George Romanes finally introduced the word intelligence, it remained heavily influenced by its evolutionary origins, how better a person can adapt (i.e., succeed) in their environment, the more “intelligent” they were (Nuzzi, 2023).

With the turn of the 19th century and the introduction of the Industrial Age, the idea of intelligence as adaptability became more specific. Alternatively, the word adaptability is the better. With the standardisation of factory work and the specialisation of occupations, it was much easier to quantify “adaptability.” by comparing those who succeeded versus those who did not. At this point, Francis Galton narrowed the definition of intelligence even further: people’s ability to gain reputation and success in a professional endeavour, particularly scholarly ones. In general, one can say that in most current uses of the term 'intelligence,' it refers to some overall mental capacity and one that particularly highlights reasoning, problem-solving, and abstract thinking. Nonetheless, research across cultures and historical periods has shown that the specific characteristics attached to the notion of overall mental ability can vary greatly, as can the importance of intelligence as an individual or group-level feature.

The direct antecedents of 'intelligence' lie in the *intelligentia or intellegentia*, meaning "the action or faculty of understanding," derived from the Latin *intellegere*, meaning 'to understand.' As one of the traditional divisions of the human soul (along with the emotions and the will), intelligence was a concept that had long been important to Western philosophers and theologians, especially in their attempts to differentiate human beings from other species in the

animal world. Nonetheless, up to the eighteenth century, it was not a word that evoked much interest on either side of the Atlantic, particularly in its modern sense as a description of a person's overall mental capacity. Intelligence began to attract attention in the West as growing curiosity about the nature of human differences meshed with the turn to scientific methods as a privileged form of explanation (Carson, 2015).

Human intelligence is humans' intellectual power, marked by complex cognitive feats and high levels of motivation and self-awareness. Intelligence enables humans to remember descriptions of things and use those descriptions in future behaviours. It is a mental process. It gives humans the cognitive abilities to learn, form concepts, understand, and reason, including the capacities to recognise patterns, innovate, plan, solve problems, and employ language to communicate. Intelligence enables humans to experience and think (Ali, 2023). There is debate about whether human intelligence is based on hereditary factors or if it is based on environmental factors. Genetic intelligence is the theory that intelligence is fixed upon birth and cannot grow. Ecological intelligence is the theory that intelligence develops throughout life depending on the environment around the person. An environment that cultivates intelligence challenges the person's cognitive abilities (Cheery, 2021).

A person's environment and genes influence each other, and it can be challenging to tease apart the effects of the environment from those of genetics. Along with the interaction is the perspective of the human development department; the focus is on improving the nurture component, as only little can be done in the nature components. Factors related to a child's home environment and parenting, education, availability of learning resources, and nutrition all contribute to intelligence (Dick, 2011).

The theory of Multiple Intelligence (MI) has influenced educators worldwide, encouraging them to envision more effective ways of teaching. This theory was developed over 30 years ago by Howard Gardner, a world-renowned psychologist. In 1983, Gardner transformed the field of education when he published Frames of Mind: The Theory of Multiple Intelligences. In this book, he described a new way of thinking about human intelligence, challenging the traditional view that there is one kind of intelligence standardised tests can measure (Strauss, 2013).

In addition to his previous interest in and work on cognitive abilities, Gardner's participation in a research project funded by the Bernard van Leer Foundation contributed to the writing of Frames of Mind. This project focused on researching human potential. Its principal investigators assigned him to write a book documenting what was known about the connection between human cognition and the biological and behavioural sciences. This research ultimately led to the theory of MI (Gardner, 2011b).

The grant from the van Leer Foundation allowed Gardner to synthesise his work on brain damage with what he had learned about cognitive development. His studies on cognitive development explored seven ways in which children mastered symbol use and included their singing, drawing, and storytelling abilities. He used literature from various fields, including psychology and anthropology, with his colleagues to determine the best intellectual capacities taxonomy (Gardner, 2011b).

Calling the different abilities, he identified that "intelligence" created controversy but popularized Gardner's work. He mentioned that had he used another word, he would not have been known worldwide. Many psychologists did not accept his theory because they generally have different ideas about studying intelligence. For example, his views on intelligence are at odds with those of psychologists like Richard Herrnstein, who believes IQ is inherited significantly (Mineo, 2018). Gardner was critical of a book Herrnstein co-authored entitled The Bell Curve, arguing that the book encourages readers to be sympathetic to the IQ elite and does not provide ideas about how to educate those who do not excel on IQ tests (Gardner, 2001). According to Gardner, intelligence involves a person's ability to solve a problem or do something valuable in one or more cultures. In the early 1980s, he identified seven intelligences, and about a decade later, he added an eighth, the naturalistic intelligence (Checkley, 1997).

Gardner mentioned that linguistic intelligence appears to be the most widely shared by humans worldwide because, without linguistic skills in semantics, phonology, syntax, and pragmatics, people would have difficulty functioning effectively in the world. In contrast, the abilities of gymnasts, mathematicians, musicians, and visual artists are often perceived as remote and even mysterious by the average person (Gardner, 2011b)

At its core, it is the proposition that individuals have the potential to develop a combination of eight separate intelligences or spheres of Intelligence; that proposition is grounded on Gardner's assertion that an individual's cognitive capacity cannot be represented adequately in a single measurement, such as an IQ score. Instead, according to this theory, a unique cognitive profile would better describe individual strengths and weaknesses because each person manifests varying levels of separate intelligence. It is important to note that, within this theory, every person possesses all intelligence to some degree (Cheery, 2023).

In 1999, Gardner also considered whether a ninth existential intelligence exists. Gardner did not want to commit to spiritual intelligence but suggested that an "existential" intelligence may be helpful. Existential intelligence is the label given to people who think philosophically. This intelligence involves an individual's ability to use collective values and intuition to understand others and the world around them. People who have excelled in this intelligence can see the big picture. Few personalities like Socrates, Buddha, Philosophers, theologians, and life coaches are examples of famous figures who exhibited exceptional existential intelligence (Slide Model, 2021).

The theory has helped provide a framework that helps guide how teachers organise their curriculum, assess learning, and create teaching practices. It has also helped teachers develop new approaches to support a broader range of learners to succeed in the classroom (Kornhaber et al., 2001). Below (Figure 1) are the strengths, characteristics, and best-suited career choices for various MI skills.

Multiple Intelligence (MI) – Concept, strengths and career choices in a nutshell

INTELLIGENCE	STRENGTHS	CHARACTERISTICS	CAREER CHOICES
Linguistic	Words, language& writing	☞ Remember written and spoken information ☞ Enjoy reading and writing ☞ Good at debating ☞ Explain things well	Writer/journalist Lawyer Teacher
Logical	Analysing problems &Mathematical	☞ Excellent problem-solving skills ☞ Enjoys thinking about abstract ideas ☞ Likes conducting scientific experiments ☞ Good at solving complex computations	Scientist, Accountants Mathematician Computer
Spatial	Visual and special judgment	☞ Enjoy reading and writing ☞ Good at putting puzzles together ☞ Good at interpreting picture, graphs ☞ Enjoy drawing, painting& visual arts	Architect Artist Engineer
Bodily Kinet..	Physical movement, motor control	☞ Good at dance and sports ☞ Enjoy creating things with his/ her hands ☞ Excellent physical coordination ☞ Tends to remember by doing compare to	Dancer Builder Sculptor
Musical	Rhythm and music	☞ Enjoys singing & use musical instruments ☞ Recognises musical pattern & tones easily ☞ Good remembering songs and melodies ☞ Rich understanding of musical structure&	Musician, composer Singer, Music Teacher conductor

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Multiple Intelligence (MI) – Concept, strengths and career choices in a nutshell

