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Multiple Intelligences and Perceptual Learning Style Preferences of Education and Engineering Students

Jordan Miranda Pocaan [1]*

[1] Sorsogon State University, Sorsogon City, PHILIPPINES
***Corresponding Author:** jpocaan@sorsu.edu.ph

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ABSTRACT

Effective learning varies based on the students' different learning styles and intelligence across the curriculum. This research determines the learning styles and multiple intelligences of 250 second-year education students and 200 engineering students. It employed a stratified sampling technique in the data collection process. It reveals that individual, group, auditory, and visual learning are among engineering students' most common learning styles, while auditory, visual, and kinesthetic learning were the most prevalent among education students. Furthermore, engineering students most commonly demonstrated interpersonal, mathematical, and kinesthetic intelligence. Moreover, visual, linguistic, interpersonal, and kinesthetic intelligence were education students' most commonly exhibited intelligence. Most intelligence types and learning styles of education and engineering students show a moderate positive correlation. The results of this study suggest that employing teaching strategies based on learning styles and multiple intelligences may positively affect students' achievement. Likewise, the academic institutions must also consider the multiple intelligences in admitting students for any specific courses.

Keywords: correlation, differences, learning styles, multiple intelligence

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INTRODUCTION

Exposure to an idea regularly improves learning; in the classroom, a concept may refer to a new ability, knowledge, or a combination of the two. Although repeated exposure to topics is necessary, utilizing the same teaching style leads students to lose attention. Differentiated instruction allows instructors to be more adaptable to students' demands, expectations, abilities, and language knowledge levels, as well as learning styles, by putting learners at the center of teaching and learning, promoting fairness and scholarly excellence, and recognizing students' individuality (Tomlinson et al., 2003). The instructor may keep the learning environment new by adapting the teaching style to the many forms of intelligence. However, insufficient studies have verified learning styles as a helpful notion for planning and providing suitably varied and personalized education (Landrum & McDuffie, 2010). Several instruments for assessing (de)motivating teaching practices are present in primary education. Furthermore, a good technique for assessing a range of encouraging and aggravating methods of instruction in higher education is needed (Vermote et al., 2020).

The hypothesis of multiple intelligences has the potential to re-engage individuals in their studies. Multiple intelligence theory contributes significantly to knowledge of the teaching process and has become a more widely used theory in higher learning research and practice (Kezar, 2001). When using multiple intelligences to explain a subject, instructors should give each unique learner a better chance of succeeding in the classroom. Teaching a student's natural strengths might help to learn more effectively. Additionally, the number of intelligences at the superior levels may use to forecast and suggest a student's academic achievement (Yavich & Rotnitsky, 2020). There are numerous aspects that influence the success of learning (Mahmood, 2020). The instructor may evaluate or quantify student learning using several instructional tactics spanning various intelligence. Students who tested using methods requiring their participation regard assessment as more equitable and effective (Flores et al., 2015). Generally, the importance of identifying the students learning styles and multiple intelligences is an advantage for the school to support the students' achievement, vis-a-vi it reflects the school's success. Hence, this study suggested learning activities for education and engineering students by determining and correlating the multiple intelligences and perceptual learning style preferences. Specifically, this research sought to achieve the following goals:

1. determine the most exhibited learning styles of the education and engineering students,
2. determine the most exhibited intelligence of the education and engineering students, and
3. correlate the perceptual learning style preferences and multiple intelligences of education and engineering students.

Multiple Intelligences

Students must simultaneously develop intellectual, emotional, and spiritual intelligence to succeed in school (Hasnidar et al., 2020). According to Young's (2003) dissertation, considerable modifications to school organizational structures and evaluation processes are necessary before fully realizing the emotional and cognitive benefits of multiple intelligences learning in school.

Moreover, the study of Wirdianti et al. (2019) on natural intelligence and personality found a relation between naturalist intelligence and responsible environmental behavior. Therefore, boosting both competencies is necessary for enhancing students' green initiatives. Similarly, the learning outcomes of students with high spatial intelligence who received integrated training were superior to those of individuals who received direct instruction.

