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Abstract

The emerging popularity of interdisciplinary teaching stems from research-based student gains in learning. Using the interdisciplinary and integrated framework of STEAM, this study aims to understand ESL teachers' integrated teaching strategies of arts, mathematics, and sciences, and examine the correlation among the domains of linguistic, artistic, musical, mathematical and logical, and science-related teaching strategies. Data collected from 67 ESL teachers in a Midwestern state was analyzed using the Pearson correlations. Results indicated that ESL teachers not only emphasize the traditional linguistic teaching strategies, but also integrate artistic, musical and mathematical, and sciences-related strategies in their classroom teaching. ESL teachers' classroom teaching strategies of arts, mathematics, and sciences were both moderately and highly correlated. Interpretations of the findings related to the integrated perspective of interdisciplinary teaching and implications for both teacher educators and school administrators were discussed.

Keywords

interdisciplinary teaching, ESL teacher, integrated teaching strategy, correlation

Integrated Teaching Strategies Used by ESL Teachers: How are Strategies of Arts, Mathematics, and Sciences Correlated?

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Introduction

The philosophy and practices of STEAM education have been drawing influential attention over the past decade demonstrating its values of sustainable development using an interdisciplinary framework (United Nations, 2015). STEAM education combining arts, technology, engineering and sciences for developing creative and scientific capacities in an integrative way is essential in producing a compound workforce for the 21st century. Interdisciplinary education tackles questions that stretch beyond the normal boundaries of what neuroscience or education research alone can address (McCandliss, 2010). STEAM curricula have demonstrated that learning activities integrating science, technology and the arts successfully engage students, resulting in improved literacy and numeracy competencies (as cited in Taylor, 2016). Integrated teaching strategies using interdisciplinary methods foster advances in cognitive ability and promote higher-order cognition learning processes. It not only helps develop students' critical thinking, appreciation of the differences between disciplines, bias recognition, and ambiguity tolerance, but also enhances students' knowledge formation capacity and ability in solving complex issues and problems (Repko, Newell, & Szostak, 2012; Tennyson, Elmore, & Snyder, 1992).

The emerging popularity of interdisciplinary teaching stems from research-based student gains in learning (Pedagogy in Action, 2018). With its various identified benefits, arts and science educators are teaming up to design innovative interdisciplinary curricula and teaching approaches. Language or ESL teaching also has the opportunity to make a real interdisciplinary leap. New findings from research in biological science are providing remarkable insights on how languages are learned in an interdisciplinary way, in contrast to the limited improvements resulting from traditional research based in the social sciences. Thus, research into how languages are best taught requires a more interdisciplinary approach that includes methods and instruments from the sciences (Stapleton, 2014).

The interdisciplinary STEAM teaching approaches that integrate multiple teaching strategies are embraced by language teachers, especially ESL teachers (Richards & Rodgers, 2014). The interdisciplinary models contribute to language education by suggesting that language or ESL teachers expand their repertoire of techniques, tools, and strategies beyond the typical linguistic ones traditionally used in classrooms. Students demonstrated positive responses to the increased variety of instructional strategies used in their language classrooms. The interdisciplinary framework provides a way of understanding language or ESL teaching from an interdisciplinary lens, guiding teachers in developing integrated teaching strategies and classroom activities that address multiple ways students learn and know in a brain-compatible manner (Sousa & Pilecki, 2013).

From a practical perspective, language learning and literacy across the curriculum provide teachers with many opportunities to use multiple and integrated teaching strategies in their classrooms. ESL teaching strategies can be integrated by applying the interdisciplinary models through creating multiple and integrated learning centers, allowing teachers and students to interact in a way unique to their characteristics. Literature learning can be effectively improved by encouraging students to share classic tales, do puppet shows, perform interpretive dances, read-aloud with finger puppets, and story-tell with costumes (Lin, 2000). The whole language teaching model recognizes the interdisciplinary nature of language by integrating musical, artistic, and interpersonal techniques to promote language learning.