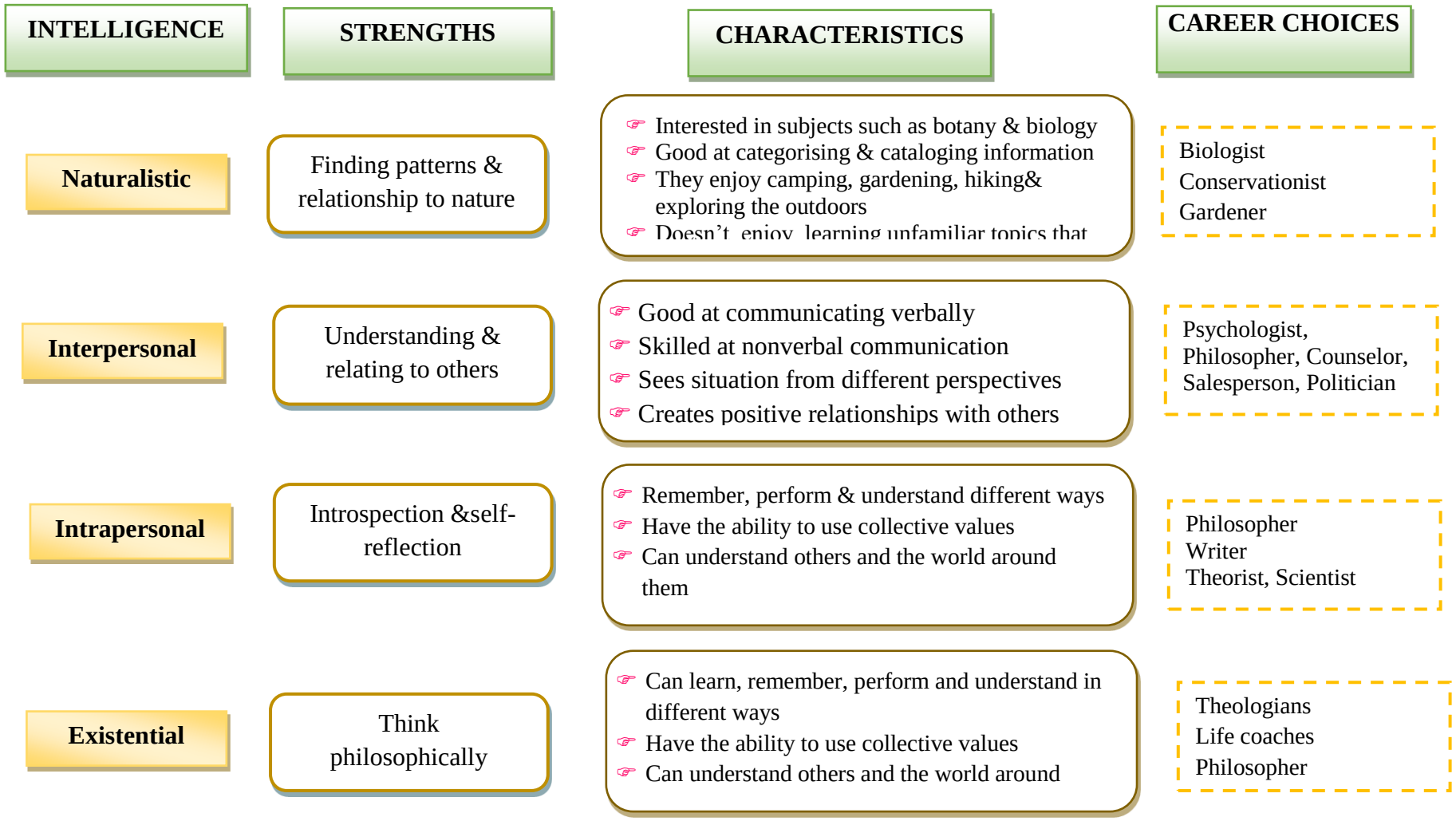


Figure 1

Although MI theory has received tremendous attention, it has been criticised. In Frames of Mind, Gardner mentioned that two books were published with critiques of his theory: Howard Gardner Under Fire and MI at 25. Gardner has responded to criticisms of his theory. 2006 for instance, he co-authored an article mentioning that Lynn Waterhouse had misunderstood his theory. One of the problems Gardner and Moran (2006) discussed regarding Waterhouse's idea of MI theory was her belief that it is not grounded in empirical findings. Gardner and Moran responded to this critique, insisting that the origins of MI theory are entirely based on practical conclusions and that Waterhouse was using a naïve perspective of science when making this claim.

In Frames of Mind, Gardner summarised some of the common criticisms of his theory and offered his responses. One of the objections critics mention involves using the word "intelligence." For instance, critics say that "talent" would be a more appropriate word to describe the ability of a gifted dancer. Gardner responds that in accepting a narrow definition of intelligence, people would likely regard the powers that fall outside of this definition as less valuable.

Another criticism of MI theory involves the connections between different faculties. Some scholars believe that since there are correlations between tests of ability, there is a level of general intelligence that people have. However, Gardner is skeptical about these correlations, arguing that almost all tests focus primarily on logical and linguistic faculties. He mentioned that people with analytical and linguistic intelligence will likely perform well on musical and spatial abilities tests. However, those with weak logical and linguistic skills will likely perform poorly even if they have the skills these tests are allegedly measuring. According to Gardner, the extent to which various intelligences are correlated is unknown (Gardner, 2011b).

Other criticisms focus on the similarities between intelligence and the lists some researchers have published about the different styles people might display, such as learning styles, personality styles, working styles, etc. Although there may be similarities, there are differences between these styles and Gardner's intelligences. Intelligence is content-specific, but researchers tend to believe that techniques remain the same across content.

In a 1997 interview, Gardner described the implications of his theory of MI for how schools might provide instruction. At the start of the interview, he emphasised that the

primary role of schools is to promote the learning of content and to develop the skills students will need and use after they graduate. However, whatever students learn in school will likely be forgotten if they take an active role. To be active requires them to ask questions, participate in hands-on activities, and recreate and transform information as needed. Unfortunately, exams do not necessarily measure how much students are involved in active learning. Students can do well on exams by memorising information they will likely forget after a few years. In contrast, students who make a prediction, experiment, analyse the data, and see the results develop skills and knowledge likely to last much longer (Edutopia, 2009).

Regrettably, American schools have too often failed to encourage the environment needed for students to take the active role that will develop the skills and knowledge they will need after they graduate. One reason for this trend involves the overuse of standardised tests to evaluate schools and teachers. At the start of the 21st century, for example, schools began to rely more on these tests to evaluate teachers and schools, leading many teachers to use a style of teaching that focuses on memorisation (Morgan, 2016).

According to Gardner (1999), teachers may ignore specific intelligences and focus primarily on providing instruction through language and logic for several reasons. First, they may need to know that different students have different types of minds. Second, they may have a set of students who vary significantly in their vital intelligence and may feel they need to be more capable of accommodating each student. Third, they may be convinced that although students are different, they must learn to be more alike to become community members. Teachers who ignore students firmly make sure MI and acknowledge the weak students are providing instruction unfairly and making sure students feel stupid (Gardner, 1999).

In a recent interview, Gardner expressed the importance of using students' vital areas when introducing them to topics in the traditional curriculum. Teachers who avoid proceeding this way as they focus primarily on pupils' weak areas increase the chances for students to develop low self-esteem (Hunter, 2021). It is crucial to allow students to develop the areas in which they are talented. In his recent interview, Gardner used physics to show how providing instruction through the intelligences commonly ignored may be achieved by teaching this subject using a method other than one focusing on a textbook.

For example, students could understand physics through bodily intelligence (Hunter, 2021).

Since uniform instruction is detrimental, one alternative for improving the teaching environment is implementing personalised education. This type of instruction involves teaching that matches students' different kinds of minds. Teachers who use this approach must first gain awareness of the reasons their students possess by learning about their interests, anxieties, goals, and strengths without stereotyping them (Gardner, 1999). At this ground proposition, the investigator’s interest in integrating MI with certain other constructs, namely the learning style adopted by the students and teaching methods practised by the teachers to predict students' overall academic success, got initiated. All the more, the investigator also realised that every subject or discipline of study needs personalised instruction. Hence, the present research focuses on formulating predictive models for the AA specific to each subject or field of study by integrating MI, LS, and TP.

C. GENESIS, CONCEPT AND THEORETICAL FRAMEWORK OF LEARNING STYLE (LS)

While Gardner's MI has been conflated with "Learning Styles (LS)," Gardner denies they are the same. The problem Gardner has expressed with LS is that the concept is ill-defined, and there "is no persuasive evidence that the LS analysis produces more effective outcomes than a 'one size fits all approach' (as cited in Strauss, 2013). As former Assistant Director of Vanderbilt University's Center for Teaching Nancy Chick (n.d.) pointed out, "Despite the popularity of LS and inventories, it is important to know that there is no evidence to support the idea that matching activities to one's learning style improves learning." One tip Gardner offers educators is to "pluralise their teaching," in other words, to teach in multiple ways to help students learn, to "convey what it means to understand something well," and to demonstrate their understanding. He also stated that LS classifies different ways pupils learn and approach information, like acting and reflecting, vision and audition, memorising and visualizing, reasoning, logically and intuitively. With this insight, the concept of LS has steadily gained influence in recent years (Northern Illinois University Center for Innovative Teaching and Learning, 2020).

A benchmark definition of "Learning Styles" is "characteristic cognitive, practical, and psychosocial behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (Curry 1981 as cited by Romanelli et al., 2009). LS is considered by many to be one factor of success in higher education. Confounding research and, in many instances, application of LS theory have begat the myriad methods used to categorise learning styles. No commonly accepted method currently exists; alternatively, several potential scales and classifications are used. Most of these scales and classifications are more similar than dissimilar and focus on environmental preferences, sensory modalities, personality types, and cognitive styles (Cook & Smith, 2006). The lack of a conceptual framework for learning style theory and measurement is a common and central criticism in this area.

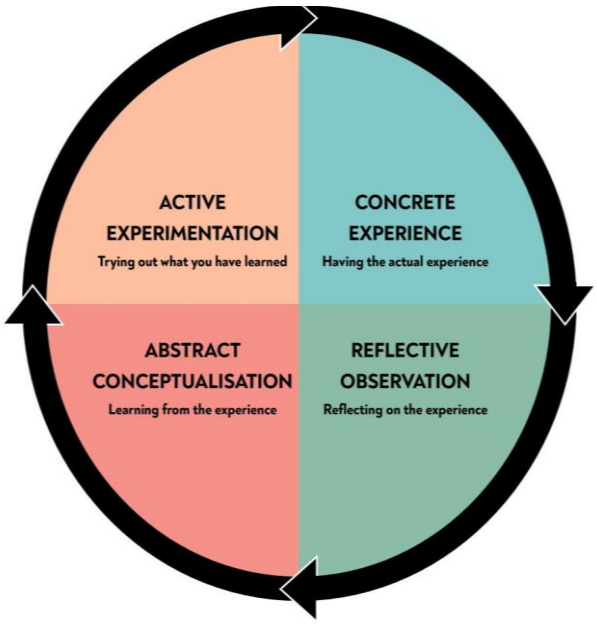
Alternatively, many researchers have argued that knowledge of LS can be helpful to educators and students. Faculty members with knowledge of LS can tailor pedagogy so that it best coincides with LS exhibited by most students (Lubawy, 2003). Alternatively, students who know their preferences are empowered to use various techniques to enhance learning, which may impact overall educational satisfaction. This ability is particularly critical and

helpful when an instructor's teaching style does not match a student's learning style. Compounding the issue of learning styles in the classroom has been the movement in many educational settings (Jham et al., 2008; Blouin et al., 2008).

