Education Quarterly Reviews

Budu, G. B., Kemetse, J. K., & Amponsah, K. D. (2022). A Ghanaian Study on Multiple Intelligences of Pre-Service Science Teachers in Selected Colleges of Education. *Education Quarterly Reviews*, 5(1), 15-27.

ISSN 2621-5799

DOI: 10.31014/aior.1993.05.01.414

The online version of this article can be found at:
https://www.asianinstituteofresearch.org/

Published by:
The Asian Institute of Research

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The Asian Institute of Research
Education Quarterly Reviews
Vol.5, No.1, 2022: 15-27
ISSN 2621-5799

DOI: 10.31014/aior.1993.05.01.414

A Ghanaian Study on Multiple Intelligences of Pre-Service Science Teachers in Selected Colleges of Education

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Abstract
The Multiple Intelligence (MI) Theory has been recognised for its significance in education. This study aimed to provide a detailed examination of each intelligence and illustrate how different MIs work. The current study seeks to discover and link pre-service science teachers' numerous intellectual domains and learning style profiles. The survey method was used for the study, which included 150 pre-service science teachers. The "multiple intelligence domains inventory for educators" was utilised to collect data for the study. According to the findings, the use of MIs in science teaching is rarely mentioned, with the features of each intelligence in the context of the various science teaching methodologies. Further, the results indicated that the intelligences mentioned by Gardner could be found in the pre-service teachers in beginning their teaching. Logical-Mathematics was highly advanced among pre-service science teachers with the musical intelligence being the lowest. Gender differences were also found to exist between males and females in only two of the eight MIs, specifically, Logical-Mathematics and Visual-Spatial, which was also significant.

Keywords: Academic Performance, Intelligent Quotient (IQ), Multiple Intelligence (MI), Multiple Intelligence Strategy, Pre-Service Science Teachers

1. Introduction

The presence of several capabilities of students in the Ghanaian education system has been noticed over time but due to the inability to exploit these capabilities practically, much harm has been done to the country in terms of academic achievement of the students that could translate into positive social transformation. According to King (2011), education is the basis for the growth and development of a nation in that the human mind makes innovations in every sector when the potential of every mind is unleashed. In light of this, the access to education in Ghana has been expanded appreciably, yet the country lacks the cutting edge on the global front in terms of innovation and invention. This failure to make innovations can be accounted for by having a narrow definition of

intelligence as an Intelligence Quotient (IQ)-based ability. However, Gardner, states that the traditional concept of intelligence based on IQ tests is very much narrow (Armstrong, 2009). It is against this backdrop that Gardner (1983) proposed the theory of Multiple Intelligences (MI) by indicating that learning occurs through various intelligences, with varying levels of each. This theory initially proposed seven types of intelligences: linguistic, logical-mathematical, spatial intelligence, bodily-kinesthetic, musical, interpersonal, and intrapersonal intelligences. He later added an eighth intelligence in 1995 called the naturalist intelligence. Though there are nine identified intelligences currently, for our educational purposes this research limited itself to the first eight intelligences.

The awareness of various intelligences in our schools must emphasise the importance of the MI theory. Students' actions in the classroom during lessons, as well as their behaviours outside of the classroom, contribute to this awareness. Many intelligences are discovered through classroom experiences, where learners gain a variety of inherent abilities. Teachers are therefore responsible for unearthing these abilities via experiences in the classroom by applying a number of pedagogical strategies. Their willingness to make use of these skills and abilities facilitates their career development and placement. These abilities can be harnessed in the classroom by identifying and nurturing the innate ability each student has rather than letting the ability to die out. These innate abilities when properly nurtured, may hand the students very important skills needed in our country for development (Morgan, 2014).

Teachers are extremely crucial in a child's education, and as a result, they must be well-prepared, experienced, and informed (Morgan, 2014). They play the major role of a learner’s performance academically. All around the world, science education has been employed as a true instrument for social change with a focus on socio-economic development and empowerment. As a reflection, various insights require that instructor’s job is integral to the learning encounters where more realities about learners should be found, explicitly in scholarly execution or in skilled areas. A pre-service science teacher bears a great deal of responsibility for inspiring students to enjoy and learn about integrated science. They should think of fresh ways to make integrated science engaging and enjoyable for their students. Whatever their scientific background, teachers should seek out new methods and resources to improve the quality of chemistry education for all pupils. To accomplish this, the facilitator or the instructor turns to an impetus, an aide and hence the main thrust to recognise the child’s capabilities (Ankomah & Kwao, 2019).

One complex and significant subject is science; therefore, science education should be instructed by able educators especially specialised science educators or teachers utilising the more impressive system that will contact every one of learner’s possibilities of intensive commitment in a comprehensive assignment. It is against this backdrop that the researchers proposed Multiple Intelligence teaching strategy which is in sharp differentiation to the traditional methodology of comprehension and communicating one’s insights. That is to say traditional learning focuses on training one or two typical intelligences, and a learner's performance is evaluated based on his or her achievement in these typical intelligences. In the conventional context, learning is accomplished through teacher-centered instructions that necessitate extensive memorising (Mpho, 2018). If not practiced in a reasonable fashion, this method of instruction may be helpful for student-teachers who are linguistically proficient, but it will be ineffective for others. Multiple Intelligence Teaching Strategy (MITS) is another direction against the seemingly perpetual regular strategies for instructing and making a decision about learners’ insight dependent on capacity to tackle issues. Multiple intelligence proponents believe that every learner has these insights that can be incorporated into the science teaching process, where a specific intelligence will not be the sole tool for determining a pre-service science teacher's aptitude in integrated science and where achievement will be judged from a variety of perspectives, though they may not be developed well or successfully.