The above case studies seem to show that it is feasible for ESL teachers to apply the interdisciplinary activities in an integrated way. The advocacy of a more interdisciplinary approach in teaching strategies purports our present knowledge of how to teach languages by encompassing a new array of techniques. Language pedagogy researchers and language teaching practitioners may have to reacquaint themselves with the methods of the physical and biological sciences. ESL teaching has nothing to fear from an infusion of the natural sciences teaching strategies (Stapleton, 2014), while teaching activities informed from the research of psychology, linguistics and social sciences continue to construct awareness and understandings of effective strategies in the social and dynamic context of the individual language classroom (Kiely, 2014).

With the increasing application and embrace of interdisciplinary models by ESL teachers, it is essential to gain research-based knowledge by conducting and documenting empirical studies. Research on ESL teachers' use of integrated strategies provides evidence and contributes to the body of inter-discipline and STEAM research. Previous literature related to ESL teachers' integrated teaching strategies primarily focuses on the presentation of the integrated strategies or classroom activities using case studies. There is a lack of studies quantitatively examining the integrated teaching strategies of ESL teachers. Thus, the purpose of this study is to explore ESL teachers' use of integrated instructional strategies by examining the degree of relationships between the various dimensions of strategies used in classrooms, guided by the perspectives of the interdisciplinary framework. Specifically, this study addressed the following questions: 1) What is the overall situation of the ESL teachers' use of multiple teaching strategies of arts, mathematics, and sciences? 2) How are these domains of strategies of arts, mathematics, and sciences integrated with each other? 3) What domains of instructional strategies used by the ESL teachers were moderately or highly correlated?

Method

Measurement Instrument

The Integrated Teaching Strategy Index (ITSI) (see Table 1) developed by the researcher was used to measure the frequency of ESL teachers' use of integrated teaching strategies. The ITSI has five subscales measuring the ESL teachers' teaching strategies framed by linguistic, artistic, musical, mathematical and logical, and sciences-related strategies. The ITSI Likert choices ranged from 1 representing "rarely or never", through 3 representing "sometimes" to 5 representing "usually or always".

Development of the ITSI utilized a series of steps and techniques to ensure its content and construct validity. It was guided by Clark's (2014) notion that learning activities integrating science, technology, and the arts successfully engage learners, resulting in improved literacy competencies. Additionally, it was based upon Armstrong's (2003) framework that literacy teaching involves practices of different and integrated strategies to improve students' literacy skills in the classroom. The researchers who had a total of 11 years of ESL classroom teaching experiences initially developed the ITSI items derived from the specific teaching strategies and activities actually implemented in the inventories of teaching strategies that were strongly proposed by various practitioners and researchers (Armstrong, 2003; Herrell & Jordan, 2004). Several experienced ESL teachers evaluated the survey items and overall design and offered their practical suggestions. Four professors who had experience in teaching ESL reviewed each of the initially developed items. Based upon their feedback, the inappropriate items were eliminated, and modifications were made to the necessary items.

Each of the final subscales of the linguistic, artistic musical, mathematical and logical, and sciences-related strategies has five items with a total of 25 survey items in the ITSI. All the ITSI subscales' internal consistency was statistically checked by computing Cronbach's alphas in SPSS. Alpha values of .7 or higher were acceptable, with .6 being acceptable for new scales. Cronbach's alphas ranged from .64 to .82 in the ITSI (see Table 1). These statistics deem the survey instrument reliable for measuring ESL teachers' integrated teaching strategies.

Participants, Data Collection, and Analysis

This study used a cross-sectional survey procedure to collect data from ESL teachers. The survey packet including a cover letter and the ITSI was mailed to 112 teachers who had enrolled in the ESL endorsement program at a Midwest state university. Sixty-seven teachers (60%) successfully completed and returned the surveys. The majority of them (97%) were females. The mean age of the teacher respondents was 40.52 ($SD=10.86$). Ninety-one percent were teaching ESL in elementary schools, 2% in junior high/middle schools, and 7% in high schools. The mean total years of being a teacher and the mean total years of teaching ESL were 12.54 ($SD=8.61$) and 5.26 ($SD=2.69$), respectively. The mean average number of classroom students they taught was 16.66 ($SD=6.22$).