Aristotle first recognized the word 'learning style' as early as 334 BC; they believed that 'each child possessed specific talents and skills' (Reiff and National Education Association, 1992). There is no currently existing holistic theory of learning styles, which others have labelled cognitive controls, cognitive styles, or personality. Learning style theories include those of Kolb, 1984; Dunn & Dunn, 1993; and Fleming, 1987.

David Kolb proposed a model involving a 4-stage cyclic structure that begins with a concrete experience, which lends to a reflective observation and subsequently an abstract conceptualisation that allows for active experimentation (Kolb, 1985) and is called an Experiential Learning Cycle. Under the Experiential Learning Cycle, there are four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Kolb believed that one must first encounter a new experience and then reflect upon that experience. These two steps lead to a new idea or concept arising within the person due to analysing and concluding their reflection.

Kolb's Experiential Learning Cycle



Source - https://www.simplypsychology.org/learning-kolb.html#Kolbs-Reflective-Cycle

Figure 2

The last part of the Experiential Learning Cycle that Kolb theorised is that a person will then apply the new ideas, concepts, conclusions, and analyses to the world around them. Kolb believed that a person can enter this cycle at any stage, but for the best learning to occur, a learner must experience all cycle stages (Kolb & Kolb, 2017).

As a next step, Kolb's learning theory (1984) sets out four distinct learning styles based on a four-stage learning cycle. Kolb explains that different people naturally prefer a single, different learning style. Various factors influence a person's preferred style—for example, social environment, educational experiences, or the basic cognitive structure of the individual. Whatever influences the choice of style, the learning style preference itself is the product of two pairs of variables or two separate "choices" that we make, which Kolb presented as lines of an axis, each with "conflicting" modes at either end. A typical presentation of Kolb's two continuums is that the east-west axis is called the Processing Continuum (how we approach a task), and the north-south axis is called the Perception Continuum (our emotional response or how we think or feel about it).

David Kolb's four learning styles correspond to the different stages of experiential learning. The following are the different types of learners described by the conditions people learn under.

- ✓ Diverging (feeling and watching) - Kolb called this style "diverging" because these people perform better in situations requiring the generation of ideas, such as brainstorming. People with diverging learning styles have broad cultural interests and like to gather information
- ✓ Assimilating (watching and thinking) - People with an assimilating learning style are less focused on people and more interested in ideas and abstract concepts. People with this style are more attracted to logically sound theories than approaches based on practical value
- ✓ Converging (doing and thinking – AC/AE) - People with a converging learning style are best at finding practical uses for ideas and theories. They can solve problems and decide by finding solutions to questions and problems and
- ✓ Accommodating (doing and feeling – CE/AE) - The Accommodation learning style is "hands-on" and relies on intuition rather than logic. These people use other people's analysis and prefer to take a practical, experiential approach. They are attracted to new challenges and experiences and to carrying out plans.

Kolb's Learning Styles

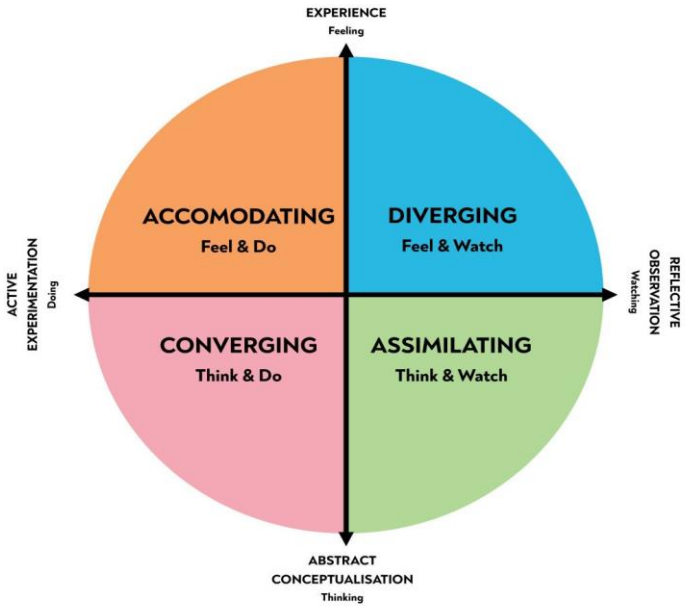


Figure 3

Dunn and Dunn (1993) believe that learning style is how each learner begins to concentrate on, process, absorb, and retain new and complex information. His LS model was based on the theory that each person has his/her strengths when it comes to learning. Some students like to learn alone, while others prefer learning in groups. Some others learn from a teacher. His model is represented through five stimuli, which are environmental, emotional, sociological, physiological, and psychological.

Dunn and Dunn Learning Style

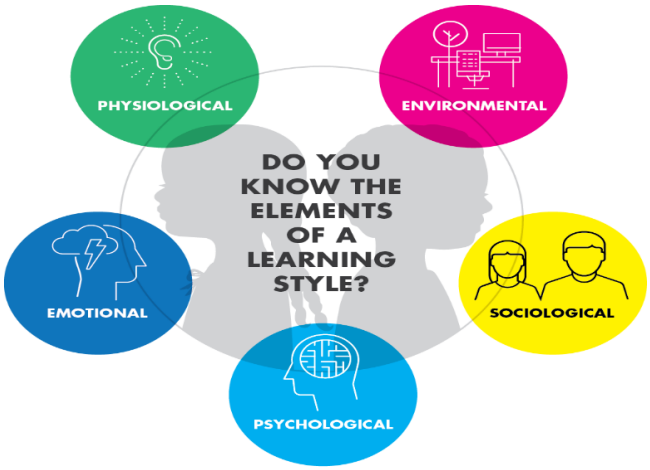
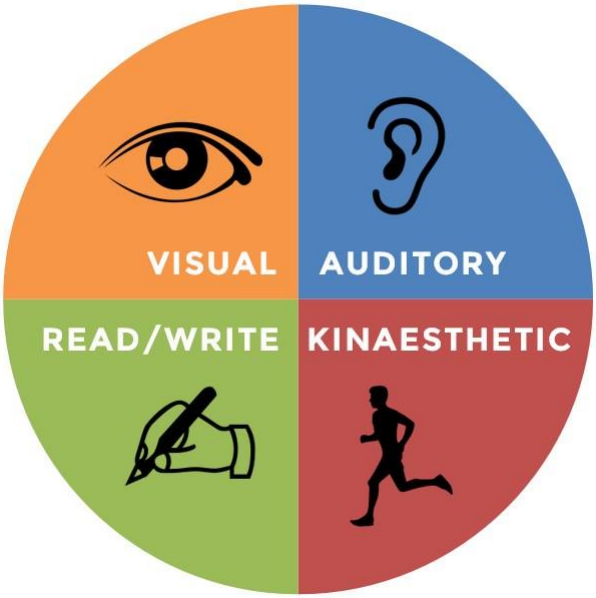


Figure 4

Educational psychologist Walter Burke Barbe (1979) and his colleagues designed the VAK learning style, assuming that people predominantly learn using one style –visual, auditory, or kinesthetic. The VAK model is a helpful tool to understand the learning style. This enables a learner to adjust the style to communicate more. The VAK model was later developed by Neil Fleming (2006). Fleming developed the acronym VARK - Visual, Aural, Reading/Writing, and Kinesthetic, referring to the instructional preference in which students or people in society prefer to take in and give out information. According to Fleming, the Visual aspect of this acronym refers to those who prefer to look at graphs, charts, hierarchies, symbols, and things other teachers use to represent words (in place of words). For a person with a visual instructional preference, a page's layout, design, and coloring give them meaning. The Aural part of the acronym refers to those with a speaking or hearing instructional preference. For example, these people learn best through group discussions, receiving feedback, phone calls, presentations, and speaking with others. The Reading/Writing part of this acronym refers to those whose instructional preference is working with either read or written words. Lastly, the kinesthetic part of this acronym refers to those whose instructional preferences are through "learning by doing," for example, experiences, examples, and practice (Learnings about Learning Style, 2022).

VARK Learning Style



Sources - https://www.uow.edu.au/student/learning-co-op/effective-studying/identify-your-learning-style/

Figure 5

Fleming, like other learning style theorists, believed in the importance of students, teachers, and people in the general society understanding, knowing, and being comfortable with different learning styles, especially their individualised way of learning. Fleming's strong desire for people in society to understand their learning styles led him to become the first to develop a learning style preference questionnaire (Fleming & Baume,2006).