2. Statement of the Problem

Ghana's educational system suffers from a lack of resources at all stages of education, especially in the first and second cycles (Education, UNICEF Ghana, 2015). In spite of this, teachers continue to use the lecture method to teach students, concentrating on their cognitive dimension. Studies have shown that the bulky nature of the curriculum makes teachers employ the lecture method (Amponsah, 2020; Amponsah, Boateng, & Mohammed; Amponsah & Ochonogor, 2016a & b) to enable them finish the syllabus on time instead of innovative methods

like collaboration, learning cycle, or multiple intelligences (Amponsah, Kotoka, Beccles, & Dlamini, 2018; Amponsah & Ochonogor, 2018). As a result, most students fail their terminal examination and this makes them believe that they are not academically capable (Ponsford & Lapadat, 2001), and they may feel inferior to their peers. However, they are also responsible for establishing their own learning style, which is very disturbing. Meanwhile, such students are not necessarily stupid because they may have other intelligences that teachers have yet to discover and analyse. In some instances, these students may also be completely oblivious of their full potentials (Morgan, 2014), which presents a problem to science teachers in the science classroom. Thus, if these pre-service science teachers are able to identify their MIs, it could be translated into their classroom practice that will go a long way to support their students. As a result, determining their intelligence profile appears to be an important part of exploring each student's capabilities in order to create an all-round learner, which entails knowing about the intelligence dimension and emphasising the more developed one while balancing it with the least developed without ignoring it. For example, if a teacher's performance with verbal and mathematical intelligence is restricted, he or she may be able to achieve more success by utilising other intelligences. Thus, the aim of this research is to classify the various forms of multiple intelligences of a group of Ghanaian pre-service science teachers in order to help them implement same to assist their students to unearth their potentials in the future in their careers. It will also inform them about the relevance of engaging in the Multiple Intelligence strategy.

3. Objectives of the Study

3.1 General objectives

To identify the Multiple Intelligences profile of some Ghanaian pre-service science teachers. It will also unearth the general perceptions of pre-service science teachers about the effects of knowing students' individual intelligences by using MI based teaching instructions.

3.2 Specific objectives

1. To examine the various types of MIs possessed by pre-service science teachers.
2. To identify the predominant Mis that pre-service science teachers possess.
3. To ascertain whether gender accounts for disparity in the intelligences pre-service science teachers possess.

4. Research Questions

This research aims to answer the following questions:

1. What are the different sorts of MIs that pre-service science teachers possess?
2. What are the most common types of MIs among pre-service science teachers?
3. What gender-based disparities in MI do pre-service science teachers possess?

5. Literature Review

5.1 Theoretical Framework

Howard Gardner first introduced the theory of multiple intelligences in his 1983 book "Frames of Mind," in which he expands the understanding of the term and identifies numerous separate sorts of mental prowess. While examining each "candidate" intelligence, Gardner devised a set of eight inclusion criteria based on a number of scientific areas. We may all have these intelligences, he says, but our particular profiles of these intelligences may differ based on genetics or experience. Gardner describes intelligence as a "biopsychological capacity to process information that can be engaged in a cultural situation to solve problems or create products of cultural worth" (Gardner, 2000, p.28).

- This theory questioned the conventional wisdom that there is only one sort of intelligence, also referred

to as "g" for general intelligence, which is solely concerned with cognitive ability.

- Linguistic, Logical/Mathematical, Spatial, Bodily-Kinesthetic, Musical, Interpersonal, Intrapersonal, and Naturalist intelligences were introduced by Gardner to widen this concept of intelligence.
- Linguistic and logical-mathematical modalities are the most prized in school and society, according to Gardner.
- Gardner additionally argues that there may be other "candidate" intelligences, such as spiritual, existential, and moral intelligence, but that these do not fit his initial inclusion criteria (Gardner, 2011).

5.1.1 Linguistic/verbal intelligence

Linguistic intelligence is concerned with language responsiveness, language learning capacity, and the capacity to use language to achieve specific objectives (Marnus, 2020). It is the ability to comprehend words, language, and linguistic meanings. People with this type of intelligence tend to; possess a wide vocabulary in the languages they know, enjoy reading, love reading and writing, possess the ability to learn languages quickly and the last is, possess the ability to understand a sentence structure's complexity. ("Linguistic intelligence and its benefits," n.d.) Linguistic intelligence establishes a foundation for the development of other forms of intelligences. According to a post titled "Importance of linguistic intelligence" (2020), linguistic intelligence may develop our cognitive capabilities, which may assist us in organizing our ideas alongside sharpening our analytical abilities.

5.1.2 Logical-mathematical intelligence

Mathematical/logical intelligence is the range to recognize designs, work with abstract symbols (e.g., geometric shapes, numbers), and perceive relation or see the relationship between separate and clear pieces of information. This intelligence is the ability to assess situations or issues rationally, discover solutions, conduct scientific research, and solve logical or mathematical operations with simplicity (MentalUP Educational Games, 2019). Persons with a high level of mathematical intelligence deconstruct their information by applying logic and examining cause-and-effect links. Over subjective information, they favour explicit facts and realistic figures. Individuals that are mathematically intelligent can also make inferences and make observations. Logsdon (2021), suggests that children with high logical-mathematical intelligence love arithmetic, computer science, technology, drawing, design, chemistry, and other "hard sciences" in school.

