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Learning Styles and Academic Performance of International Baccalaureate (IB) Students in Mathematics

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ABSTRACT

Studying students' learning styles and their impact on academic performance in mathematics is essential for enhancing educational outcomes and tailoring instructional strategies for diverse learners. Within this framework, this descriptive study examined the learning styles of International Baccalaureate (IB) students and their relationship to academic performance in mathematics during the 2023–2024 academic year. Data were collected from 83 student respondents through total enumeration using a researcher-developed questionnaire, which underwent rigorous testing for reliability and validity. The results showed a high preference for visual, reading/writing, and kinesthetic learning styles, with moderate reliance on auditory input. Further analysis revealed no significant relationship between learning styles and academic performance, suggesting that factors such as academic maturity and time management may play a greater role. However, significant differences in academic performance were observed across grade level and amount of time spent on studying, while variations in learning style preferences were noted based on sex, distance from school, and study duration. Specifically, female students demonstrated significantly higher preferences for visual and reading/writing learning styles than male students, while students living farther from school and those with shorter study durations exhibited a greater reliance on auditory learning. These findings emphasize the need to incorporate diverse visual strategies, implement targeted bridging programs to address the "transition shock" among Grade 11 students, provide recorded auditory resources for long-distance commuters, and integrate experiential approaches that connect mathematical concepts to real-world contexts.

Keywords: Academic performance, International Baccalaureate Mathematics, Learning styles

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INTRODUCTION

Each student has unique learning preferences that influence how they process and understand information, which may lead to differences in learning outcomes (Catingub, 2020). Learning styles can be defined as the ways in which individuals perceive and process information during the learning process (Özeke, 2025). Various models have been developed to classify learning styles in education and psychology. One of the most widely recognized frameworks is Neil Fleming's VARK model, which categorizes learners into four preferences: visual, auditory, reading/writing, and kinesthetic (Gangadharan, 2025). These differences in learning preferences underscore the importance of inclusive education, and thus, this study aligns with Sustainable Development Goal 4, which emphasizes inclusive and equitable quality education and lifelong learning opportunities for all (United Nations, 2015). Recent reports further highlight the importance of adapting teaching strategies to meet diverse learner needs and improve learning outcomes (UNESCO, 2017). By examining students' learning styles and their relationship with academic performance in mathematics, this study aimed to contribute to more inclusive and effective instructional practices.

In mathematics, students' performance and problem-solving abilities may be influenced by their learning styles (Mangwende, 2024). According to Retnawati (2022), students' performance in mathematics may be influenced by various factors, including motivation, learning styles, and problem-solving abilities. Anyamene and Odalonu (2022), noted that one important consideration in designing classroom instruction is understanding the relationship between students' learning styles and academic performance. Doing so may help students enhance their learning for improved performance in mathematics (Cardino Jr and Ortega-Dela Cruz, 2020).

The researcher is an International Baccalaureate mathematics teacher at an IBDP accredited school in the Kansai region of Japan. Since the department is following the IB course, the curriculum is international of nature and is more rigorous than a typical Japanese curriculum. As a math teacher of the IBDP course for over 7 years now, the researcher has seen low performing and high performing students in mathematics. I've observed students' different preferences in learning. Some students prefer that they have visual aids such as power point presentations when learning. There are others who are very keen at listening to the lecture. And a good number prefer that they write or read as they learn or would have some occasional activities where they stand and move around in the classroom.

Through this study, the researcher wanted to know if students' learning style has a relationship to their academic performance in Mathematics. The findings could help teachers come up with better teaching strategies to help accommodate learners with varied learning style.

OBJECTIVES OF THE STUDY

This study aimed to determine the level of learning styles of International Baccalaureate (IB) students and their relationship to academic performance in Mathematics in a major city in the Kansai region of Japan during the final term of the Academic Year 2023–2024. Specifically, it sought to assess the students' learning styles in terms of visual, auditory, reading/writing, and kinesthetic modalities. The study also examined whether significant differences existed in the level of learning styles of IB students when grouped according to the identified variables, as well as whether significant differences existed in their academic performance in Mathematics based on the same variables. Furthermore, the study investigated the relationship between the students' learning styles and their academic performance in Mathematics.