On the whole, LS theories make two straightforward predictions. First, a learning style is proposed to be a consistent attribute of an individual. Thus, a person's learning style should be constant across situations. Consequently, someone considered an auditory learner would learn best through auditory processes regardless of the subject matter (e.g., science, literature, or mathematics) or setting (e.g., school, sports practice, or work). Second, cognitive function should be more effective when consistent with a person's preferred style; thus, the visual learner should remember better (or problem-solve better or attend better) with visual materials than other materials (Willingham et al., 2015).

Although there are a multitude of inventories and models for assessing learning styles, most are unreliable (Coffield et al., 2004). Moreover, researchers are well aware of this problem. A recent survey of 92 learning styles showed that reliability problems were among the chief concerns of researchers with progress in their field (Peterson et al., 2009). Regarding the second prediction - cognitive performance - one must distinguish between evidence supporting a learning styles theory and evidence that would prompt a change in educational practice (Pashler et al., 2009). One needs to observe a statistical interaction between individuals' learning styles and the instruction method to support the theory. For example, suppose we examined ''visual learners'' and ''auditory learners.'' Members in each group would be randomly assigned to an instructional condition, where the material would be presented visually (e.g., a silent film) or auditorily (e.g., an audiotaped story). Participants should learn better when they experience the material in their preferred modality.

Practical classroom implications require a particular pattern of data that supports the theory and shows that instruction matched to learning styles optimises achievement for each group. This is where the present study outlined the importance of integrating the Teaching Pedagogy practised by the teachers and the Learning Style construct to predict school students' Academic Achievement (AA). Now, another question arises regarding an appropriate instrument to use in assessing the learning styles of school children.

The investigator realises that any instrument/inventory to assess LS of school children should support either prediction for educational practice. Several reviews that span decades have evaluated the literature on learning styles (Arter & Jenkins, 1979; Kampwirth & Bates, 1980; Kavale & Forness, 1987; Kavale et al., 1998; Pashler et al., 2009), and each has concluded that there is no viable evidence to support the above-explained theories. Even a recent review intended to be friendly to theories of learning styles (Kozhevnikov et al., 2014) failed to claim that this theory prediction has empirical support. The lack of supporting evidence is especially unsurprising in light of the unreliability of most instruments used to identify learners' styles. Hence, an underlying challenge to research learning styles exists: It is impossible to prove that something does not exist. However, by unpromising the data today, a new experimental paradigm may eventually reveal that the theory was correct. Still, given the focus on educational application, researchers need to set a different standard. They not only need to know that learning styles exist but also need to know that teaching to learning styles benefits students in some way.

Hence, an instrument or inventory of Learning Styles suitable to the Indian education system was searched for, and a Learning Style Inventory was formulated by Kaur and Kaur (2022). was chosen owing to its usage in educational research of the Indian context. The types of LS are

1. Enactive Reproducing style: Emphasis is on the concrete experiences and is based on imitation and practice. It is based on the reproductive orientation
2. Enactive Constructive style: Emphasis is given on processing enactive information
3. Figural Reproducing style: Indicates that the learning occurs mainly through maps, charts, pictures, models, diagrams, and photographs. It is reproduction-oriented and is based on imitation and practice
4. Figural Constructive style: Emphasis on the figural experiences that will lead to conceptualisation
5. Verbal Reproducing style: Based on the information mainly given through written or spoken modes and
6. Verbal Constructive style: Emphasis is given to conceptualisation based on reflective, abstractive, and accommodative thinking.

Types first and second can be grouped to form an Enactive learning style, third and fourth may be clubbed together to form a figural style, and fifth and sixth may be put together as verbal style. The first, third, and fifth styles are grouped to form a reproducing learning style. Second, fourth, and sixth are grouped to create a constructive learning style. Enough empirical evidence to prove the dependability of the tool was established by research carried out by Raj and Joaklm, 2022; Misra, 2018; Agarwal and Suraksha, 2017; Kaur and Kaur, 2022 and so on.

Hence, the review collated on LS gave an insight into the similarities and differences between MI and LS, the assumption of the three major theories of LS, and the type of instrument that could be used. As already indicated, the research on the chosen LSI was carried out in different states of India; no studies were conducted with the students enrolled in Samacheer Kalvi.

D. GENESIS, CONCEPT AND THEORETICAL FRAMEWORK OF TEACHING PEDAGOGY (TP)

The Multiple Intelligence (MI) and Learning Style (LS) as student-related constructs explained in the above two heads had established that MI is quite different from LS, and both have an equal role in the Academic Achievement (AA) of students. MI represents different intellectual abilities, whereas LS, according to Howard Gardner, is how an individual approaches a range of tasks. Gardner further phrases LS as "a hypothesis of how an individual comes from various materials. The teaching methods play a vital role in both these constructs to influence AA appropriately. The hope underlying MI and LS theories is that understanding student differences will improve instruction.

Teaching is demanding in various ways, including time, effort, and commitment. Teachers prepare pupils for the job market and the socio-economic development of every nation. They must exhibit good qualities and accommodate their students' academic, social, and emotional needs (Williams, 2003). The passion they have reflected through their effectiveness. While in the classroom, they adapt to various learning styles and classroom dynamics by using superior classroom management techniques to create a healthy classroom environment that is safe, resourceful, and productive. As perceived by the student, teaching quality is closely linked to student engagement measures, and the relationships work mainly in expected directions. (An et al., 2008).

Ainonmadiah et al. (2016) explained that teachers and students have close interpersonal relationships, where teachers' teaching styles in the classroom are a component or element that ensures a sense of learning among students. In addition, the methods and practices of learning and facilitation directly impact students’ perceptions and concerns in mastering education in general and Science and Mathematics in particular (Anis Humaira et al., 2019). Teacher quality makes the highest contribution to a student's success. Based on a study by Nur Farhah and Fatimah Wati (2018), what students obtain depends not on the school attended but on the teachers. Creative and innovative teaching practices can attract students (Rumainah & Faridah, 2017). Grasha (1996) also stated that teachers' teaching styles are crucial for creating an ideal learning climate in the classroom.

Mazaheri and Ayatollahi (2019) defined teaching styles as teachers' preferred ways to solve problems, perform tasks, and make decisions in the teaching process. Heydarnejad et al. (2017) defined teaching style as teachers' personal qualities and attitudes, reflected through teaching techniques, activities, and approaches in teaching specific subjects in the classroom. In other words, the teaching style is a combination of motivation, personality, attitude, belief, and strategies in teaching (Karimnia & Mohammadi, 2019). Therefore, teachers' teaching styles represent their behaviour while teaching in the classroom and are one of the main determining factors for student learning success (Baradaran, 2016; Rosalia, 2017).

The teaching styles outlined by Grasha (1996) refer to teachers' beliefs, behaviours, and needs that emerge in an educational context. Grasha believed that a teacher's teaching style reflects the teacher's personal qualities regarding teaching, guiding, and directing the teaching process, thus impacting students and their ability to learn. In general, the success or failure of students is associated with a teacher's teaching style, which is directly related to the teaching methods used during teaching. Indirectly, the teaching style becomes one component of a comprehensive transfer of teaching content. The teaching style may also be influenced by educational background, teaching experience, cultural background, and individual interests (Nouraey & Karimnia, 2016; Tavakoli & Karimnia, 2017). These factors can be identified by observing and studying teacher behaviour.

Literature related to teaching styles displays various theories, models, and categorisations of teaching styles using different terminologies. For example, this includes the categorisation of teaching styles into a didactic direct style and a student-centered indirect style (Flanders, 1970), Formal-Informal (Bennett et al., 1976), Open-Traditional (Solomon & Kendall, 1979), Intellectual Excitement-Interpersonal Rapport (Lowman, 1995), and Expert, Formal Authority, Personal Model, Facilitator, and Delegator Teaching Styles (Grasha, 1996) are among the few terminologies used to explain these constructs better. In the present study, only the Grasha–Riechmann Teaching Style model is followed because it has potential in subject-wise teaching.

Grasha (Heydarnejad et al., 2017) argued that teaching styles involve constant teacher behaviour in interaction with students during the teaching-learning process. Grasha described teaching styles as a criterion for personal qualities and behaviours that govern how teachers

manage classes. Hence, teaching styles consist of all techniques, activities, and teaching approaches a teacher uses in the teaching process. The five dimensions of the Grasha–Riechmann Teaching Styles are Expert Teaching Style, Formal Authority Teaching Style, Personal Model Teaching Style, Facilitator Teaching Style, and Delegator Teaching Style. The dimensions or attributes of the Grasha–Riechmann Teaching Styles regarding teacher roles, student characteristics, and the advantages and disadvantages of each teaching style are explained below:

- ✓ **Expert Teaching Style:** Grasha (1996) argued that teachers with the Expert Teaching Style have knowledge and expertise on what students want to learn. The Expert Teaching Style makes teachers maintain their status as experts among their students by displaying accurate and comprehensive knowledge. In this regard, teachers with the Expert Teaching Style encourage students to face challenging situations to develop competencies in learning. As an expert, teachers convey information, expect students to learn what they receive, and take advantage of the presented data. Teachers are also careful in communicating information and will ensure that students are always ready. The Expert Teaching Style of Bergil and Erçevik (2019) can be seen as an advantage where teachers have accurate and comprehensive knowledge, skills, and information on the scope of targets to be taught to students. This extensive knowledge and skills consolidation can benefit experienced students. However, it should be emphasised that excessive use of Expert Teaching Styles may scare and curb the learning of students who are inexperienced or do not have a basic knowledge of the expected target topic. Furthermore, the teacher's presentation of knowledge or information may not interest and motivate the students. Additionally, displaying teacher knowledge and skills may not always show students the implicit thought process that produces an answer.