5.1.3 Spatial intelligence

Spatial intelligence is the ability to detect and draw understanding from visual input or data. People who have this spatial aptitude are generally able to generate effective pictures that convey concepts and develop prototypes that use spatial reasoning (Fitzgibbons, 2019). Learners that are visual-spatial require the ability to see what they learn. They have remarkable ability to put what they see in their heads into tangible form. They learn best when colour and variety of audiovisual stimuli are used (Fuini & Gray, 2000). They learn through thinking, envisioning, and constructing mental images in their heads. Jigsaw puzzles, maps, colors, and decorations all appeal to these students (Bilgin, 2006).

5.1.4 Bodily-kinesthetic intelligence

Bodily-kinesthetic learning is sometimes known as "hands-on" or "physical" learning. Students' bodies assist them in understanding and remembering as they engage in amusing acts. Such students can recognize the final aim of a physical activity, have a keen sense of timing, and alter their responses quickly. According to Bilgin (2006), this intelligence is found in students that learn best via activities: games, movement, hands-on chores, and building.

5.1.5 Musical/Rhythmic intelligence

This involves the capacities such as identification and usage of the rhythmic and tonal designs and sensitivity to sounds from human voice, the environment and musical instruments. Students with this intelligence can even make up amusing tunes to help them recall historical events, geographic locations, or numerical topics. These are the

ones that are constantly humming or drumming their fingers (Fuini & Gray, 2000). Students with high levels of this intelligence enjoy music and rhythmic patterns, and they are attentive to sounds in their surroundings. They have musical ears, which allows them distinguish various musical patterns and instruments with ease. When there is musical beat to the content of their study, they learn best (Bilgin, 2006).

5.1.6 Interpersonal intelligence

Interpersonal intelligence is defined by sensitivity to the moods, thoughts, temperaments, and motives of others. Bilgin (2006) suggests that this intelligence is shown in children who are clearly people oriented and gregarious. Students can enhance their interpersonal intelligence by working in groups.

5.1.7 Intrapersonal intelligence

Intrapersonal intelligence is concerned with the ability to be introspective and self-reflective. It refers to a thorough knowledge of oneself, including one's strengths and weaknesses. Students will benefit from understanding that laughing at their mistakes is a non-threatening path to increase self-understanding. In fact, the ability to better understand ourselves by laughing at our flaws or blunders is a non-threatening path to increase self-understanding (Bilgin, 2006).

5.1.8 Naturalist intelligence

Chapman (1996) defines naturalist intelligence as the capacity to adapt to and survive in one's environment. Naturalist students must recognize links between their thinking and the natural world (Fuini & Gray, 2000). Students with this sort of intellect may have a deep attachment to the outer environment, which can start at a young age.

5.2 Empirical Review

The literature emphasises the use of multiple intelligences in the classroom and the results produced. Integrated science (biology, chemistry and physics), as one of the most complex subjects, needs more qualified teachers and a more effective strategy to reach all students' potentials through holistic task participation. The multiple intelligences (MI) theory acknowledges that students in the same class have a wide range of abilities (Maphalala, 2017). MI research has been discovered around the world in Europe, Asia and the American continent. In Spain, Gomes's (2007) performed an investigation and the results showed that teacher belief plays a significant role in student performance. Gomes also emphasises the importance of teachers taking into account students' preferences in the learning process. Some research also discovered that an action research study found that using the MI theory could activate each student's full learning potential (Emendu & Udogu, 2013; Morgan, 2014; Winarti, Yuanita, & Nur, 2019; Yalmanci, Gozum, 2013), resulting in a positive effect on both teachers and students.

According to Lunenburg (2014), visual, musical, and bodily-kinesthetic stimuli are used by students in science courses. However, a study about MI found in the U.S from the University of Rochester on organic chemistry students depicts two other different intelligences. Ruffner (2011), found the dominant type of intelligences among some 20 chemistry students to be logical-mathematical, bodily-kinesthetic, and interpersonal intelligences. Hence a teacher teaching such students would have to strategically put up a structure of delivering chemistry to them in a way that enforces or addresses these intelligences more.

In Taiwan, Cheng (2010) conducts a study and finds that gender differences in MI, motivation, strategy utilisation, and learning styles do affect students' performance in English learning to some extent. Also, in India, Kaur (2014) in his quest to understand multiple intelligences in terms gender observed that the majority of the respondents had average levels of aptitude for all eight components of Gardner's multiple intelligences, according to the findings of the inquiry. The survey also discovered that eighth-grade boys scored themselves higher on Visual-Spatial Intelligence than eighth-grade girls. Musical, Logical-Mathematical, Bodily-Kinesthetic, and Naturalist intelligence showed substantial gender differences in ninth grade. It was discovered that in ninth grade, girls took

a little lead, whereas in eighth grade, boys were ahead of girls. Female students, compared to previous research, tended to rank themselves higher in most intelligences, and their means in the areas of naturalistic and existential intelligences were substantially higher than male learners, according to Zare-ee et al. (2015). According to a study conducted in a Malaysian school, both instructors and students recognise MI as an important aspect of successful learning (Zainudin, 2012). According to the statistics, XU (2020) revealed in his study in China that both male and female learners had a high self-perceived Musical Intelligence. Furthermore, there were differences in their self-perceived MI, with male learners self-perceiving three intelligences to be higher than female learners: mathematical-logical intelligence, body-kinesthetic intelligence, and interpersonal intelligence.