LITERATURE REVIEW

Learning styles are recognized as important factors that influence how students process, understand, and retain information. Learners exhibit different preferences in acquiring knowledge, commonly categorized under the VARK model as visual, auditory, reading/writing, and kinesthetic learning styles. These preferences are shaped by individual experiences and learning environments, emphasizing the need for instructional approaches that accommodate learner diversity (Magulod, 2019; Luangrungruang, 2022). Furthermore, learning styles are often flexible and multimodal, with students utilizing multiple approaches depending on the learning context rather than relying on a single dominant style (Zamora, 2023; Demberel & Baasanjav, 2025). The importance of recognizing learning styles lies in their potential influence on student engagement and academic achievement. Studies have shown that students possess varying learning preferences, with kinesthetic, auditory, and visual styles frequently emerging as dominant modes of learning. Teachers who align instructional strategies with these

preferences may enhance learners' participation and understanding of academic content (Godoy, 2023; Lumanog, 2016). Similarly, Clamares and Pelandas (2024) found a significant relationship between learning styles and academic performance, suggesting that students' preferred modes of learning contribute to their academic success.

However, not all studies support a direct relationship between learning styles and academic achievement. Isa et al. (2021) reported no statistically significant relationship between learning styles and academic performance, while Leasa et al. (2020) found that learning styles did not significantly influence students' critical thinking skills. These findings suggest that although learning styles may shape learning preferences, academic outcomes are also affected by other factors, including instructional methods, learning environments, and cognitive abilities.

Academic performance in mathematics is a multidimensional construct that reflects learners' mastery of mathematical concepts, reasoning, problem-solving, and analytical skills. It is influenced by cognitive, behavioral, and environmental factors that affect students' ability to meet academic demands (Department of Education, 2016; Bernardo et al., 2022; Mullis et al., 2020). Research indicates that factors such as sex, grade level, study habits, extracurricular involvement, and distance from school contribute to variations in mathematics achievement among students (Albert et al., 2023; David et al., 2018).

Among these factors, study habits and study time have consistently been identified as important predictors of mathematics performance. Students who demonstrate effective time management, regular review of lessons, and active engagement with learning materials tend to achieve better academic outcomes (Karikari, 2020; Sayyadi, 2019; Flores, 2019). Likewise, participation in extracurricular activities has been associated with positive learning behaviors, discipline, motivation, and academic development, which may indirectly support mathematics achievement (Vicente, 2020; Onoda & Omi, 2023; Freeman, 2017).

Previous studies have also highlighted the influence of demographic and environmental factors on mathematics performance. Gender differences in mathematics achievement have been linked more to social, motivational, and environmental influences than to inherent ability (Nakamuro, 2025; Stoet et al., 2016). In addition, distance from home to school has been shown to affect students' academic outcomes, as longer travel times may reduce study opportunities and contribute to fatigue (Baliyan & Khama, 2020; Peteros et al., 2022). Collectively, these findings indicate that both learning styles and contextual factors play important roles in shaping students' academic performance in mathematics.

METHODOLOGY

This section presents the discussion of the research methodology used, the subjects and respondents of the study, the research instruments used, the validity and reliability of the instruments, the procedure for data gathering, and the statistical tools and procedure for data analysis.

Research Design

This study employed the descriptive method of research in determining the level of Learning Styles of IB students in relation to their academic performance in mathematics during the Academic Year 2023-2024. The descriptive method focuses on describing the characteristics of the population being studied (McCombes, 2023). This method also identifies trends, frequencies, and categories of the focus of the study.

This research design aims to determine relationships between variables, test hypotheses, and develops generalizations on the basis of its findings, so it's the appropriate choice in determining the level of learning styles of IB students and their relation to the level of their academic performance in mathematics.

Study Respondents

The respondents of the study were the 83 IB students enrolled in the IBDP program during the school year 2023-2024. Since the total number of respondents was manageable, total enumeration was employed within the purposively selected group of IB students. According to Mercado-Asis et al. (2021), total enumeration is an approach that includes all eligible participants and therefore covers all members of the target population.