- ✓ **Formal Authority Teaching Style:** Grasha (1996) reported that the Formal Authority Teaching Style requires teachers to have status or position among students. This is because teachers are considered members of schools or faculties who contribute to the teaching and learning process by providing positive and negative feedback to the students. In this context, the teachers create concrete learning situations by setting

learning objectives, rules, expectations, and learning principles for students. Accordingly, teachers with the Formal Authority Teaching Style focus on preparing students with the necessary thinking structure for learning. The teachers also care about the correct, accepted, and standard way of doing things. Thus, students can be motivated through quality, effective, and meaningful learning methods. The main advantages of the Formal Authority Teaching Style are that it emphasised teacher expectations, techniques, and standard ways to do things during the teaching and learning process. However, using the Formal Authority Teaching Style can also result in limited, permanent, and inflexible student engagement in the learning process. Hence, a solid attachment to the Formal Authority Teaching Style can contribute to rigid, standard, and less flexible ways of managing students.

- ✓ **Personal Model Teaching Style:** Grasha (1996) explained that the Personal Model Teaching Style refers to teachers who teach based on their example. They will directly guide and encourage students to emulate it. Teachers with Personal Model Teaching Styles set the prototypes for thinking and behaving. In this regard, the teachers constantly supervise, guide, and instruct students by showing them how to do things. In doing so, the teachers motivate students to observe, imitate, or reflect on the methods and approaches they provide. The need for direct observation and imitation by students is the main strength of the Personal Model Teaching Style (Bergil & Erçevik, 2019). Teachers with a Personal Model Teaching Style encourage students to observe and then imitate the teachers' approach that is considered appropriate. However, some teachers may believe that their approach is the best, and this consequently makes some students feel that they have low capacities if they cannot meet those expectations and standards. As a result, the students will feel less confident and demotivated in learning that exceeds their ability.

- ✓ **Facilitator Teaching Style:** Grasha (1996) stated that the Facilitator Teaching Style emphasises teacher and student interaction. Therefore, teachers with this teaching style act as facilitators in the classroom. They guide students by asking questions, exploring options, suggesting alternatives, and encouraging students to make informed decisions. The main goal of teaching is to nurture independent students with high self-efficacy,

where teachers encourage students to initiate and carry out their responsibilities in learning. The teachers' choices, questions, and opportunities guide and lead the students in learning situations. In the Facilitator Teaching Style, students can develop their learning criteria. This style also shows that teachers are more likely to guide students to carry out project-based activities and provide optimal motivation to students. In this regard, the teachers work with the students on project assignments on a consultative basis by providing support and encouragement to the students. The main strength of the Facilitator Teaching Style is that the personal flexibility given by teachers is focused on the needs and objectives of student learning (Bergil & Erçevik, 2019). This will enable students to explore alternative options and methods of action. Nonetheless, the main drawback of the Facilitator Teaching Style is that it is time-consuming. Teachers and students may need more time to implement practical activities or project assignments. In addition, the Facilitator Teaching Style may also become ineffective when a more direct approach is required. Students may feel uncomfortable if this mechanism is not used positively and in a motivational manner.

- ✓ **Delegator Teaching Style:** Delegator Teaching Style refers to teachers who emphasise the development of a student's self-capacity. Students will be encouraged to conduct self-learning such as projects, and teachers will act as a reference source. The Delegator Teaching Style aims to develop students' competencies by giving them autonomous characteristics. In this style, students are expected to work on projects independently and function as members with independent powers within their group. When the students need help, they can refer to teachers as a source of information to meet their needs (Grasha, 1996). Using the Delegator Teaching Style, students consider themselves independent, capable, and autonomous. As a result, each student can take initiative and self-reflect by evaluating themself. Nevertheless, teachers are sometimes confused about students' willingness to take responsibility and face the need for autonomy. The students also need to self-assess their ability to face adversity in life (Ewan et al., 2021). This situation can indirectly cause the students to feel worried and anxious in their efforts to carry out the tasks the teachers gave. Therefore, as a weakness, it should be borne in mind that students may not have the desired ability to fulfil their autonomous obligations.

Besides, students may need rigorous supervision and intensive encouragement to overcome anxiety and reform themselves in learning norms.

Studies on the patterns of Grasha–Riechmann Teaching Styles were minimal locally and internationally. Over the most recent five years, fewer research reports were found to identify the relationship of teaching experience with the Grasha–Riechmann Teaching Styles among teachers. International research on the Grasha–Riechmann Teaching Styles of teachers barely focuses on teaching experience. Still, it is more likely to focus on teacher creativity and burnout (Ghanizadeh & Jahedizadeh, 2016), teacher self-efficacy (Baleghizadeh & Shakouri, 2017), student academic achievements (Khalid et al., 2017; Martin, 2019), student motivation (Massaada, 2016; Rosalia, 2017), as well as teachers' behaviour management and instructional management (Kazemi & Soleimani, 2016).

The collated literature on Teaching style has given ample evidence for the investigator to consider Grasha's theories of Teaching styles compared to other approaches. However, the investigator also felt the need to have an Indianised instrument to assess the Teaching style and analyse its role in students' Academic Achievement. While searching for an inventory, the investigator found one formulated by Sharma and Saran (2002) called the Teaching Style Scale (TSS). This TSS was based on the theories of Grasha and Grasha (1996) to measure the actual Teaching Pedagogy (TP) adopted by the teacher). TSS described TP as quite different from the methods of instruction used by the teacher. One difference that the TSS showed from the original Grasha's model was that the nomenclature of the style, Personal Model, was changed to Demonstrator for easy understanding. Below (Figure 6) are the strengths and weaknesses of the best-suitable teaching pattern choices for various TP based on Grasha's model.

Grasha's Model of Teaching Style

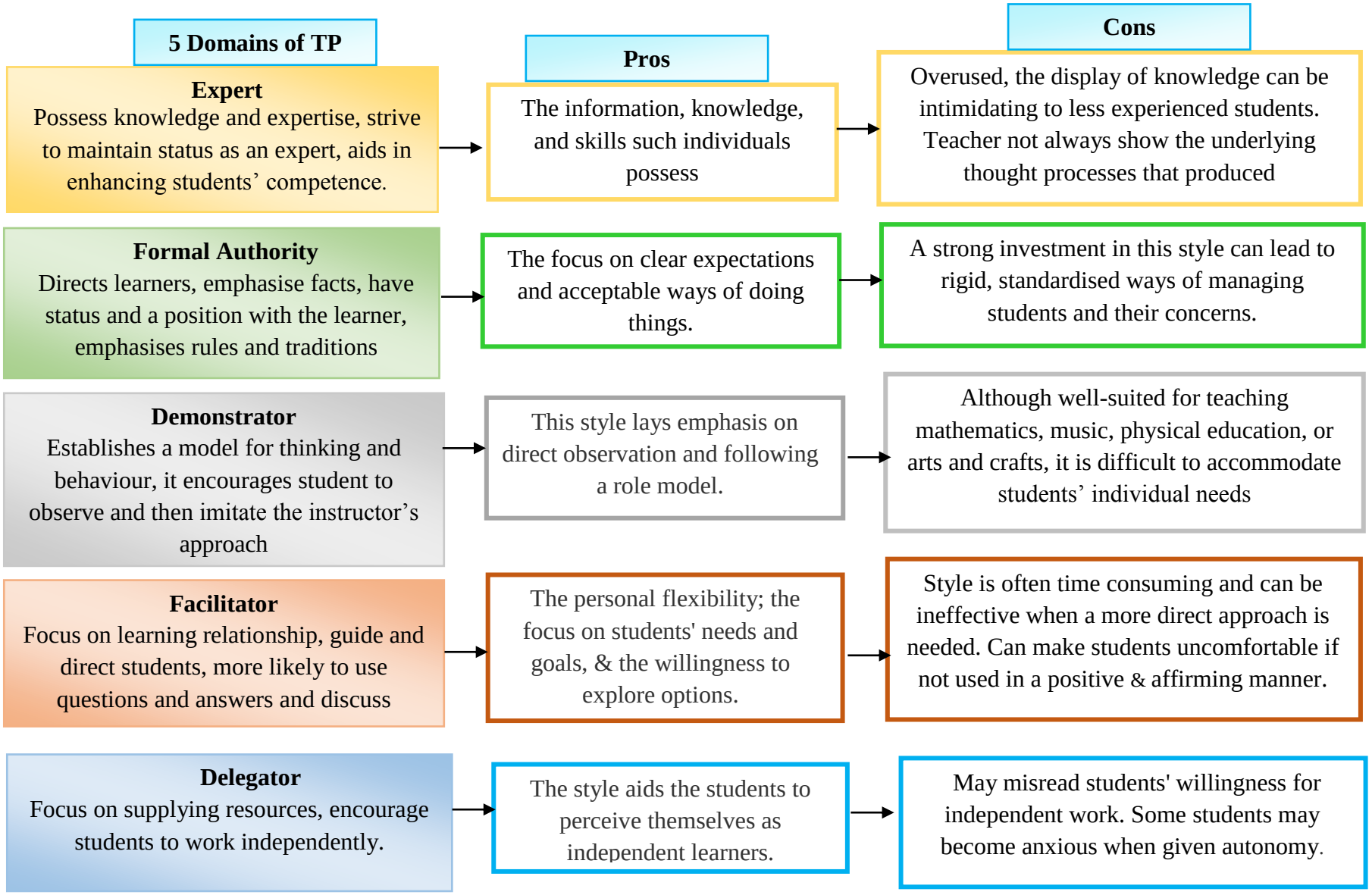


Figure 6

E. INTERRELATIONSHIP BETWEEN MULTIPLE INTELLIGENCE (MI), LEARNING STYLE (LS), TEACHING PEDAGOGY (TP), AND ACADEMIC ACHIEVEMENT (AA)

The preceding reviews and theoretical underpinnings on four primary constructs, AA, MI, LS, and TP, had already confirmed their relationship. Moreover, the theoretical framework of the three constructs, namely MI, LS, and TP, has also established its links within the theoretical framework. With all these in mind, the investigator aimed to collate empirical evidence of the interrelationship of the study variables. Accordingly, the reviews are presented below after careful exploration of the literature.