6. Method

6.1 Research Design

This research examined multiple intelligences of pre-service science teachers in selected colleges of education using a cross-sectional descriptive survey research design (Ihudiebube-Splendor & Chikeme, 2020). Descriptive cross-sectional studies provide information about the current state of phenomena or their relationships at a specific period. Participants in a cross-sectional study are chosen based on the study's inclusion and exclusion criteria. The use of a cross-sectional descriptive survey design is justified by the fact that it is more cost-effective and faster to collect data. Furthermore, the cross-sectional descriptive survey allows for the collection of a wide range of data while also assuring that a large number of samples are accessed. It also helps to perform a study that will enable one to measure and compare several variables at a single point in time. Furthermore, a higher level of work quality is achieved because more accurate data may be collected under the right conditions. Sample surveys have substantial difficulties when it comes to gathering basic information for every unit of the population. Sampling errors are more prevalent with smaller sample sizes. The advantages of a descriptive sample survey, however, far outweigh the downsides, given the uniformity and size of the study's target population.

6.2 Population and Sample

All the pre-service science teachers of selected Colleges of Education formed the target population but due to the restrictions COVID-19 has imposed on mass gatherings, only levels 200 and 300 pre-service science teachers were easily accessible for participation in the study. The target population was all pre-service teachers in the selected colleges of education. The underlying assumption in selecting students in these levels was as a result of the modular system run by the colleges.

6.3 Sampling

The study was carried out with a total of 150 pre-service science teachers in selected colleges of education. The respondents were selected from levels 200 and 300 pre-service science teachers. Selection of participants was based on convenience and purposive sampling. Students were sent links on various social media platforms to answer the questionnaires created with Google forms.

6.4 Instruments

Multiple intelligence inventory was used to collect data about the multiple intelligence profile and the learning styles of the pre-service science teachers. This inventory has been used in several studies, and considered as valid and reliable. The reliability coefficient for this research was .78. Pre-service science teachers were given the survey questionnaires made up of 24 statements on multiple intelligences to ascertain their opinions about the different learning techniques they have experienced inside and outside the classroom. The questionnaire consisted of four sections. The first section answered questions regarding their demographic information, the second on knowledge on effect of multiple intelligences of pre-service science teachers. Given a scale of 1 to 5, they were asked to rate the extent they agree or disagree on each item provided in the questionnaire. The third section asked about their learning style in connection with the eight types of intelligences in that section, with each MI having three (3) statements. For each statement, students have to write a corresponding number of the scale presented at the

beginning: from 0 to 4 (0 = Unadvanced, 1=Slightly advanced, 2=Moderately advanced, 3=Advanced, 4= Highly advanced). Finally, the last section rates the extent they agree or disagree with the benefits which student-teachers can derive from the multiple intelligences by Howard Gardiner, where participants have to select a corresponding number on the scale of 1 to 5, where 1=Totally disagree, 2=Disagree, 3=Neutral, 4= Agree, 5=Totally agree.

6.5 Procedure for Data collection.

With the use of Google forms, the questionnaire was sent to the sample on their various WhatsApp platforms to be filled with the help of their course representatives. The purpose of the study was explained to them through an introductory letter from the Head of Department of Teacher Education, University of Ghana. The process was monitored until 150 respondents were obtained.

7. Results

7.1 Demographic information

The study sought to find out the following information such as age, gender, level, religious status and learning style about the respondents. With regard to the demographic distribution, the outcome of the responses is presented in Table 1.

Table 1: Descriptive statistical data of socio-demographic details of pre-service science teachers

Variable	Category	Frequency	Percentage (%)
Gender	*Males*	78	52
	Females	72	48
Level of Education	200	85	66.6
	300	65	33.4
Religious status	*Christian*	112	74.7
	Islam	31	20.6
	Traditional	7	4.7
Learning style	Memorization	61	40.6
	Discussion	53	35.3
	Analysis	32	21.3
	Prefer not to say	4	2.7

From Table 1, males were more than females representing 52% and 48% respectively with a mean age of 22 years. On the level of education, it was found out that the level 200 (66.6%) respondents were more than that of level 300 (33.4%). Most of the respondents were Christians followed by the Islam and a few traditionalists of percentages of 74.7%, 20.6% and 4.7% in descending order. Interestingly, respondents have a variety of learning styles, which are defined as the method of learning and the sort of intelligence profile that such a respondent should have, as shown in Table 1.

The multiple Intelligence domains of a Ghanaian Pre-service science teacher

Research question 1: What are the various types of MIs possessed by pre-service science teachers?
Many are the intelligences inherent in most Ghanaian pre-service science teachers. From the research question 1, the intelligences mentioned by Gardner can be found in the pre-service teachers in the beginning of their teaching. In as much as the eight intelligences can be seen in the pre-service science teacher, the intelligence profile is proportioned in a way such that one of the intelligences is exhibited more or developed more than the other intelligences. Table 2 shows that Ghanaian pre-service teachers used in this study exhibit all the eight MIs in the classroom.