Instruments

The study utilized a researcher-made questionnaire consisting of two parts: the first gathered respondents' demographic information, including sex, grade level, distance from home to school, hours spent on extracurricular or club activities, and study time, while the second measured students' learning styles in the areas of visual, auditory, reading/writing, and kinesthetic learning using 40 items rated on a five-point Likert scale ranging from "Almost Never" to "Always." To ensure validity, the instrument was evaluated by three experts in International Baccalaureate Mathematics education and assessment using the Good and Scates standardized criteria. Their recommendations were incorporated into the final version, resulting in an average validation score of 4.89, interpreted as "excellent," indicating high validity. Reliability was established through a pilot test involving 30 students from a neighboring school who were not included in the study. Using Cronbach's Alpha, the instrument obtained a reliability coefficient of 0.872, which is interpreted as "good," demonstrating that the questionnaire was a reliable and consistent measure of the variables under investigation.

Data Gathering Procedure

The researcher asked for the approval of the school's principal by sending a letter of permission and meeting the principal themself for the conduct of the study. Upon approval, the researcher administered the instrument to the respondents. The administration and retrieval of the research instrument were done through google forms with the help of the homeroom teachers to ensure 100% retrieval. After collecting the data, it was tabulated, analyzed, and interpreted according to the specific problems set forth in this study. Scores of each respondent were encoded according to variables and the computations were done through the use of SPSS software.

Data Analysis and Statistical Treatment

The study employed three analytical schemes descriptive, comparative, and relational based on its research objectives, and the collected data were analyzed in accordance with the objectives presented in Chapter 1. For Objective No. 1, a descriptive analytical scheme using the mean was utilized to determine the level of learning styles of IB students in terms of Visual, Auditory, Reading/Writing, and Kinesthetic dimensions. Objectives No. 2 and No. 3 employed comparative analytical schemes using the Mann–Whitney U test to determine whether significant differences existed in the level of learning styles and the level of academic performance in mathematics, respectively, when students were grouped according to the specified variables. Meanwhile, Objective No. 4 utilized a relational analytical scheme through Spearman's Rho to determine whether a significant relationship existed between the level of learning styles and the academic performance in mathematics of IB students.

Ethical Consideration

Research ethics were carefully observed throughout the study to ensure the protection and well-being of the respondents. The questionnaire was reviewed and approved by the school principal to ensure its appropriateness within the context of Japan. Prior to participation, the purpose of the study and the nature of the questionnaire were clearly explained to the respondents, and their participation was entirely voluntary. Students were informed that they could choose not to participate or withdraw at any time without any consequences, reflecting informed consent. Anonymity was ensured by not collecting any personally identifiable information, and responses were recorded without names. Confidentiality was maintained by securely handling the data and limiting access to the researcher only. Furthermore, the study posed minimal risk, as it did not involve any sensitive or harmful content, ensuring that participants were not exposed to psychological, emotional, or academic harm. These measures were implemented to uphold ethical standards and protect the rights of the respondents.

RESULTS AND DISCUSSION

This section deals with the presentation, analysis and interpretation of data gathered to carry out the objectives of this study. All these were made possible by following certain appropriate procedures so as to give the exact data and solution to each specific problem.

Level of Learning Styles of IB students according to Visual, Auditory, Reading/Writing, and Kinesthetic

Table 1

Level of Learning Styles of IB students in the area of Visual

Items	Mean	Interpretation
As a student, I …		
1. visualize information in my mind to help me better remember it.	3.90	High Level
2. have to see information in order to remember it.	4.04	High Level
3. use outlines, drawings, symbols, diagrams and mind maps to help organize my notes.	3.37	Moderate Level
4. am detail-oriented when it comes to tasks and projects.	3.64	High Level
5. prefer to observe first before I talk or act.	3.78	High Level
6. color-code my notes, vocabulary words, and textbook.	3.45	Moderate Level
7. prefer to present my ideas by using visuals such as illustrations, models, and diagrams.	3.39	Moderate Level
8. can easily understand and recall information presented in pictures, diagrams, or charts.	3.64	High Level
9. prefer to sit near the front of the class so I could better see everything better.	3.19	Moderate Level
10. look at the visuals that go along with the text to help me remember it.	3.76	High Level
Overall Mean	**3.62**	**High Level**

Table 1 illustrates the level of learning style of IB students in the area of Visual. The data reveals that the overall mean score was 3.62, which is interpreted as a "high level". Item No. 9, "As a student, I prefer to sit near the front of the class so I could better see everything better," received the lowest mean score of 3.19, interpreted as a "moderate level". Conversely, item No. 2, "As a student, I have to see information in order to remember it," garnered the highest mean score of 4.04, interpreted as a "high level".