Gurbuz et al. 2010; Bakić-Mirić, 2010; Neto et al. 2008; Wu and Alrabah, 2009 conducted studies in different countries and stressed the importance of identifying the learners' profiles and empowering them with recognition of their intelligence. These studies also confirmed that the MI of learners occupies an essential place in honour of the diversity of ways that learners approach the curriculum; it helps teachers and learners to plan programmes for individualized instruction successfully. Thus, it seems necessary to recognize students' intelligence when designing the teaching and learning process to enhance their learning performance. Accordingly, reviews related to the relationship between the constructs mentioned above, namely MI, LS, TP, and AA, are collated and presented in brief as below:

i. Multiple Intelligence and Learning Styles

Smoak (2007) worked on the effects of incorporating LS and MI in a language arts/mathematics classroom for returning dropouts at Columbia College. The study aimed to determine if students' awareness of their learning styles and multiple intelligences would increase student achievement, engagement in the learning process, and retention in the classroom. The subjects of this study were a small group of pre-GED students in an adult education environment. Data was collected using a modified Dunn & Dunn Learning Style Inventory, a multiple intelligence survey excerpted from the works of Thomas Armstrong and Bickey's Basic Assessment of Cognitive Organization. The study reported that the findings on individual learning styles and multiple intelligences did not affect their achievement. This study contradicts the results of quoted studies and hence needs further exploration.

Tee et al. (2009) studied the relationship between LS and MI among Malaysian students. A population of 97 students was selected as the sample. The Kolb Learning Styles Model (1976) and Gardner's Multiple Intelligences theoretical framework were used in this

research. This quantitative approach showed that most students tend to possess Diverger LS, emphasising Intrapersonal Intelligence for the excellent level and Verbal Linguistic Intelligence for the low level. The Chi-Square test for the 0.1 significance level indicates a significant correlation between Kolb's learning style and musical intelligence.

Ahanbor and Sadighi (2014) aimed to investigate the relationship between LS and MI to examine whether combining them could improve students' learning. Results indicated that all male and female students who participated in the study had linguistic, logical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic intelligence. As for the difference between males and females in terms of the types of intelligence, results demonstrated that males and females do not differ in terms of linguistic, logical, spatial, body-kinesthetic, musical, interpersonal, and naturalist intelligence. However, a significant difference was noticed between males and females concerning intrapersonal intelligence. Besides, a statistically significant relationship was observed between male and female students' LS and their MI.

Zare-ee and Shahi (2010) studied the possible relationships between Iranian students' MI and their LS. Survey data were collected from 300 randomly selected learners from the school's student population in central Iran. The results of the study showed that visual style was highly correlated with all kinds of multiple intelligences, very strongly associated with interpersonal and intrapersonal intelligence at the 0.01 level (2-tailed), and strongly linked with natural, musical, logical, existential, kinesthetic, verbal and visual-spatial intelligence at the 0.05 level (2- tailed). Strong, positive correlations were also found between auditory style and natural and existential intelligence at the 0.01 level (2-tailed). Auditory style and visual-spatial intelligence were not associated.

Panahandeh et al. (2015), in their work on the 'Relationship between Iranian English as Foreign Language Learners' Multiple Intelligences and their Learning Styles,' investigated the relationship between Iranian EFL learners' MI profiles and their LS. The study further examined whether there is any significant difference between genders in using the different types of LS. To this end, two questionnaires, a 90-item multiple intelligences questionnaire and a 24-item learning styles questionnaire adapted from Willing (1988), were distributed among 120 Iranian EFL learners (60 males and 60 females) during class time. To find the answer to the first research question, the Pearson Correlation analysis showed a significant

positive relationship between the different types of MI and LS in particular and the MI and LS as general factors. Finally, an independent-sample t-test analysis revealed a significant difference between male and female students using only the communicative type of LS. Female students use this type of LS more than male students.

Sener and Cokcalıskan (2018) aimed to reveal secondary school students' MI and LS. It also aimed to describe gender differences and the relationship between the students' LS and MI. The research study employed a quantitative research design, and the data were collected from the students of a state school in the winter term of the 2015-2016 Education Year. The data were gathered using The Perceptual Learning-Style Preference Questionnaire (PLSPQ) and the Multiple Intelligence Inventory. It was observed that the students had almost all these types of learning styles, but mostly, they were found to be tactile and auditory learners. The three intelligence groups, naturalistic, visual, and kinesthetic, received the highest scores. The analyses also indicated a significant difference between males and females. It was seen that most of the intelligence types and learning styles had a moderate positive correlation.

Samsun (2022) researched the relationship between the MI levels and the LS of Turkish English Language Teaching (ELT) students with 143 students. Data were collected by two different instruments, one of which was a "Perceptual Learning Style Preference Questionnaire," and the second one was a "Multiple Intelligence Domains Evaluation Scale." The results of the data analyses revealed that visual-spatial intelligence and visual learning style were the most dominant types of intelligence and learning styles. Furthermore, a statistically significant correlation was observed between the LS and linguistic, visual-spatial, interpersonal, and intrapersonal intelligence.

ii. Multiple Intelligence and Teaching Styles

Cawepbell (1997) discovered scores of approaches to MI while researching teaching and learning through MI. In this article, she describes five multiple intelligences formats, with examples and suggestions from schools nationwide. They are a) Lesson design: Begin by reflecting on a concept we want to teach and identify the intelligences that seem most appropriate for communicating it; b) Interdisciplinary curriculums: Adapt, do not rework – the curriculum to highlight multiple intelligences. Some schools, for example, may add a more robust arts program, while some teachers may create learning stations in their classrooms or invite community experts in to mentor their students; c) Student Projects:

Teach students how to initiate and manage complex; d) Project Assessments: Have students show what they have learned by generalising their findings, connecting the content to their personal experiences, and applying their knowledge to new situations and e) Apprenticeships: Have students participated are three apprenticeships one in an art form or craft, one in an academic area, and a third in a physical discipline such as dance or sports. Though an old study, the results signify the relationship between MI and teaching styles for better learning.

Gouws (2007), in an article titled, Teaching and learning through multiple intelligences in the outcomes-based education classroom. As outcomes-based education forms the foundation of the new school curriculum in South Africa, educators are confronted with the challenge of meeting the different needs of individual learners and helping learners (many previously disadvantaged) achieve their maximum potential. One way of realising this ideal is by applying Howard Gardner's theory of multiple intelligences in the classroom. The article discusses Gardner's multiple intelligences theory and outcomes-based education in South Africa, as it is believed that together, they can contribute to solving some of the present problems in South African education. The article defines the use of MI theory in an OBE classroom. It suggests how educators worldwide could incorporate different intelligences in their teaching and learning activities.

Sulaiman et al. (2010) carried out a study with the assumption that instructions in science and mathematics required various teaching strategies to ensure a successful teaching and learning process. One hundred seventy-four respondents from different secondary schools in Peninsular Malaysia were chosen randomly. Questionnaires were used to investigate the level of multiple intelligences and teaching strategies. Correlation analysis was applied to investigate the relationship between multiple intelligences and teaching strategies. Teaching strategies based on various intelligences suggest teaching science and mathematics in numerous ways.

Hajhashemi et al. (2011) found a relationship between the MI profiles and language learning strategies used by Iranian EFL high school students. Two hundred and twenty-nine students (121 males and 108 females) participated in the study. The instruments used to elicit information for this study were McKenzie's (1999) MI inventory and the Strategy Inventory for Language Learning (SILL) Questionnaire. The findings revealed a low, positive correlation between the two variables of MI and learning strategies, $r = 0.24$. In addition, it

was found that there is a common, positive correlation between MI and different strategy types. The highest correlation was seen between meta-cognitive strategies and MI, followed by compensation and cognitive processes. Furthermore, the findings recommended that having access to the MI profiles and learners' learning strategies could help the teachers plan activities to connect both methods and students' talents and provide students with the best possible instruction.