Table 2: Multiple Intelligence Profile of Pre-service science teachers

Variable	Frequency (N=150)	Mean	SD
Verbal- Linguistic	150	5.1267	2.43105
Logical-Mathematic	150	6.0200	2.03483
Bodily-Kinesthetic	150	5.7800	2.26994
Visual-Spatial	150	5.6467	2.14925
Musical	150	4.7467	2.37489
Interpersonal	150	5.4667	2.37342
Intrapersonal	150	5.6867	2.11145
Naturalistic	150	5.1267	2.43105

Research Question 2: What is the predominant type of MIs pre-service science teachers have?

Table 3 examined the advancement levels of the pre-service science teachers' multiple intelligence domains. From table 3, it is observed that logical mathematics with a mean score of 6.02 is the highest intelligence found in pre-service science teachers followed by bodily-kinesthetic with a mean score of 5.7 approximately 5.8, the third is Intrapersonal and the least intelligence to be found according to the research is the musical intelligence with a mean score of 4.7.

Table 3: Advancement levels of the pre-service science teachers' multiple intelligence domains

Variables	Mean	SD	Minimum	Maximum	Level
Verbal- Linguistic	5.1267	2.43105	.00	9.00	Moderately advanced
Logical-Mathematics	6.0200	2.03483	2.00	9.00	Highly advanced
Bodily-Kinesthetic	5.6467	2.14925	.00	9.00	Advanced
Visual-Spatial	4.7467	2.37489	1.00	9.00	Slightly advanced
Musical	5.7800	2.26994	.00	9.00	Advanced
Interpersonal	5.4667	2.37342	.00	9.00	Moderately advanced
Intrapersonal	5.6467	2.11145	1.00	9.00	Advanced
Naturalistic	5.1267	2.43105	.00	9.00	Moderately advanced

The Table depicts the intelligences of some being dominant and some less dominant, resulting from their way of learning and how they understand what they have been taught. It was observed that only Logical-Mathematics was highly advanced among pre-service science teachers. This is not surprising as these students have strong mathematical background to be able to pursue science. Similarly, it is also not a coincidence that Bodily-Kinesthetic is advanced in these pre-service science teachers. Science involves practical activities and as such a science student must exhibit the characteristics required to be able to perform hands-on activities.

Research Question 3: What differences in MI do pre-service science teachers have based on gender?

Results on MI on pre-service science teachers based on gender are presented in Table 4. From the Table it is observed that apart from bodily kinesthetic where females have a higher mean than males, all the means in the remaining seven were higher for males.

Table 4: Mean ratings of pre-service science teachers' multiple intelligence domains according to their gender

MIs	Gender	N	Mean	Std. Deviation	Std. Error Mean
Verbal intelligence	males	78	1.7179	.96561	.10933
	females	72	1.6111	1.12031	.13203
Logical-mathematical	males	78	2.3974	.74450	.08430
	females	72	2.0000	.94943	.11189
Bodily-kinesthetic	males	78	1.7949	.95834	.10851
	females	72	1.9167	.96049	.11319

Visual-spatial	males	78	1.9103	1.02166	.11568
	females	72	1.2361	1.05474	.12430
Musical	males	78	1.3590	1.09277	.12373
	females	72	1.2361	.98572	.11617
Interpersonal	males	78	1.9487	.93832	.10624
	females	72	1.6528	1.07677	.12690
Intrapersonal	males	78	2.1667	.79637	.09017
	females	71	2.0986	.95849	.11375
Naturalistic	males	78	2.1026	.81527	.09231
	females	72	1.7917	1.12510	.13259
Total	Respondents	150			

The variances of the two groups in the population are comparable, which is a key assumption of the independent-samples t-test. If you don't stick to this assumption (i.e., if the variances aren't equal), you're more likely to make a Type I error. To formally test if these variances are different across the population, Levene's Test for Equality of Variances was employed. To put it differently, Levene's test assesses if the two samples were chosen from similar populations. In the first section of the Independent Samples Test table, Table 5 presents the results of this test. The premise of homogeneity of variances was breached by linguistic, interpersonal, intrapersonal, and naturalistic intelligences, as shown in Table 5. The modified t-test, also known as the unequal variance t-test, separate variances t-test, or Welch t-test, was used to accept unequal variances and provide a valid test result. However, the assumptions of homogeneity of variances were met for logical-mathematical, bodily-kinesthetic, visual-spatial, and musical, therefore the 'standard' independent-samples t-test result in SPSS Statistics (equal variances assumed) was used for interpretation.

A total of 78 males and 72 females took part in the study. To ascertain if there were any differences in logical-mathematical, bodily-kinesthetic, visual-spatial, and musical abilities between male and female respondents, an independent-samples t-test was used. According to a boxplot assessment, there were no outliers in the data. Shapiro-test Wilk's (p >.05) revealed that logical-mathematical, bodily-kinesthetic, visual-spatial, and musical intelligence scores were normally distributed for both males and females. Additionally, there was homogeneity of variances, as assessed by Levene's test for equality of variances for logical-mathematical intelligence (p = .059); bodily-kinesthetic intelligence (p = .971); visual-spatial intelligence (p = .498); and musical intelligence (p = .089). Males (M = 2.40, SD = 0.74) exhibited more logical-mathematical intelligence than females (M = 2.00, SD = 0.95). Similarly, males (M = 1.91, SD = 1.02) exhibited more visual-spatial intelligence than females (M = 1.24, SD = 1.06). Additionally, males (M = 1.36, SD = 1.03) exhibited more musical intelligence than females (M = 1.24, SD = 0.99). It was however surprising in this study that females (M =1.92, SD = 0.96) exhibited more bodily-kinesthetic intelligence than their male (M = 1.80, SD = 0.96) counterparts.