This implies that IB students show a strong reliance on visual stimuli for memory retention rather than viewing it as merely a preference. It suggests that, within the context of a rigorous mathematics curriculum, the use of visual aids such as diagrams, graphs, and written notation may support students in understanding and retaining abstract concepts. These visual representations appear to help learners process information more effectively and connect ideas to long-term memory.

This finding is in line with the study of Haryana et al. (2020), which indicates that many students learn more effectively through visual representations. The study highlights that incorporating visual-based approaches—such as diagrams, charts, and images—can enhance student engagement and support learning.

Table 2

Level of Learning Styles of IB students in the area of Auditory

Items	Mean	Interpretation
As a student, I …		
1. read out loud the information to help me better remember it.	3.01	Moderate Level
2. prefer to listen to class lectures rather than reading from the textbook.	3.71	High Level
3. create songs to help remember information.	1.35	Very Low Level
4. can voice my thoughts well.	3.11	Moderate Level

5. prefer spoken directions from the teacher about the task.	3.53	High Level
6. learn best by hearing information.	3.19	Moderate Level
7. can accurately remember details of information heard in conversations or lectures.	3.23	Moderate Level
8. can concentrate better if there are no distracting background noises.	3.41	Moderate Level
9. benefit from studying through oral group discussions.	3.29	Moderate Level
10. prefer oral presentations to writing essays.	3.00	Moderate Level
Overall Mean	**3.08**	**Moderate Level**

Table 2 presents the level of learning style of IB students in the area of Auditory. The overall mean score was 3.08, interpreted as a moderate level.

Item No. 3, "As a student, I create songs to help remember information," obtained the lowest mean score of 1.35, interpreted as very low level. In contrast, item No. 2, "As a student, I prefer to listen to class lectures rather than reading from the textbook," garnered the highest mean score of 3.71, interpreted as high level.

This implies that IB students show a preference for verbal communication in acquiring and processing information. It suggests that, while textbooks remain an important reference, students tend to benefit from live lectures and spoken explanations when learning new concepts. For these learners, the teacher's verbal delivery appears to support their understanding by helping translate academic content into a more accessible form.

This finding aligns with Kayalar (2017) and Luangrungruang (2022), who emphasize the importance of spoken explanations and verbal interaction in supporting students' understanding. These studies indicate that students with an auditory learning preference tend to rely on auditory input to process and retain information, highlighting the importance of verbal instruction in supporting comprehension.

Table 3

Level of Learning Styles of IB students in the area of Reading/Writing

Items	Mean	Interpretation
As a student, I…		
1. enjoy making lists, reading definitions, and creating presentations.	3.37	Moderate Level
2. find reading my textbook a great way to learn new information.	3.42	Moderate Level
3. take lots of notes during class and while reading books.	3.66	High Level
4. prefer it when teachers make use of blackboards/whiteboards and handouts.	4.41	High Level
5. prefer writing essays to oral presentations	2.95	Moderate Level
6. prefer written feedback for my work or performance.	4.24	High Level
7. tend to do well in multiple-choice and essay tests.	3.42	Moderate Level
8. learn best by writing and rewriting information.	3.88	High Level
9. use bullet points and numbered paragraphs when organizing my thoughts.	4.23	High Level

10. express myself better when writing rather than when talking.	3.33	Moderate Level
Overall Mean	**3.69**	**High Level**

Table 3 displays the level of learning style of IB students in the area of Reading/Writing. The overall mean score was 3.69, which is interpreted as a "high level". Item No. 5, "As a student, I prefer writing essays to oral presentations," received the lowest mean score of 2.95, interpreted as a "moderate level". Conversely, item No. 4, which states, "As a student, I prefer it when teachers make use of blackboards/whiteboards and handouts," scored the highest mean score of 4.41, interpreted as a "high level".