Rahbarnia et al. (2014) investigated the relationship between multiple intelligences and students' mathematical problem-solving for K7 students. A sample of 209 K7 schoolgirls were tested on McKenzie's Multiple Intelligences Inventory and math exam, including 120 questions based on Revised Bloom Taxonomy (RBT). Obtained results indicate that several intelligences like logical, spatial, existential, intrapersonal, and naturalist positively correlated to mathematical problem solving, and others like linguistic, bodily-kinesthetic, and interpersonal positively correlated to mathematical performance just in some aspects. For improving students' mathematical problem-solving, at least in undergraduate mathematics, paying attention to multiple intelligence (MI) theory in mathematics curriculum and book context could be critical because this study revealed that intelligence correlated to mathematical problem-solving.

Rekha (2022) conducted a study on Multiple Intelligences-based Pedagogy for Effective Learning Outcomes and suggested teaching strategies for learners with linguistic intelligence, spatial intelligence, bodily-kinesthetic intelligence, etc. Besides, the outcome of the study will provide a basis for government/policy makers for policy formation, decision-making, and planning, and curriculum developers for incorporating appropriate pedagogy in curriculum, teachers in planning their learning experiences, and creating cohesive yet diverse classroom environment, researchers in exploring the individual potential of learners and provide bases for their development, parents in nurturing their children following the natural tendencies.

iii. Learning Styles and Teaching Styles

Brown (2003), in an article titled, Teaching Style vs. Learning Style. Myths and Realities. Brown stated that teaching styles reflect teachers' beliefs and values about the learners' role in learning; learning styles provide insight into how learners perceive, interact with, and respond to the environment in which learning occurs. Many teachers teach in the way they were taught, which usually can be characterized as field independent (content-

oriented, formal teaching methods, less student involvement, structured class activities), a style that can work well with students who are field dependent (prefer structure and guidance from the teacher). When students' learning preferences match their instructor's teaching styles, student motivation and achievement usually improve, but some students may do better with a learning/teaching style mismatch. Learners need to become better all-around learners by adapting their learning styles to non-preferred teaching styles. Teachers can become more flexible by being willing to change their view of the role of students. The following five perspectives on teaching were suggested to help teachers identify, articulate, and justify their teaching approaches: (1) transmission (focus on content, teacher-directed); (2) developmental (values students' prior knowledge, directs students to develop more complex understandings); (3) apprenticeship (authentic tasks in real-world settings); (4) nurturing (focus on interpersonal elements and students' emotional and intellectual needs); and (5) social reform (relate ideas explicitly to the lives of the students). These five perspectives, in turn, agree with Grasha's views of Teaching styles.

Hussain and Ayub (2012) researched to find the association between learning styles and teaching styles at the undergraduate level. Canfield Learning Styles Inventory (CLSI, 1992) and Staffordshire Evaluation of Teaching Styles (SETS, 2007) were used. Two hundred sixty-two students and 12 teachers were taken through random sampling. There was a positive correlation between student learning style and teacher teaching style, which was statistically significant ($r = .77$, $n = 262$, $P < .0005$). The results indicated that awareness-raising sessions should be arranged for students and teachers to realize the importance and implications of knowing their learning and teaching styles.

A case study analysis by Aldajah et al. (2014) in analyzing the compatibility of Teaching styles with the Learning styles of the students in UAE showed that the student's learning styles are balanced: active-reflective, intuitive-sensor, visual-verbal, and they prefer global over sequential learning style. Moreover, the instructors' teaching styles were a mix of expert, formal authority, personal model, and delegator. This spectrum of teaching addresses most of the students' learning methods, which reflects positively on the learning process. The analysis also concluded that to enhance teaching quality and improve its effectiveness, attention must be paid to the compatibility of the instructors' teaching styles versus the students' learning styles, and it is this compatibility that plays a vital role in how much

knowledge the students can gain from the material presented in class. This paper provided recommendations that instructors can implement to enhance the teaching process further.

Awla (2014) collated literature based on the belief that understanding students' learning styles and preferences can benefit both students and teachers. As students learn in various ways, changing each student's learning style in the classroom appears impossible. Instead, teachers might modify their teaching style to be more consistent with their students' learning styles. The purpose of this paper is threefold.: first, to define and classify the concept of learning styles; second, to give an account of the significance of identifying and understanding learners' learning styles; third, to argue that students will have better achievements if their teachers' styles or the way they receive instruction matches their learning style. Moreover, it was suggested that teachers should take a balanced approach to teaching styles to cope with various learning styles.

iv. Multiple Intelligence, Learning Styles, and Teaching Styles as predictors of Academic Achievement of school students

Studies by Park (1997) and Park (2001) revealed solid relations between ethnicity and learning style preferences and between achievement level and learning style preferences. Multiple comparisons of means tests revealed that middle achievers showed a statistically significant higher preference for auditory learning style than did low achievers. Moreover, high and middle achievers had statistically significantly higher choices for individual learning styles than low achievers. Finally, similar to the previous findings, all the groups preferred kinesthetic and tactile learning, as all groups preferred either significant or minor preferences and visual learning styles.

Bilgin and Durmus (2003) determined the relationship between the LS and academic success of primary school students. Students' academic performances in Mathematics, Science, Social Studies, and Literature were assessed through their transcripts from the first semester of the 2000-2003 academic years. Pearson moment correlation analyses showed a significant correlation ($r=.20$, $n= 240$, $p<.01$) between LS and academic success.

A study by Kia et al. (2009) stated that LS had a significant role in the AA with 184 students (90 male and 94 female students) in Iran. The findings showed that most male students used verbal and solitary LS, and female students used aural and verbal learning

styles. The AA of female students was more than the AA of male students. Those who use a visual LS have the most significant achievement. Students with logical and physical LS have the most minor AA.

Niroo et al. (2012) investigated the effect of mathematical teaching based on Gardner's MI theory with the assumption that there exists a relationship between logical intelligence and students' mathematical functioning in general and, in particular, in the level of concept knowing, concept application and reasoning from the cognitive perspective. The statistical sampling includes 40 first-grade male students in one public high school in Tehran, and the selection was made through all counts in one educational year (2010-2011). The data was collected through the MI questionnaire and TIMSS questions on the mathematics test. The results indicated that in the case of the pre-test, a significant relationship exists between mathematical intelligence and students' mathematical functioning in general and in levels of application and reasoning; however, such a relation does not exist in the story of knowing. Generally and at all cognitive levels, no significant association was observed between these two variables. This was because in teaching mathematics based on Gardner's MI theory, students with low mathematical intelligence have more remarkable advances in levels of application and reasoning compared to those with high mathematical intelligence.

Pérez et al. (2014) examined the relationships between MI, AA, and motor performance in secondary school children. Four hundred and eighty school children (171 female and 309 male) participated in the study, with an average age of 13.33 years (SD: 1.41). The Revised Self-Efficacy Inventory for Multiple Intelligences (IAIM-R) and the motor test Sport Comp were applied, and the average results of the academic year they had made were obtained. The analysis of the results showed that females scored significantly higher on Linguistic, Spatial, and Interpersonal MI, and older pupils scored considerably higher on linguistic and naturalistic MI. It was the logical MI that showed significant relationships with academic performance, and it was the logical MI that better predicted this achievement. The bodily-kinesthetic MI was significantly related to motor competence, and the best intelligence indicated its achievement.

Rezaeinejad et al. (2015) investigated the LS of high school students and its relationship with educational achievement. The statistical population consisted of 3958 students. According to correlation coefficients, among students in the experiential field, there is a positive significant relationship between students who use Visual-Verbal LS and their

educational achievement score. Similarly, among the students in the mathematics field, there was a positive, meaningful relationship between students who used active-reflective and visual-verbal LS and academic achievement scores. In the Humanities field, there is no significant relationship between the student's LS and their score. Hence, the research stated that different LSs are essential for various disciplines of study.

Paulican and Paulican (2015) explored the relationship between the teacher's teaching style and the student's performance. Using the Grashna-Rechmann (1996) Teaching Style Survey, the teaching style was rated as expert, formal authority, personal model, facilitator, and delegator. On the other hand, the student's performance was determined by the grades they got from the courses taught by the faculty. The correlation between the student grades and the teaching style of the faculty is tested. Results showed that the personal model teaching style in Natural Sciences/Biology was significantly negatively correlated with the performance of the students ($r=-0.863$, $p=0.049$).

Yaghoob and Hosseini. (2016) investigated the relationship between the multiple intelligences and the academic achievement levels of high school students based on Gardner's multiple intelligences theory. A descriptive correlation study with 270 students of the high school of Bandar Abbas was selected by clustered random sampling, and all of them filled out Gardner's multiple intelligences questionnaire. The findings revealed moderate inter-correlation between linguistic and spatial MI and academic achievement ($p<05$). MI, such as logical, spatial, linguistic, intrapersonal, bodily-kinesthetic, interpersonal, and naturalistic, have a significant positive relationship with students' academic achievement ($p<05$). Also, MI, like spatial, linguistic, and interpersonal, were statistically meaningful and could predict academic achievement ($p<05$), with musical intelligence being a tunable negative predictor for academic achievement.

Ahmed et al. (2021) explored teachers' teaching styles and their effect on students' achievement. The study comprised 480 BS students from Education University Faisalabad from 5 classes. The Teaching Styles Survey was used as an instrument. The result showed that the top teaching style of teachers was a demonstrator. Female students had achieved higher grades in the class than that of male class fellows. Female students rated that teachers use formal authority, role models, delegators, and facilitators as the most frequently used teachers' styles. Expert teaching style had a weak positive correlation with demonstrator

teaching style, a moderate correlation with formal authority and facilitator teaching styles, and a strong positive correlation with delegator teaching style.