Data were analyzed using the SPSS 24.0 software. Average mean scores and standard deviations in each of the five subscales of the survey were used to understand the overall situation of the ESL classroom teachers' use of multiple teaching strategies of arts, mathematics, and sciences. Pearson's correlation coefficients were applied to examine how these domains of strategies are integrated with each other and identify what domains of instructional strategies were highly or moderately correlated.

Results

Levels of Multiple Teaching Strategies

Table 1 presents the means of standard deviations for each of the ITSI subscales and items of the ESL teachers' teaching strategies. The means of each of the five subscales were also presented in Figure 1 displaying a general frequency picture of the teaching strategies domains. All of the aforementioned descriptive statistics indicated that the ESL teachers used linguistic strategies in

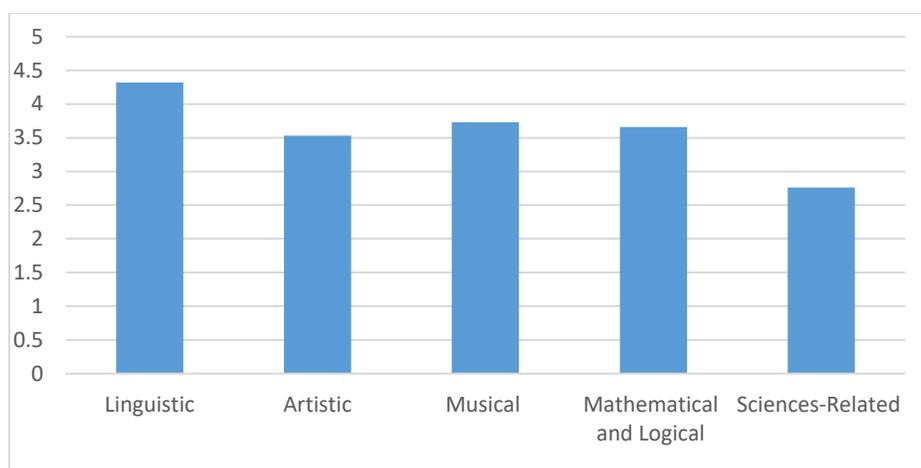
their classroom most frequently ($M=4.32$, $SD=0.50$) while sciences-related strategies were used least frequently ($M=2.76$, $SD=0.75$). The order of ESL teachers' use of teaching strategies in their classroom from the most to the least frequently was as followed: linguistic, musical, mathematical-logical, artistic, and sciences-related.

Table 1: Means and Standard Deviations of the ITSI Subscales and Items ($n=67$)

<i>Subscales and Their Items</i>	<i>Cronbach's α</i>	<i>M</i>	<i>SD</i>
<i>Linguistic Strategies</i>	.82	4.32	0.50
1. I have students talk or write about vocabulary words from their reading.		4.58	0.65
2. I have students retell the text they have just read to improve reading comprehension.		4.29	0.81
3. I emphasize a balance of students' listening, speaking, reading, and writing in my classroom activities.		4.62	0.57
4. I have students speak spontaneously about different topics.		3.66	1.02
5. I use both silent and oral reading to develop comprehension.		4.49	0.91
<i>Artistic Strategies</i>	.64	3.53	0.57
1. I have students draw or paint pictures to show their understanding of what I teach.		3.71	0.98
2. I use cards of artwork such as paintings, drawings, and cartoons to present what I teach to students.		3.15	1.26
3. I have students create charts, diagrams, or graphs to depict the concepts being learned.		3.91	0.94
4. I have students draw before they write.		3.51	0.98
5. I have students imagine or mind-map stories.		3.38	0.95
<i>Musical Strategies</i>	.78	3.73	0.68
1. I use rhythmic patterns to help students remember certain words.		3.84	0.96
2. I use songs to help students learn new concepts.		3.59	1.16
3. I take time out to share the sounds of particularly interesting words when reading aloud to my students.		3.84	0.97
4. I encourage students to read sentences out loud with rhythmic patterns.		4.04	0.89
5. I have students listen to recorded music or songs related to what is being taught.		3.29	1.16
<i>Mathematical and Logical Strategies</i>	.65	3.66	0.62
1. I have students do logic puzzles such as "crossword" to enhance their vocabulary.		2.81	1.11
2. I have students play math or logic games that show what has been learned.		3.60	0.96