This implies that IB students show a strong preference for structured, instructor-provided written materials in the learning process. It suggests that students are better able to organize their thoughts and confirm their understanding when information is presented through printed text and live-notated board work. These written tools help provide clarity and structure, which may support students in understanding and keeping track of complex mathematical concepts.

This finding is consistent with existing literature on learning styles, particularly within the reading/writing modality. Studies by Ojeh et al. (2017) and Akhlaghi et al. (2018) indicate that learners with a reading/writing preference tend to favor textual input as a key mode of processing information. Ojeh et al. (2017) further explain that such learners rely on written notes and handouts to perceive, organize, and retain new concepts, highlighting the role of structured written materials in supporting academic understanding.

Comparative analysis in the level of Learning Styles of IB students in the areas of Visual, Auditory, Reading/Writing, and Kinesthetic when grouped and compared according to variables Sex, Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying

Table 4

Difference in the level of Learning Styles of IB students in the area of Visual when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	Kruskal Wallis H	p-value	Sig. level	Interpretation
Sex	Male	31	24.85	274.500		0.000		Significant
	Female	52	52.22					
Grade Level	Grade 10	30	40.47		0.454	0.797		Not Significant
	Grade 11	29	41.33					
	Grade 12	24	44.73					
Distance from Home to School	Near	41	40.65	805.500		0.612	0.05	Not Significant
	Far	42	43.32					
Time Spent on Extra-curricular/Club Activities	Shorter	47	41.54	824.500		0.843		Not Significant
	Longer	36	42.60					
Time Spent on Studying	Shorter	50	40.23	736.500		0.409		Not Significant
	Longer	33	44.68					

Table 4 presents the level of visual learning styles of IB students when grouped according to sex, grade level, distance from home to school, time spent on extra-curricular or club activities, and time spent on studying. The results show that when grouped according to grade level, distance from home to school, time spent on extra-curricular activities, and time spent on studying, the computed p-values were higher than 0.05, indicating no significant differences. Thus, the null hypothesis for these variables was accepted, suggesting that these factors do not significantly influence students' visual learning style.

In contrast, a significant difference was found when students were grouped according to sex, as indicated by a p-value of 0.000, which is lower than the 0.05 level of significance. Consequently, the null hypothesis for sex was rejected. The mean rank results further revealed that female students (52.22) demonstrated a significantly higher visual learning preference than male students (24.85).

Overall, the findings suggest that visual learning style is generally unaffected by environmental conditions and academic habits, but it is significantly influenced by sex. This implies that female students tend to rely more on visual tools such as diagrams, graphs, and structured notes in understanding mathematical concepts within the IB curriculum. The results align with related studies indicating that learning style preferences may vary by sex and that instructional effectiveness improves when teaching strategies match students' preferred learning modalities.

Table 5

Difference in the level of Learning Styles of IB students in the area of Auditory when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	Kruskal Wallis H	p-value	Sig. level	Interpretation
Sex	Male	31	39.55	730.000		0.473		Not Significant
	Female	52	43.46					
Grade Level	Grade 10	30	44.42		0.645	0.724		Not Significant
	Grade 11	29	39.40					
	Grade 12	24	42.13					
Distance from Home to School	Near	41	36.35	629.500		0.034	0.05	Significant
	Far	42	47.51					
Time Spent on Extra-curricular/ Club Activities	Shorter	47	39.99	751.500		0.384		Not Significant
	Longer	36	44.63					
Time Spent on Studying	Shorter	50	4718.00	566.000		0.016		Significant
	Longer	33	34.15					

Table 5 presents the level of auditory learning styles of IB students when grouped and compared according to sex, grade level, distance from home to school, time spent on extra-curricular or club activities, and time spent on studying. The results show that when grouped according to sex, grade level, and time spent on extra-curricular activities, the computed p-values were greater than 0.05, indicating no significant differences. Thus, the null hypothesis for these variables was accepted, suggesting that these factors do not significantly influence students' auditory learning style.