Also, the learning outcomes of learners with poor spatial intelligence provided by holistic education were worse than those provided via direct supervision (Salam et al., 2019). Asmorowati et al. (2021) analyze the science students' process skills. The findings indicated that linguistic and interpersonal intelligence in physical chemistry work placement might assist learners in strengthening their problem-solving abilities.

Sellars (2006) attested to how low achiever students' intrapersonal intelligence impacted their conceptions as students and their acts within the context of learning. Arum et al. (2018) assessed the students' logical-mathematical intelligence profile. The author concluded that learners' logical-mathematical intelligence was not yet ideal; thus, instructors must plan a course that may increase their logical-mathematical intelligence level on each indication and in general.

Sternberg and Kibelsbeck (2021) described why philosophy of musical intelligence may be applied to music education, in which musical acquisition is seen as a sort of inquiry. In his research on the innovative involvement of technological learners integrating bodily-kinesthetic intelligence to improve analytical reasoning, Kivunja (2015) highlights the importance of kinesthetic intelligence. The author stated that imparting school competencies must challenge learners to memorize large amounts of knowledge pertinent to the modern environment of the twenty-first century.

Learning Style

Utilizing preferred learning assessments to enhance student personality is a new topic of schooling and study (Childs-Kean et al., 2020). Jalinus et al. (2020) compare the learning style between engineering and non-engineering students. The results indicate that engineering students tended to adopt the accommodator learning style more than non-engineering students. In addition, using Dunn and Dunn and Kolb learning style models, Larkin-Hein and Budny (2001) investigate many effective techniques to educate college physics and engineering learners.

Husin et al. (2019) investigated the preferred video applications, suitable approaches, and innovations to meet peace education students' learning styles in teacher education institutes. Teachers are enlightened that they may utilize diverse teaching approaches for their learners depending on different teaching strategies if they share a genuine interest (Abdelhadi et al., 2019).

METHODOLOGY

Research Design and Instruments

The study utilized a correlational descriptive research design using the multiple intelligence test based on Howard Gardner's MI model by Chapman et al. (2005) and through the implementation of Reid's (1987, 1998) perceptual learning-style preference questionnaire (PLSPQ) (Rhouma, 2018). The survey questionnaire on multiple intelligences was composed of 70 questions that covered the seven intelligences. In addition, the PLPQ questionnaire consists of two sections. The first section focused on the four sensory channels, with five random items for each set; the second section addressed the attributes of the participants.

Respondents

The respondents of this study were the 200 second-year engineering and 250 second-year education students in one state university in Sorsogon City, Philippines, during the second semester of the academic year 2021-2022. It used the stratified random sampling approach (Hayes, 2021) that involves dividing a population into smaller groups–called strata. The sample population for engineering courses was n=200, and the sample population for education was n=250.

Procedure

During the third week of February 2022, an electronic questionnaire presented the research instruments to the respondents. The researcher asks for assistance from the instructors and professors in disseminating the instruments. After the retrieval of the questionnaires, the data interpretation began. The items were arranged by encoding their constituent parts. Then, each item was categorized according to its subcomponent, and the total was calculated based on the original questionnaire.

Data Analysis

The study used the statistical package for social sciences (SPSS) v.26 in quantifying the data. Descriptive statistics, such as mean and standard deviation, were employed to answer the research objectives 1 and 2. Moreover, the study used the Pearson product moment correlation to answer research objective 3.

RESULTS AND DISCUSSION

Profile of the Respondents

For engineering courses, there were 200 respondents in this study, 71 (93%) out of 76 were bachelor of science in mechanical engineering students, 87 (95%) out of 92 were bachelor of science in civil engineering students, and 42 (93%) out of 45 were bachelor of science in electrical engineering students. Regarding sex, 128 respondents were males, and 72 were females. The respondents ranged from 18-24 years old.