3. I have students use their mathematical or logic talents to predict or guess the meanings of what is taught.	3.59	0.98
4. I have students explore the patterns found in words, for example, <u>set</u> , <u>get</u> and <u>let</u> .	4.49	0.75
5. I provide opportunities for students to compare or classify what they have learned.	3.86	0.75
<i>Sciences-Related Strategies</i>		.76
1. I design lessons that bring nature in the classroom via videos, objects, animals, plants, etc.	3.34	0.91
2. I have students collect their favorite animal or plant drawings, photographs or objects.	2.46	0.95
3. I encourage students to perform learning activities by using objects from the natural world.	3.12	1.11
4. I have students classify flora, fauna, and natural phenomena.	1.92	0.97
5. I integrate natural phenomena into my teaching.	2.94	1.09

Figure 1: Distribution of the Teaching Strategies Domains Used by ESL Teachers



Note: 1= rarely or never, 2= seldom, 3= sometimes, 4= often, 5= usually or always

Integrated Teaching Strategies

The results of the Pearson intercorrelations among teaching strategies domains of arts, mathematics, and sciences are summarized in Table 2. Significantly, all the pairs of the subscales of the ESL teachers' teaching strategies domains were positively related to each other in a statistically significant way ($p < .05$). This reveals that the domains of linguistic, artistic, musical, mathematical and logical, and sciences-related strategies were positively integrated with each other.

The correlation coefficient is a commonly used measure of the relationship magnitude: values of less than .30 signifies a small degree correlation, .30-.49 is a medium degree correlation, and .50 or more is a high degree correlation (Field, 2013). Using these criteria, the following pairs of teaching strategies domains were highly correlated: linguistic vs artistic, musical vs artistic,

mathematical and logical vs artistic, and sciences-related vs artistic. Pairs of moderate correlations between teaching strategies domains include linguistic vs musical, linguistic vs mathematical and logical, linguistic vs sciences-related, musical vs mathematical and logical, musical vs sciences-related, and mathematical/logical vs sciences-related.

Table 2: Intercorrelations of the Teaching Strategies Used by ESL Teachers

Teaching Strategies	Linguistic	Artistic	Musical	Mathematica/Logical
Artistic	.566**			
Musical	.313**	.548**		
Math/Logical	.447**	.533**	.364*	
Sciences-Related	.355**	.610**	.491**	.457**

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

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

Discussion

This study found that the ESL teachers used linguistic teaching strategies in the classroom with the frequency of “often” or “always”. Linguistic teaching strategies offer students keen sensitivity to language. Teachers need to create opportunities to increase verbal interaction in classroom activities and contextualize language as much as possible. ESL teachers generally used artistic and musical teaching strategies in their classrooms between the frequencies of “sometimes” and “often”. Artistic teaching strategies create opportunities for students to keenly observe language phenomenon and describe language meanings in an interesting and imaginative way. Music provides an interesting mirror of the history, literature, and culture of a country, which can be seen in song texts and musical style. In addition, music texts offer a unique means of reinforcing speaking, listening, reading, and writing skills through specially designed activities. The use of musical teaching strategies in ESL classroom offers a unique approach to enhance students' awareness of English culture and aid in the practice of communication skills (Failoni, 1993).