In contrast, significant differences were found when students were grouped according to distance from home to school and time spent on studying, as their p-values were lower than 0.05. Consequently, the null hypothesis for these variables was rejected.

The mean rank results further showed that students living "far" from school had a higher auditory preference (47.51) compared to those living "near" (36.35), while students with shorter study time had a higher auditory preference (47.18) than those with longer study hours (34.15).

Overall, the findings suggest that auditory learning preference is less influenced by personal demographics and school involvement, but more shaped by environmental and behavioral factors such as commuting distance and study habits. This implies that students facing longer travel time or limited study opportunities tend to rely more on listening and classroom-based explanations to understand lessons. The results align with studies emphasizing that environmental conditions, time management, and study behavior significantly affect students' learning experiences and academic engagement.

Table 6

Difference in the level of Learning Styles of IB students in the area of Reading/Writing when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	Kruskal Wallis H	p-value	Sig. level	Interpretation
Sex	Male	31	30.26	442.000		0.001		Significant
	Female	52	49.00					
Grade Level	Grade 10	30	40.07		0.873	0.646		Not Significant
	Grade 11	29	40.83					
	Grade 12	24	45.83					
Distance from Home to School	Near	41	45.39	722.000		0.204	0.05	Not Significant
	Far	42	38.69					
Time Spent on Extra-curricular/ Club Activities	Shorter	47	41.16	806.500		0.716		Not Significant
	Longer	36	43.10					
Time Spent on Studying	Shorter	50	39.82	716.000		0.309		Not Significant
	Longer	33	45.30					

Table 6 demonstrates the level of learning styles of IB students in the area of Reading/Writing when grouped and compared according to Sex, Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying.

When grouped and compared according to Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying, the calculated p-values were higher than the 0.05 level of significance, interpreted as "not significant". Therefore, the null hypothesis for these variables was accepted.

However, when grouped and compared according to Sex, the computed Mann-Whitney U test result yielded a p-value of 0.001, which is lower than the 0.05 level of significance, interpreted as "significant". Thus, the null hypothesis stating "there is no significant difference in the level of learning styles of IB students in the area of reading/writing when grouped according to sex" was rejected.

This implies that biological sex is a major determinant in this learning modality. The data reveals a significant difference in Mean Ranks, with females (49.00) scoring substantially higher than males (30.26). In the context of the rigorous IB mathematics

curriculum, this suggests that female students rely much more heavily on the power of the written word—utilizing detailed note-taking, printed handouts, and textbook definitions—to perceive and process complex abstract information. For these students, the act of "writing to learn" is a primary cognitive anchor, whereas their male counterparts may not find this specific sensory input as essential for academic mastery.

This finding aligns with Farman et al. (2021), who observed that learning style preferences may vary between male and female students across different sensory modalities. Similarly, Mozaffari et al. (2020) explain that students engage with information differently depending on their preferred modalities, influencing how they understand and retain knowledge. This may help explain the stronger preference for reading/writing approaches observed among the female students in the present study.

Table 7

Difference in the level of Learning Styles of IB students in the area of Kinesthetic when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	Kruskal Wallis H	p-value	Sig. level	Interpretation
Sex	Male	31	41.05	776.500		0.781		Not Significant
	Female	52	42.57					
Grade Level	Grade 10	30	40.70		0.363	0.834		Not Significant
	Grade 11	29	41.31					
	Grade 12	24	44.46					
Distance from Home to School	Near	41	44.60	754.500		0.331	0.05	Not Significant
	Far	42	39.46					
Time Spent on Extra-curricular/ Club Activities	Shorter	47	40.13	758.000		0.417		Not Significant
	Longer	36	44.44					
Time Spent on Studying	Shorter	50	38.21	635.500		0.077		Not Significant
	Longer	33	47.74					

Table 7 presents the level of learning styles of IB students in the area of Kinesthetic when grouped and compared according to Sex, Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying.

When grouped and compared according to Sex, Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying, all calculated p-values were higher than the 0.05 level of significance, which is interpreted as “not significant”. Consequently, the null hypothesis stating that there is no significant difference in the kinesthetic learning style when grouped by these variables was accepted for all categories.