Moreover, there were 250 education student respondents in this study. 71 (80%) out of 89 were bachelor of elementary education students, 34 (81%) out of 42 were bachelor of physical education students, 34 (81%) out of 37 were bachelor of culture and art education students, 19 (83%) out of 23 were bachelor of technical-vocational teacher education major in food & service management, 8 (89%) out of 9 were major in automotive technology, 12 (86%) out of 14 were major

Table 1. Distribution of sample chosen by stratified sampling method according to courses

Courses	Population by stratum	Sample by stratum	Percent
Engineering			
BSME	76	71	93%
BSCE	92	87	95%
BSEE	45	42	93%
Total	213	200	94%
Education			
BEED	89	71	80%
BPED	42	34	81%
BCAED	37	30	81%
BTVTED (Food & Svcs. Mgmt.)	23	19	83%
BTVTED (Auto. Tech.)	9	8	89%
BTVTED (Elec. Tech.)	14	12	86%
BSED (Filipino)	26	21	81%
BSED (Mathematics)	25	20	80%
BSED (Science)	23	19	83%
BSED (English)	20	16	80%
Total	308	250	83%

Table 2. Descriptive statistics for perceptual learning style preferences of engineering students

Learning styles	Indicator	Mean	Standard deviation	n
Auditory	Major	39.62	4.391	200
Group	Major	39.99	4.420	200
Individual	Major	40.30	5.685	200
Kinesthetic	Minor	34.75	7.339	200
Tactile	Minor	33.81	6.157	200
Visual	Major	38.80	3.703	200

in electrical technology, 21 (81%) out of 26 were bachelor of secondary education major in Filipino, 20 (80%) out of 25 were major in mathematics, 19 (83%) out of 23 were major in science, and 16 (80%) out of 20 were major in English. In terms of sex, 147 were females and 103 were males. Respondents ranged from 18-23 years old (**Table 1**).

Perceptual Learning Style Preferences of the Students

Based on the data in **Table 2**, individual (M=40.30), group (M=39.99), auditory (M=39.62), and visual (M=38.80) were the major learning styles of the engineering student-respondents. It was relevant to the findings of Kapadia (2008) that there is no one best learning style in pursuing engineering courses. Individual and group as major learning styles imply that the respondents work effectively alone and with others and can remember information effectively alone and with others. Nevertheless, the success of students in the interactive condition was much higher than that of students in the constructive condition. (Menekse & Chi, 2019).

Furthermore, auditory, and visual major learning styles infer that the respondents learned while attending lectures, discussions, board works, watching videos, and conversing with instructors or classmates. Sanjanaashree and Soman (2014) claimed that visual learning would help engineering learners remember more easily than reading texts in books, and auditory learning helps to study independently rather than expecting someone's help.

Furthermore, kinesthetic (M=34.75) and tactile (M=33.81) were cited as minor learning styles. Physically, kinesthetic or tactile learners benefit most from touching or experimenting with an idea. The method

Table 3. Descriptive statistics for perceptual learning style preferences of education students

Learning styles	Indicator	Mean	Standard deviation	n
Auditory	Major	41.60	3.115	250
Group	Minor	35.83	5.049	250
Individual	Minor	36.84	6.301	250
Kinesthetic	Major	38.72	4.462	250
Tactile	Minor	36.27	4.939	250
Visual	Major	39.44	2.211	250

Table 4. Descriptive statistics for types of intelligence of engineering students

Types of intelligence	Mean	Standard deviation	n
Interpersonal	39.42	2.265	200
Intrapersonal	34.51	5.190	200
Kinesthetic	38.67	3.224	200
Linguistic	35.39	4.443	200
Mathematical	38.74	3.332	200
Musical	34.20	4.506	200
Visual	35.86	4.663	200

is multisensory learning because kinesthetic learners hear or see to acquire and complete their education via direct personal experience (Western Governors University, 2020). Unlike auditory and visual learning, visual and auditory teaching are required for knowledge acquisition. Kinesthetic is hands-on and largely focuses on a student seeking a means of understanding.

Table 3 shows that auditory (M=41.60), visual (M=39.44), and kinesthetic (M=38.72) were the dominant preferred learning styles of the education student-respondents. Syofyan and Siwi (2018) study stated that visual, auditory, and kinesthetic are the three main learning styles. It implies that education student-respondents prefer to learn via visual channels and enjoy oral-aural learning channels implies complete bodily engagement with an educational setting (Gholami & Bagheri, 2013; Kinsella, 1995; Oxford, 1995). Since education courses were generalists in curriculum, it is essential to master the three main learning styles.