Mimid et al. (2020) reviewed the MI that students employ for academic performance. The population of this study was 205 students in the 11th grade of senior high school. The results showed that a low correlation existed between MI and academic performance. In other words, MI did not significantly affect academic performance and suggested that MI might not be the only factor that affects achievement. The study also found that Intrapersonal and Musical MI were the least ordinary intelligence employed by the students who participated in the research.

Hu and Yang (2022) conducted an empirical study to explore the teaching effect of English reading with the method of instruction guided by MI Theory. The MI-based education was carried out in the experimental class, while the traditional one was used in the control class. A reading test and interview were held at the end of the experiment. The results showed that English reading in the experimental class improved students' reading ability, especially in solving the questions concerning logical intelligence and spatial MI. It also was found to help stimulate students' reading interest. A variety of classroom activities greatly enhanced their participation and learning passion. This research provided adequate references for implementing MI Theory in junior middle school English Performance.

Vadivukarasi and Gnanadevan (2022) aimed to discover the influence of various dimensions of MI on the academic achievement of higher secondary students. The survey method with stratified random sampling technique has been followed. MI scale of Surbhi Agarwal and Suraksha Pall was used. The AA was measured through the marks the selected higher-secondary students obtained in their examinations. The sample comprises 679 higher secondary students (382 males and 297 females). In the light of the analysis and interpretation of data, the study revealed a significant contribution of various dimensions of MI on the AA of higher secondary students. It further revealed that 28.9% of the total variance in AA was attributed to multiple dimensions of MI.

Raju. and Madhuri's (2023) study determined the influence of LS on AA of government and private secondary school students living in different socio-environments. This study considered three learning styles - visual, auditory, and kinesthetic. A sample of 200 students of class 9th, 10th, and 11th standard of Visakhapatnam District, India, was selected for the study. The study revealed that kinesthetic LS was more prevalent than visual

and auditory learning styles. There was also a positive correlation between kinesthetic LS and AA.

Nanaware and Baviska (2023) identified secondary students' preferred sensory modalities for learning and analysed the association between AA and LS subscales. The study included 100 students selected using simple random sampling from Karnataka's class 8th and 9th-grade students. Findings revealed that the predominant sensory modality of learning was aural and more prevalent than visual and kinesthetic learning (34%). The relationship between LS and AA was statistically significant ($p<0.05$). The main effects of the three variables - visual, auditory, and kinesthetic were also substantial on AA. The female students were more dominant in the blend of all (Collaborative) LS.

To conclude, the reviews collated under the main head of exploring the interrelationship between the four variables of the present study, namely, MI, LS, TP, and AA of the school environment, have found specific gaps, as mentioned below.

- ✓ Studies concerned with the Indian educational environment are very scarce, particularly with TP and LS. Though a handful of studies explore the relationship between MI and AA, not many were conducted with school education
- ✓ Among the many studies that have been cited, no one study has taken the Samacheer Kalvi (Tamil Nadu Unified System of Education) into consideration
- ✓ Almost every study collated either showcased AA as a whole or focused only on one or two subjects. Not even one study has dealt with every subject of study that a student has to learn
- ✓ The most critical gap that had been identified was that every study collated had either taken one construct as a predictor (either MI or LS or TP) with AA as the outcome variable or a maximum of two constructs as predictors (MI and LS or MI and TP or LS and TP) with AA as the outcome variable. This is a common observation in both the global and Indian studies and
- ✓ The constructs considered also had contradictory results in concluding the impact of MI LS or TP on the AA of students. Moreover, the influence of socio-demographic variables on every construct under study was also observed to contradict other related studies.

F. CONCEPTUAL FRAMEWORK OF THE STUDY

The study on "**Predictive Models of Multiple Intelligence, Learning Style and Teaching Pedagogy for the Academic Achievement of School Children**" was planned to be carried on based on certain assumptions that were conclusive of the collated literature.

1. AA cannot be a total measure as a student doing well in one subject may not be the same in the other as knowledge acquisition depends on both student-related and teacher-related factors
2. MI and LS of the students are two constructs gaining significance in predicting their AA. It is also a well-realized fact that different subjects require different sets of MI that a student possesses and LS that they practice
3. Teaching Pedagogy (TP) is a wider term encompassing the instructional materials and strategies practised by the teachers and becomes a crucial predicting factor in determining the AA. All the more, the TP followed by an English teacher cannot be the same as a Mathematics Teacher, as the subjects need a different set of instructions and
4. Though the student-related like MI and LS of students and teacher-related factors, the TP of teachers was assumed to play a significant role in the subject-wise AA of students, the influence of socio-demographic factors cannot be ignored.

With all these four assumptions, the study was undertaken with few research questions

1. Is there an impact of sociodemographic factors on MI possessed and LS practised by a student? Similarly, does the TP adopted by the teacher vary with their profile?
2. Does MI influence Subject-wise AA?
3. Does LS influence Subject-wise AA after controlling MI?
4. Does TP influence Subject-wise AA after controlling MI and LS?

These research questions, in turn, have to be taken together and provide a suggestive model of AA in every subject, integrating all constructs.

Accordingly, the conceptual framework of the study was formulated and depicted in Figure 7.

Conceptual Framework of the Study

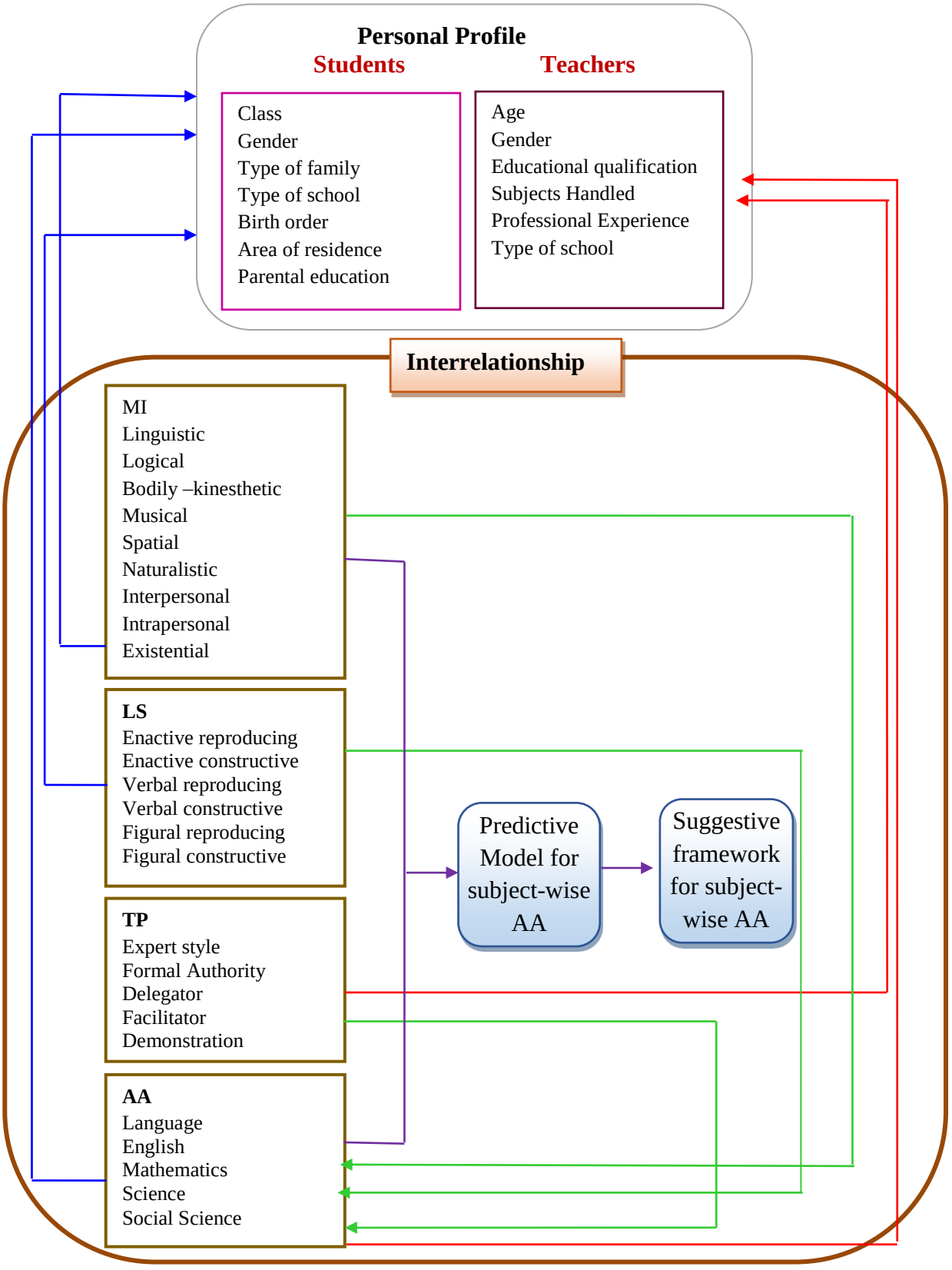


Figure 7