This indicates that the preference for kinesthetic learning—perceiving and processing information through physical experience and “learning by doing”—is a common and relatively stable characteristic among IB students. Unlike the Visual or Auditory domains, which showed variations based on sex or study habits, the Kinesthetic modality remained consistent across the student population. This finding corresponds with the perspective that VARK learning styles focus on sensory modalities and provide a flexible framework that may be applied across different educational contexts. Although Bostancı (2020) notes that kinesthetic preferences can be influenced by applied lessons or sports-oriented backgrounds, the relatively similar results across groups may

suggest that students in the IB programme develop or maintain comparable experiential learning preferences. Likewise, Isa et al. (2021) and Farman et al. (2021) explain that while students may have individual ways of processing information, learning styles are often balanced or multimodal and may not necessarily vary according to demographic variables.

Comparative analysis in the level of academic performance in mathematics of IB students when grouped and compared according to variables Sex, Grade Level, Distance from Home to School, Time Spent on Extra-Curricular/Club Activities, and Time Spent on Studying

Table 8

Difference in the level of academic performance in mathematics of IB students when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	Kruskal Wallis H	p-value	Sig. level	Interpretation
Sex	Male	31	40.32	754.000		0.624		Not Significant
	Female	52	43.00					
Grade Level	Grade 10	30	42.75		43.220	0.000		Significant
	Grade 11	29	21.79					
	Grade 12	24	65.48					
Distance from Home to School	Near	41	40.34	793.000		0.535	0.05	Not Significant
	Far	42	43.62					
Time Spent on Extra-curricular/ Club Activities	Shorter	47	43.19	790.000		0.607		Not Significant
	Longer	36	40.44					
Time Spent on Studying	Shorter	50	36.22	536.000		0.007		Significant
	Longer	33	50.76					

Table 8 presents the differences in the academic performance in mathematics of IB students when grouped according to sex, grade level, distance from home to school, time spent on extra-curricular or club activities, and time spent on studying. The results of the Mann-Whitney U test showed that sex, distance from home to school, time spent on extra-curricular activities, and time spent on studying (in general grouping) yielded p-values higher than 0.05, indicating no significant differences. Thus, the null hypothesis for these variables was accepted, suggesting that these factors do not significantly influence students' mathematics performance.

In contrast, significant differences were found when students were grouped according to grade level and time spent on studying, as reflected by p-values lower than 0.05. Consequently, the null hypothesis for these variables was rejected. The mean rank results further revealed that Grade 11 students performed lower (21.79) compared to Grade 10 (42.75) and Grade 12 (65.48), indicating a possible transition difficulty during the intermediate level of the IB program. Likewise, students who spent more time studying obtained higher mean ranks (50.76) compared to those who studied less (36.22), highlighting the importance of sustained study effort in improving mathematics performance.

Overall, the findings suggest that demographic variables and extracurricular involvement have minimal impact on mathematics achievement, while academic maturity and study habits play a more crucial role. The results align with related studies emphasizing that increasing academic demands across grade levels influence student performance, and that students' readiness and

adaptability are key determinants of success. Furthermore, consistent with existing literature, effective study habits and time management significantly enhance mathematics outcomes, while sex differences appear to be negligible, indicating that performance is more strongly shaped by environmental, cognitive, and behavioral factors rather than biological distinctions.

Correlational analysis between the level of Learning Styles of IB students and their level of academic performance in mathematics

Table 9

Relationship between the level of Learning Styles of IB students and their level of academic performance in mathematics

Variable	rho	p-value	Sig. level	Interpretation
Level of Learning Style **Level of Academic Performance in Mathematics**	0.084	0.448	0.05	Not Significant

Table 9 presents the relationship between the level of learning styles of IB students and their level of academic performance in mathematics.

The data reveals that the calculated Spearman's rho value was 0.084 with a p-value of 0.448. Since the p-value is higher than the 0.05 level of significance, the result is interpreted as "not significant". Thus, the null hypothesis stating that "there is no significant relationship between the level of learning styles of IB students and their level of academic performance in mathematics" was accepted.