Moreover, individual, tactile, and group were cited as minor learning styles. It means that by using the minor learning styles, students can also function well, and to accommodate various learning styles, educators need to use a flexible instructional approach (Peacock, 2001).

Types of Intelligence of the Students

Based on **Table 4**, interpersonal (M=39.42) was the leading type of intelligence of engineering student-respondents followed by mathematical (M=38.74), kinesthetic (M=38.67), visual (M=35.86), linguistic (M=35.39), intrapersonal (M=34.51), and musical (M=34.20). Interpersonal skills are important for engineering students as a requirement for programs involving collaboration and internships, which constitutes the transition from student to the professional workplace, so planned strategies to promote the students' interpersonal development are significant (Lopes et al., 2015). Engineering education groups have long acknowledged that graduates must acquire technological expertise in specific fields and be highly trained in effective communication, collaboration, management, innovation, and a variety of other human characteristics (Willmot & Colman, 2016).

Table 5. Descriptive statistics for types of intelligence of education students

Types of intelligence	Mean	Standard deviation	n
Interpersonal	38.26	1.264	250
Intrapersonal	35.49	3.342	250
Kinesthetic	38.19	1.084	250
Linguistic	38.32	.728	250
Mathematical	35.39	3.366	250
Musical	35.22	3.287	250
Visual	38.66	.918	250

The learners must possess mathematical intelligence before pursuing engineering courses. In order to choose adequate material for the construction, engineers test the material's strength and use formulas to determine the material's strength. In addition, learners with logical-mathematical and visual-spatial intelligence can accurately represent the situation or issue and solve it. They can find a general rule to solve problems (Kobandaha et al., 2019). In addition, Mel (2021) claimed that engineering students prefer to study using intrapersonal and bodily-kinesthetic intelligence. In terms of verbal-linguistic intelligence, students are classified into the average category (Hasanudin & Fitrianingsih, 2018). However, the musical was the least type of intelligence by the respondents. It was relevant to the findings of Ahvan and Pour (2016) that musical intelligence was a tunable negative predictor of academic performance achievement of students.

Table 5 shows that visual was the leading type of intelligence of education students-respondents, followed by linguistic (M=38.32), interpersonal (M=38.26), kinesthetic (M=38.19), intrapersonal (M=35.49), mathematical (M=35.39), and musical (M=35.22). Visual intelligence enables learners to know information via static pictures and activate their imaginations by imagining items from various perspectives (Nadrljanski et al., 2009). Furthermore, education students are the future teachers; therefore, students' linguistic and interpersonal intelligence should enhance. Linguistic intelligence involves the capability to deliver spoken successfully and written language. Linguistic intelligence comprises the capacity to manage grammar or the grammatical structure, pronunciation or the tones of dialect, interpretation or the sense of dialect, and the practical component or the actual implications of language (Armstrong, 2013). Therefore, interpersonal intelligence entails understanding and interacting with others, from empathizing with others to managing a big group of individuals towards a shared objective (Syurfah, 2017).

Another implication was that education student-respondents are hands-on learners, meaning they absorb information by doing (Ekwueme et al., 2015). Respondents' Intrapersonal Intelligence enables them to understand themselves and, as a result, devise learning techniques based on their strengths (Perez & Ruz, 2014). Although mathematics was not the primary intellect, it enabled students to recognize links between non-alphabetic objects, such as forms and symbols, to answer scientific issues. Like engineering students-respondents, musical education was the least type of intelligence.

Correlation of Perceptual Learning Style Preferences and Multiple Intelligences of the Students

Table 6 displays significant correlations between each intelligence type and the learning styles of engineering students, with the exception of a few intelligence types for which no link was identified. Linguistic intelligence is significantly related to visual (r=.014), tactile (r=-.031), auditory (r=0.64), group (r=0.66), and kinesthetic (r=-0.39) learning styles, however, there is no significant relationship found between linguistic intelligence and individual earning styles (r=1.48). The table 6 also shows that mathematical intelligence is significantly related to visual (r=0.25), tactile (-0.51), auditory (r=0.15), kinesthetic (r=.015), and individual (r=0.21) learning styles, though group learning style (r=-.161) is not significant. Moreover, musical and kinesthetic intelligence shows significance in all learning styles (visual r=0.26, r=0.43; tactile r=-.119, r=104; auditory r=-.113, r=.008; group r=.030, r=.066; kinesthetic r=.382, r=.580; and individual r=.019, r=1.033).