The study ensured the participation of 78 males and 72 females. For verbal intelligence (p =.028), interpersonal intelligence (p =.014), intrapersonal intelligence (p =.032), and naturalistic intelligence (p =.000), the assumption of homogeneity of variances was broken, as revealed by Levene's test for equality of variances. To investigate if there were gender differences in linguistic, interpersonal, intrapersonal, and naturalistic intelligences, a Welch t-test was employed. A boxplot revealed no outliers, and Shapiro-Wilk's test (p >.05) revealed that the verbal, interpersonal, intrapersonal, and naturalistic scores for each level of gender were normally distributed. Males showed (M = SD = 0.97) verbal intelligence than females (M = 1.61, SD = 1.12). Males (M = 1.95, SD = 0.94) also showed interpersonal intelligence than females (M = 1.65, SD = 1.08). Additionally, males (M = 2.17, SD = 0.80) exhibited more intrapersonal intelligence than females (M = 2.10, SD = 0.96), and finally, males (M = 2.10, SD = 0.96) exhibited more naturalistic intelligence than female (M = 1.79, SD = 1.13).

In spite of the gender differences discussed so far, these differences were not significant. There were however, differences between males and females regarding logical-mathematical (p=.005) and visual-spatial (.000), which were significant.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Verbal/linguistic	Equal variances assumed	4.898	.028	.627	148	.532	.10684	.17041	-.22991	.44358
	Equal variances not assumed			.623	140.739	.534	.10684	.17142	-.23206	.44573
Logical-mathematical	Equal variances assumed	3.626	.059	2.864	148	.005	.39744	.13875	.12324	.67163
	Equal variances not assumed			2.837	134.514	.005	.39744	.14009	.12037	.67450
Bodily-kinesthetic	Equal variances assumed	.001	.971	-.777	148	.439	-.12179	.15679	-.43163	.18804
	Equal variances not assumed			-.777	146.991	.439	-.12179	.15680	-.43168	.18809
Visual-spatial	Equal variances assumed	.461	.498	3.975	148	.000	.67415	.16959	.33902	1.00927
	Equal variances not assumed			3.970	146.154	.000	.67415	.16980	.33856	1.00973
Musical	Equal variances assumed	2.938	.089	.721	148	.472	.12286	.17042	-.21391	.45964
	Equal variances not assumed			.724	147.925	.470	.12286	.16972	-.21252	.45825
Interpersonal	Equal variances assumed	6.128	.014	1.798	148	.074	.29594	.16459	-.02932	.62120
	Equal variances not assumed			1.788	141.372	.076	.29594	.16550	-.03124	.62312
Intrapersonal	Equal variances assumed	4.697	.032	.473	147	.637	.06808	.14390	-.21631	.35246
	Equal variances not assumed			.469	136.584	.640	.06808	.14516	-.21897	.35512
Naturalistic	Equal variances assumed	15.331	.000	1.949	148	.053	.31090	.15955	-.00439	.62619
	Equal variances not assumed			1.924	128.640	.057	.31090	.16156	-.00877	.63056

Table 5: Independent samples t-test of pre-service science teachers' multiple intelligence by gender

Thus, in spite of the foregoing and the differences reported, from the Table 5, it is observed that gender differences that exist between males and females in only two of the eight MIs, specifically, Logical-Mathematics and Visual-Spatial, is significant. The other six were not significant, suggesting that males and females exhibit similar intelligences in them.

4. Discussion

The data analysis determined that the intelligence that pre-service science teachers highly possess is logical-mathematical intelligence followed by bodily-kinesthetic and intrapersonal intelligence, respectively. The least possessed intelligence is musical intelligence. In addition, the data analysis proposes that gender affects pre-service science teachers' intelligence profile since some responses depicted the influence of gender evoked the use of some intelligences. In this study, gender differences that exist between males and females in only two of the eight MIs, specifically, Logical-Mathematics and Visual-Spatial, is significant. The other six were not significant, suggesting that males and females exhibit similar intelligences in them. However, a study conducted by Al-Faoury and Smadi, (2015) indicated that there are gender differences in the test scores of multiple intelligences. The findings

demonstrated that there was a statistically significant difference in adjusted mean scores of students' intelligences owing to gender, with females scoring higher in the linguistic and interpersonal intelligences and men scoring higher in the logical and intrapersonal intelligences. Similarly, Loori (2005) investigated and reported on the variations in multiple intelligences preferences of male and female students learning English as a second language at American higher education institutions. According to the findings, there were substantial disparities in IQ preferences between males and girls. Learning activities requiring logical and mathematical intelligences were chosen by males, whereas learning activities involving intrapersonal intellect were preferred by females. Also, research conducted by Agarwal (2017) revealed that male and female students do not differ with reference to multiple intelligence, although male students had much higher naturalistic intelligence and bodily-kinesthetic intelligence than female students. Male pupils have higher levels of logical, bodily-kinesthetic, and naturalistic intelligence. Female students are smarter than male students in terms of linguistic, spatial, musical, interpersonal, intrapersonal, and existential intelligence.