The ESL teachers also used mathematical and logical teaching strategies in their classrooms between the frequencies of “sometimes” and “often”. These strategies assist logical organization and development of the students’ learning contents. It also motivates students to solve difficult learning problems and nurture critical thinking (Repko et al., 2012). Sciences-related teaching strategies appear to be used in the classrooms the least frequently, between “seldom” and “sometimes”. This finding seems to reveal the need to strengthen its integration into teaching in the classroom. The application of natural sciences to language teaching not only has the potential to enrich our inventory of ideas, but it also presents methods to discover which of them are most likely to be correct (Stapleton, 2014).

The results of this survey research further show that ESL teachers’ use of the teaching strategies domains of linguistic, artistic, musical, mathematical and logical, and sciences-related strategies are all significantly related to each other. Teaching strategies of arts, mathematics, and sciences

are highly or moderately integrated by ESL teachers in their ESL classrooms. With the integrated teaching strategies, students become aware that different people have different strengths and that each person has a substantive contribution to make. When multiple activities are available and integrated in the classroom, students can find their personalized ways to actively participate, take advantage of language acquisition opportunities, and develop their high order of language ability such as critical thinking, bias recognition, and solutions to complex problems (Armstrong, 2014; Kallenbach & Viens, 2004; Stapleton, 2014).

ESL teachers seem to adopt and implement integrated strategies or activities in their classrooms. The findings of this study generally reveal a positive situation of the ESL teachers' integrated teaching strategies in classrooms. They not only emphasize the traditional linguistic teaching strategies, but also integrate artistic, musical and mathematical, and sciences-related strategies in their teaching. Such findings also show that the philosophy and practices of interdisciplinary framework can be well accepted and implemented by ESL teachers. It provides an enhanced theoretical framework for ESL teachers to integrate different teaching strategies and styles in their classrooms. This study also supports or confirms the notion that interdisciplinary teaching and STEAM education can be feasibly designed and implemented by innovative teachers (Stapleton, 2014; Taylor, 2016).

Kiely (2014) and Stapleton (2014) have discussed the issue of interdisciplinarity in ESL teaching and research, and highlighted its importance and impact. This study provides empirical evidence to purport their notion by better understanding ESL teachers' integrated teaching strategies of arts, mathematics, and sciences and examining the correlation among the domains of linguistic, artistic, musical, mathematical and logical, and sciences-related teaching strategies. The results help educational leaders picture the profile of ESL teachers' integrated teaching strategies. Since interdisciplinary teaching and STEAM programs are perceived to be valuable and practical in education (Sousa & Pilecki, 2013; Stapleton, 2014), this study provides important evidence and implications on enhancing interdisciplinary teaching for educational administrators in formulating and implementing relevant policies in ESL instructions, and designing meaningful professional development plan for ESL teachers. Based on these findings, it is advocated that schools consider the integration of ESL teaching with their STEAM programs available.

This study also provides useful information for ESL and other teacher educators regarding the emerging popularity of interdisciplinary teaching. Teacher educators of different disciplines may need to adopt the philosophical framework of interdisciplinary teaching and STEAM education and apply the relevant best interdisciplinary practices in teacher preparations. They may need to integrate the interdisciplinary elements into the development and re-development of their teacher preparation programs and course redesigns. It is suggested that interdisciplinary teaching skills, particularly enhancing the natural science-related teaching strategies for preparing teachers, be intentionally addressed as an expectation in the pedagogy-related courses.

Switching from a disciplinary-oriented teaching style to an interdisciplinary one seems to be feasible from the cost-effective perspective. Preparing or being an interdisciplinary teacher can benefit from educators' familiarity on the methodologies and empirical practices of related disciplines, the instructional strategy of task modeling that promotes learning through observation, and the synthesis of insights from across disciplines. Instructors or teachers can plan

the share of an interdisciplinary course and determine the ideal level of interdisciplinarity based upon their experience and the nature of the course (Pedagogy in Action, 2018).

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