Meanwhile, visual intelligence is significantly related to tactile (r=-.054), auditory (r=-.032), group (r=.035), and individual (r=0.19) learning styles, however, found no significant relationship with visual (r=-.139) and kinesthetic (r=.151). Furthermore, interpersonal intelligence was found to be significantly related to learning styles in visual (r=.052), tactile (r=-12), auditory (r=.059), kinesthetic (r=-.007,

Table 6. Pearson product moment correlation of perceptual learning style preferences and multiple intelligences of engineering students

		MI linguistic	MI mathematical	MI musical	MI kinesthetic	MI visual	MI interpersonal	MI intrapersonal
PLSP visual	Pearson r	.014	.025	.026	.043	**-.139**	.052	.008
	Sig. (2-tailed)	.843	.720	.715	.549	.049	.462	.910
	n	200	200	200	200	200	200	200
PLSP tactile	Pearson r	-.031	-.051	-.119	.104	-.054	-.012	**.181***
	Sig. (2-tailed)	.660	.474	.094	.144	.450	.861	.010
	n	200	200	200	200	200	200	200
PLSP auditory	Pearson r	.064	.015	-.113	.008	-.032	.059	**.197****
	Sig. (2-tailed)	.367	.829	.111	.907	.654	.410	.005
	n	200	200	200	200	200	200	200
PLSP group	Pearson r	.066	**-.161***	.030	.066	.035	**.148***	.056
	Sig. (2-tailed)	.356	.022	.674	.356	.627	.036	.433
	n	200	200	200	200	200	200	200
PLSP kinesthetic	Pearson r	-.039	.015	-.062	.039	**.151***	-.007	**.228****
	Sig. (2-tailed)	.586	.832	.382	.580	.033	.926	.001
	n	200	200	200	200	200	200	200
PLSP individual	Pearson r	**.148***	.021	.019	-.033	.019	.088	.130
	Sig. (2-tailed)	.036	.770	.787	.642	.792	.218	.066
	n	200	200	200	200	200	200	200

Note. **Correlation is significant at the 0.01 level (2-tailed) & *Correlation is significant at the 0.05 level (2-tailed)

Table 7. Pearson product moment correlation of perceptual learning style preferences and multiple intelligences of education students

		MI linguistic	MI mathematical	MI musical	MI kinesthetic	MI visual	MI interpersonal	MI intrapersonal
PLSP visual	Pearson r	-.041	-.064	.199**	.075	.065	.080	-.082
	Sig. (2-tailed)	.519	.315	.002	.234	.309	.208	.197
	n	250	250	250	250	250	250	250
PLSP tactile	Pearson r	-.073	-.161*	.100	.077	-.013	.038	-.154*
	Sig. (2-tailed)	.249	.011	.115	.224	.833	.555	.015
	n	250	250	250	250	250	250	250
PLSP auditory	Pearson r	.028	-.161*	.041	.187**	.141*	.092	-.104
	Sig. (2-tailed)	.664	.011	.514	.003	.026	.148	.102
	n	250	250	250	250	250	250	250
PLSP group	Pearson r	-.181**	-.117	.009	-.018	.162*	.127*	.130*
	Sig. (2-tailed)	.004	.064	.885	.773	.010	.045	.040
	n	250	250	250	250	250	250	250
PLSP kinesthetic	Pearson r	-.039	-.013	.031	-.041	-.047	-.125*	-.011
	Sig. (2-tailed)	.544	.839	.627	.516	.457	.048	.865
	n	250	250	250	250	250	250	250
PLSP individual	Pearson r	-.039	-.118	.125*	.013	.013	.049	-.168**
	Sig. (2-tailed)	.544	.063	.049	.832	.842	.438	.008
	n	250	250	250	250	250	250	250

Note. **Correlation is significant at the 0.01 level (2-tailed) & *Correlation is significant at the 0.05 level (2-tailed)

and individual (r=.088), except with group. Lastly, intrapersonal intelligence is significant with visual (r=.088), group (r=0.56), and individual (r=.130) learning styles but less likely significant with auditory (r=.197) and kinesthetic (r=.288) learning styles and not significant with tactile (r=.181) learning styles.