Individuals should be encouraged to learn using their natural intelligence. Different types of intelligence should appeal to instructional practices. Multiple intelligences make a significant addition to education. Pre-service science teachers will be asked to create lesson plans that incorporate some of the eight intelligences (Campbell, 1997). Many people will still tell you that someone is intelligent if they are skilled at math or science or articulate or speak multiple languages if you ask them. Even though educational methods and theories are constantly evolving, our culture and many school systems continue to place a premium on linguistic and logical-mathematical ability. A significant portion of the learning is devoted to improving those skills, or is presented in a style that appeals to and relies on the talents of a linguistic/logical-mathematical mind. Pre-service science teachers should consider the different types of learners in their classrooms, support all forms of intelligences in each student, and allow for an individual learning process. Allowing our students to discover and develop their various talents can have a variety of advantages for them. The MI theory can be a beneficial tool for pre-service and in-service science teachers to improve the quality of science teaching and learning, which will ultimately improve academic achievement (Amponsah, Bukari, Asano, Boateng, & Darkwa, 2021). Science teachers can use numerous approaches to help students improve their cognitive, social, and emotional abilities by incorporating multiple intelligences into their teaching methodologies.

Quality teaching, according to Normore (2017) and Hattie (2003), is a key component in predicting student learning achievement. According to Vermunt (2014), teachers' teaching approaches can enhance student learning processes, resulting in an increase or change in learning achievement in areas such as subject matter knowledge and understanding, skills, motivation, emotions, and so on. According to Yilmaz (2012), pupils with dominant intellect in mathematical-logical and linguistic activities have a strong correlation with math learning achievement. Furthermore, based on multiple intelligence theory, there is a substantial association between group divisions in cooperative learning and student accomplishment (Abdulkarim & Jadiry, 2012), including collaborative learning. According to Tiantong and Siksen (2013), knowing MI can help students make better use of their unique knowledge and talents. Each intelligence has its own set of qualities, tools, and processes that explain various approaches to problem-solving, learning, and thinking.

Conclusion

This paper sought to find the dominant intelligence among pre-service science teachers and the benefits MI-based instruction has on the work of the pre-service science teachers. Despite the fact that some research has been done, further research in other countries is needed to compare the results of this study. It was found that Ghanaian pre-service teachers used in this study exhibit all the eight MIs in the classroom. This study has shown that only Logical-Mathematics was highly advanced among pre-service science teachers. This is not surprising as these students have strong mathematical background to be able to pursue science. Similarly, it is also not a coincidence that Bodily-Kinesthetic is advanced in these pre-service science teachers. Science involves practical activities and as such a science student must exhibit the characteristics required to be able to perform hands-on activities. Gender differences exist between males and females in only two of the eight MIs, specifically, Logical-Mathematics and Visual-Spatial. The other six were not significant, suggesting that males and females exhibit similar intelligences in them.

Implication

Extra tuition might help one to build and maintain their emotional intelligence. In Ghana, the importance of multiple intelligence is not well emphasized in the colleges of education curriculum, but its inclusion is long overdue. It is thought that this will go a long way toward assisting pre-service science teachers in acquiring these important skills and imparting their students in the world of work. According to this method, learning and teaching should be oriented on each individual's unique intelligences. Gardner stressed that the multiple intelligences reflect different learning techniques as well as diverse topical fields.

Acknowledgments

This research was not funded or otherwise supported by anyone or any entity. However, we'd want to thank all of the pre-service teachers included in the research, as well as their Tutors, who helped us in a variety of ways.

References

Agarwal, S. (2017). A comparative study of multiple intelligence among male and female students of class XI. *International Journal of Advanced Research in Education & Technology (IJARET), 4*(1), 82-85.

Al-Faoury, H. O. &Smadi, M. O. (2015). The effect of an integrative skills program on developing Jordanian university students' select multiple intelligences. *Theory and Practice in Language Studies, 5*(1), 38. DOI: 10.17507/tpls.0501.05.

Amponsah, K. D. (2020). South African twelfth grade students' conceptions regarding electrochemistry. *Journal of Education and Learning (EduLearn), 14*(3), 363-369.

Amponsah, K. D., Boateng, F. K., & Mohammed, S. M. (2021). Pre-Service science teachers' conceptual understandings of electrochemistry at the university of Ghana. *African Journal of Chemical Education (AJCE) 11*(2), 129-147

Amponsah, K. D., Bukari, Z., Asano, R., Boateng, F. K., & Darkwa, S. A. (2021). Impact of Multiple Intelligence (MI) on Science Process Skills (SPS) among Senior High School Students. *Social Science learning Education Journal 6*(8), 533-545.

Amponsah, K. D., Kotoka, J. K., Beccles, C., & Dlamini, S. N. (2018). Effectiveness of Collaboration on Low and High Achieving School Students' Comprehension of Electrochemistry in South Africa. *European Journal of STEM Education*, *`3*(2), 1-15.

Amponsah, K. D. & Ochonogor, C. E. (2018). Facilitating Conceptual Change in Students' Comprehension of Electrochemistry Concepts through Collaborative Teaching Strategy. *American Journal of Educational Research*, *6*(6): 596-601.