This implies that a student's preferred sensory modality—whether they are visual, auditory, reading/writing, or kinesthetic—does not directly dictate or predict their success in the IB mathematics curriculum. While IB students certainly have unique ways of perceiving and processing information, these preferences do not necessarily translate into higher or lower grades. In the context of the rigorous international IB curriculum, this suggests that academic achievement is likely influenced by a constellation of other factors—such as study habits, time management, and academic maturity—rather than the specific sensory "lens" a student uses to learn. Essentially, a student can reach a high level of performance (Level 4 or 5) regardless of their dominant learning style, provided they engage effectively with the material.

The result of this study is supported by the findings of Isa et al. (2021), who demonstrated that there is no statistically significant relationship between learning styles and academic performance, suggesting that learning styles alone do not directly contribute to achievement. This is further supported by Leasa et al. (2020), who found that learning styles did not have a significant influence on the development of critical thinking skills, indicating that the way information is received and processed is not necessarily a determining factor in the development of complex cognitive abilities. Additionally, the lack of significance aligns with the understanding that VARK models are primarily oriented toward sensory modalities or the human physiological dimension, providing a practical framework for how students prefer to learn rather than serving as a direct predictor of learning outcomes. While various models classify learning preferences, the literature suggests that academic performance is a multidimensional construct influenced by a combination of cognitive, behavioral, and environmental factors. Finally, as observed by Farman et al. (2021) and Demberel and Baasanjav (2025), students often exhibit multimodal and flexible tendencies, adapting their approaches to specific learning situations, which may help explain why a single dominant learning style does not necessarily determine academic success.

CONCLUSION

The study found that most IB students were female, with Grade 10 comprising the largest group. Students generally exhibited high preferences for Visual, Reading/Writing, and Kinesthetic learning styles, while Auditory learning was at a moderate level, with experiential and hands-on activities being the most preferred approach. Female students demonstrated significantly stronger Visual and Reading/Writing preferences than male students, while students living farther from school and those spending less time studying showed greater reliance on Auditory learning. Academic performance in mathematics varied

significantly by grade level and study duration, with Grade 12 students and those who studied longer achieving higher performance levels. Despite these differences, Kinesthetic learning preferences remained consistently high across all groups. The findings further revealed no significant relationship between learning styles and mathematics performance, indicating that academic achievement is influenced more by factors such as academic maturity, adaptability, study habits, and time management than by students' preferred learning styles. Consequently, while learning styles help explain how students prefer to process information, they do not directly predict success in mathematics within the IB curriculum.

RECOMMENDATIONS

Based on the results and conclusions of the study, several recommendations were formulated to enhance student learning and academic performance in the IB Diploma Programme. The IB DP Department should implement a mandatory Time Management and Productivity Workshop each semester, particularly for students who experience long commuting distances, to help them maximize "dead time" for review and active recall. In addition, the Mathematics Department is encouraged to integrate at least one experiential or hands-on activity per unit to strengthen students' strong preference for kinesthetic learning and improve real-world application of mathematical concepts. Teachers should also enhance instructional design by incorporating more visual and reading/writing strategies such as concept maps, graphic organizers, annotated examples, infographics, step-by-step guides, and visual summaries, alongside improved classroom arrangements to ensure clear access to learning materials. To support consistent study habits linked to higher performance, weekly independent study guides with structured schedules and practice activities should be provided. The provision of auditory learning resources such as recorded lectures and verbal explanations is also recommended to support students with limited study time due to commuting. Furthermore, a targeted Grade 11 bridging program should be implemented to help students adjust to the increased academic demands of the curriculum through scaffolded materials and guided review sessions. Lastly, students should be encouraged to engage in self-reflection activities on their learning styles, while future researchers are advised to explore other influential factors such as motivation, self-regulation, emotional intelligence, and academic resilience that may better explain academic performance beyond learning styles.

Conflict of Interest

The authors declare the absence of any conflict of interest that could have influenced the content or conclusions of this paper. They affirm that no financial, personal, or professional relationships with other individuals or organizations have compromised the objectivity, integrity, or impartiality of the research work. As a final point, no external parties influenced the study design, data collection, analysis, or interpretation.

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