The data revealed that most engineering students' intelligence types and learning styles had a moderate positive correlation. It was parallel to the study of Sener and Cokcaliskan (2018), suggesting that the ambivalence between learning styles and multiple intelligence can be observed across students due to individual differences. In addition, Barkana et al. (2009) stated that the disparities in learning styles would influence an individual's career choice and engineering achievement.

Based on **Table 7**, the linguistic intelligence of education students is significant with visual (r=-.041), tactile (r=-.073), auditory (r=.028), kinesthetic (r=-.039), and individual (r=-.039) learning styles, and less likely significant to group (r=-.1.81) learning styles learning style. Moreover, mathematical intelligence is significantly related to visual (r=1.064), group (r=-.117), kinesthetic (r=-.013), and individual (r=-.118); however, it is not significant with tactile and auditory learning styles (r=-.161).

Furthermore, musical intelligence is significant with the tactile (r=.100), auditory (r=.041), group (r=.009), kinesthetic (r=.031) learning styles, and less likely significant with visual (r=.199) and not significant with the individual (r=.125) learning style. Kinesthetic intelligence is significantly related to visual (r=.075), tactile, group (r=.077), kinesthetic (r=-.018), individual (r=.013) learning styles, and less likely related to auditory (r=.187) learning styles. In addition, visual intelligence is significant with visual (r=0.65), tactile (r=-.013), kinesthetic (r=-.047), and individual (r=.013) learning styles, except for auditory and group learning styles. Interpersonal intelligence is significant with visual (r=.080), tactile (r=.038), auditory (r=.092), and individual intelligence (r=.049), except for group (r=r.127) and kinesthetic (r=-.125). Lastly, intrapersonal intelligence is significantly related to visual (r=-.082), auditory (r=-.104), and kinesthetic (r=-.011) learning styles but is less likely significant in individual learning styles (r=-.168) and not significant with tactile (r=-.154) and group (r=.130) learning styles.

The data revealed that most engineering students' intelligence types and learning styles had a moderate positive correlation. It was parallel to the study of Sener and Cokcaliskan (2018), suggesting that the ambivalence between learning styles and multiple intelligence can observe across students due to individual differences. In addition, Barkana et al. (2009) stated that the differences between learning styles would affect a person's choice of profession and their success in engineering.

Similar to the results in **Table 6**, the majority of intelligence types and learning styles of education students showed a somewhat favorable link with education students, as shown in **Table 7**. Nja et al. (2019) concluded that education students have multiple learning styles, which rely on student achievement. Teaching strategies based on learning styles and students' multiple intelligence may positively affect learning. Moreover, Abdi et al. (2019) discovered that students trained using Multiple Intelligences-based teaching techniques outperformed those instructed using standard methods.

CONCLUSIONS

The study determined and correlated learning styles and multiple intelligences of education and engineering students. It was found that individual, group, auditory, and visual were among the major learning styles of engineering students. Moreover, interpersonal, mathematical, and kinesthetic are the most exhibited types of intelligence. Furthermore, the auditory, visual, and kinesthetic were the major learning styles of the education students. In addition, visual, linguistic, interpersonal, and kinesthetic were the most exhibited types of intelligence. It was also found that most of the intelligence types and learning styles of education and engineering students had a moderate positive correlation. A student's awareness of learning style and numerous intelligence types may be very valuable and essential. Understanding learning styles and intelligence types may enable students to discover and develop through their unique advantages and shortcomings. The results of this study suggest that employing teaching strategies based on learning styles and multiple intelligences may positively affect students' achievement. Likewise, the academic institutions must also consider the multiple intelligences in admitting students for any specific courses.

The study used only a quantitative method in measuring students learning styles and intelligence; further exploration like interviews and observation may provide relevant implications to the findings and results.

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