Amponsah, K. D. & Ochonogor, C. E. (2016a). Gender differences in constructivist approach to high school learners' comprehension of electrochemistry concepts. The Eurasia Proceedings of Educational & Social Sciences (EPESS), 4, 220-231. Retrieved October 12, 2021 from http://dergipark.gov.tr/download/article-file/334051

Amponsah, K. D. & Ochonogor, C. E. (2016b). Impact of a constructivist approach to learning on high achieving students' comprehension of electrochemistry concepts. The Eurasia Proceedings of Educational & Social Sciences (EPESS), 4, 210-221. Retrieved October 12, 2021 from http://dergipark.gov.tr/download/article-file/334053.

Armstrong, T. (2009). Multiple intelligences in the classroom (3rd ed.). Alexandria, VA: Association for Supervision & Curriculum Development.

Cheng, H. Y., Hou, Y. J., Hou, Y. A., & Chung, W. Y. (2010). Gender differences in multiple intelligences, learning behavior and English performance: a case study in Taiwan. *International Journal of the Humanities, 8*(2).

Education, UNICEF Ghana. (2015). Retrieved October 12, 2021 from https://www.unicef.org/ghana/education#

Emendu, N. B, & Udogu, M. (2013). Effect of Multiple Intelligences Teaching Strategies on Student's Achievement and Retention in Chemistry. The International Journal of Engineering and Science (IJES), 2, 30-34.

Fitzgibbons, L. (2019, July 10). What is spatial intelligence? Definition from WhatIs.com. WhatIs.com. https://whatis.techtarget.com/definition/spatial-intelligence

Gardner, H. E. (2000). *Intelligence reframed: Multiple intelligences for the 21st century*. Hachette UK.

Gardner, H. (2011a). *Frames of mind: The theory of multiple intelligences*. Hachette Uk.

Gardner, H. (2013). *Integrating learning styles and multiple intelligences- educational* Leadership http://www.ascd.org/publications/educational-leadership/sept97/vol55/num01/Integrating-Learning-Styles-and-Multiple Intelligences.aspx

Ihudiebube-Splendor, C. N., & Chikeme, P. C. (2020). A descriptive cross-sectional study: Practical and feasible design in investigating health care–seeking behaviors of undergraduates.In SAGE Research Methods Cases. Retrieved October 12, 2021 from https://www.doi.org/10.4135/9781529742862

Kaur, M. (2014). Gender differences in Multiple Intelligences with respect to grade level. American *International Journal of Research in Humanities, Arts and Social Sciences, 8*(2), 117-120.

Kelly, M. (n.d.). *Spatial intelligence and its importance in education. ThoughtCo.* https://www.thoughtco.com/spatial-intelligence-profile-8096

King, E. M. (2011, January). Education is fundamental to development and growth: Keynote address at education world forum. In The World Bank, QE2 Conference Center, London.

Linguistic intelligence and its benefits. (n.d.). *Mind movies blog*. https://www.mindmovies.com/blogroll/linguistic-intelligence-and-its-benefits

Logsdon, A. (2021, July 26). *What makes logical-mathematical learners unique.* https://www.verywellfamily.com/mathematical-logical-learners-2162782

Loori, Ali. (2005). Multiple intelligences: A comparative study between the preferences of males and females. *Social Behavior and Personality: an international journal, 33,* 77-88. 10.2224/sbp.2005.33.1.77.

Marenus, M. (2020, June 9). *Gardner's theory of multiple intelligences*. https://www.simplypsychology.org/multiple- intelligences.html

MentalUP Educational Games. (2019, December 12). *Logical mathematical intelligence: Examples, activities and careers* | MentalUP. MentalUP.co. https://www.mentalup.co/blog/logical-mathematical-intelligence

Morgan, H. (2014). Maximizing student success with differentiated learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *87*(1), 34-38.

Mpho, O. M. (2018). Teacher centered dominated approaches: Their implications for todays inclusive classrooms. *International Journal of Psychology and Counselling*, *10*(2), 11-21.

Multiple Intelligences (Howard Gardner)- InstructionalDesign.org http://www.instructionaldesign.org/theories/multiple-intelligences/

Ponsford, K. & Lapadat, J. (2001). Academically capable students who are failing in high school: perceptions about achievement. *Canadian Journal of Counselling, 35*, 137-156.

Winarti, A., Yuanita, L., & Nur, M. (2019). The effectiveness of multiple intelligences-based teaching strategy in enhancing the multiple intelligences and Science Process Skills of junior high school students. Journal of Technology and Science Education, 9(2), 122-135.https://doi.org/10.3926/jotse.404

Xu, J. (2020). Identifying Students' Self-Perceived Multiple Intelligence Preferences: The Case of Students from Heilongjiang International University, China. Arab World English Journal (AWEJ) Volume, 11.

Yalmanci, S. G., Gozum, A. C. (2013). The effects of multiple intelligence theory-based teaching on students' achievement and retention of knowledge (Example of the enzymes subject). International Journal on New Trends in Education and Their Implications, 4(3), 27-36.

Zainudin, E. F. (2012). Malaysian teachers' and students' perceptions of students' Multiple Intelligence profiles in Malaysian secondary schools (Doctoral dissertation, University of Birmingham).

Zare-ee, A., Mohd Don, Z., Knowles, G., & Tohidian, I. (2015). Gender differences in self-estimates of multiple intelligences among learners of English. International Online Journal of Education and Teaching, 2(4), 249-264.