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Interdisciplinary and intercultural differences in learning strategy use: implications for language processing, curriculum and instruction

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Abstract This investigation examines English as foreign language college interdisciplinary and intercultural differences in learning strategy use and their implications for language processing. Positivism underpins this research at the levels of ontology (standardized variables), epistemology (detachment from the subjects) and methodology, using nomothetic research strategy (survey), instruments (questionnaires) and data analysis techniques (multivariate analysis of variance and analysis of variance). Main findings show interdisciplinary differences between the Humanities and Science majors in student use of compensation strategies in favour of the Science major while finding no intermajor differences in student use of other strategies. The findings indicate no ethnic differences in learning strategy use, since European, American and Eastern ethnicities almost use typical strategies. Therefore, disagreements on alleged unmediated deterministic relationships between ethnicity and cognitive processing remain in place. Instead, curriculum and instructional designs, strategy training and individual differences rather than cultural stereotypes influence language processing. For curriculum and instructional designs to facilitate language processing and pedagogy, effective strategies should underlie national, classroom-level and school-level curriculum developments.

Keywords Learning strategies · Language processing · Curriculum and instruction · Ethnicity · Language learning

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Introduction

Educators had been concerned with information delivery of a defined domain of knowledge to their students and assessing the extent to which students mastered it. Such a transmission model of instruction might have been suitable to address the needs of isolated communities in the past because they used to face local and predictable challenges. Transmission instruction can no longer address the uncertainties and unpredictable challenges that face twenty-first century students who live in a small world. Twenty-first century educators are therefore responsible for helping higher education students learn how to learn and become independent lifelong learners so that they can face political, social and economic uncertainties in a highly volatile and interdependent world (Shawer 2010a).

Learning strategies have long been a major factor for effective independent learning in general and English as foreign language learning (EFL) in particular (Oxford 1990a; Shawer et al. 2009). For example, students use cognitive strategies to process information while they plan, organize, monitor and self-regulate their learning through metacognitive strategies (Cohen 1998; O'Malley and Chamot 1990; Oxford 1989; Shawer et al. 2008). This is what causes some learners to significantly outperform their counterparts in academic achievement while other learners give up within-ability cognitive enterprises and even courses, despite having similar academic abilities. Concerns have therefore been voiced about the patterns of strategy use that influence student cognitive processing and ultimately academic success (Shawer 2010a).

Practical concerns have been also expressed about the influence of interdisciplinary differences in terms of curriculum diversification programmes on student development and use of learning strategies. Curriculum

diversification concerns matching curriculum to different tracks of learning. For example, secondary education students can follow Humanities and Science majors of study (Pollard and Triggs 1997; Saez and Carretero 1998; Shawer 2010b). Further concerns point to ethnic culture influences on student cognitive functioning in terms of learning strategy use (e.g., Rahimi et al. 2008). This study therefore examined EFL college student interdisciplinary and intercultural differences and their implications for cognitive processing in terms of learning strategy use. The following sections examine the literature about such possible relationships between learning strategy use and ethnic culture and interdisciplinary differences.

Learning strategy use, ethnic culture differences and cognitive processing

The intricate relationship that exists between cognitive style and learning strategy use influences the ways in which students process information (cognitive functioning/processing) (Shawer et al. 2008). Cognitive style concerns student "preferred and habitual approach to *organizing* and *representing* information" (Riding and Rayner 1998, p. 15). When learning tasks contradict student congenital predispositions, they find difficulty in processing incompatible tasks for lacking those strategies that concur with their inborn cognitive processors (styles). For example, some students deal with words better than numerals for possessing innate verbal processors. On facing abstract tasks, including numerals, they need to develop strategies that enable them to process mathematical tasks that they are not naturally equipped to handle. This causes some people to process comfortably verbal tasks while they find difficulty in processing numbers and vice versa.

As such, cognitive style is the psychological make-up that makes learners process learning in particular fixed ways rather than others, while learning strategies are those mental operations students employ to process tasks incompatible with their habitual style (Shawer et al. 2008). Coordination between cognitive style and learning strategy should therefore take place in curriculum and instructional designs to equip students with learning strategies that enable them to process tasks incompatible with their habitual styles. As a result, learning strategies influence language processing and production in real-life communication through assisting learners in processing, storing and retrieving information (Brown 1994; Chamot and Kupper 1989). Students use cognitive strategies as "steps or mental operations used in learning or problem-solving that require direct analysis, transformation, or synthesis of learning materials in order to store, retrieve and use knowledge" (Wenden 1986, p. 10). These cognitive strategies are in action when students ask questions about, check and revise cognitive enterprises (Riding and Rayner 1998), make analogies, memorize, repeat and write things down, self-test and make inferences (Hedge 2000).

On the other hand, students use metacognitive strategies to plan, regulate and monitor first-order cognition to self-regulate learning (Shawer et al. 2008), being "general skills through which learners manage, direct, regulate and guide their learning, i.e. planning, monitoring and evaluating" (Wenden 1998, p. 519). Metacognitive strategies therefore enable students to overview, pay attention to, set goals and objectives for, organize and self-monitor learning (Hedge 2000). They also enable students to debrief discussions and document progress (Rasekh and Ranjbary 2003). Communication strategies also facilitate communication as "techniques learners use when there is a gap between their knowledge of the language and their communicative intent" (Wenden 1986, p. 10). However, some strategies suit particular language skills better than others. The writing skill makes more use of planning, self-monitoring, deduction and substitution, whereas the speaking skill benefits more from risk-taking, paraphrasing, circumlocution, self-monitoring and self-evaluation. On the other hand, listening comprehension depends on elaboration, inference, selective attention and self-monitoring, while reading comprehension better occurs when students preview, skim, read aloud, guess, deduce and summarize.

Disagreement over ethnic culture differences influence on cognitive functioning in terms of strategy use remains in place. Culture refers to accepted behaviour patterns a group of people share, which distinguish them as a particular race, ethnicity, religion or social class (Savignon and Sysoyev 2002). Some believe ethnic culture differences influence learning strategy use and ultimately learning outcomes (Oxford 1990a; Watson-Raston 2002). "There are, in every society, unstated assumptions about people and how they learn, which … invisibly guide whatever educational process may occur there" (Singleton 1991, p. 120).

Although research findings agree on the positive relationships between language learning and strategy use and between strategy training and strategy use improvement (e.g., Chamot and Kupper 1989; Cotterall and Murray 2009; Hong-Nam and Leavell 2007; Kasper 1997; O'Malley and Chamot 1990; Oxford 1993; Rasekh and Ranjbary 2003; Rossi-Le 1989; Rubin and Thompsons 1994; Yu and Wang 2009), research findings challenge any relationships between ethnic culture differences and learning strategy use. Some studies indicate that college EFL learners from certain ethnic backgrounds are predisposed to use certain strategies than others, such as Asian students who tend to use traditional strategies of repetition and rote learning (O'Malley and Chamot 1990; Politzer

and McGroarty 1985). For example, Taiwanese and Japanese students use memory strategies and avoid social interaction (Rasekh and Ranjbary 2003), whereas Chinese learners use memory and cognitive more than metacognitive strategies (Peacock and Ho 2003; Yu and Wang 2009). European students were found to outperform Eastern counterparts in higher-order strategy use, including metacognitive, social and affective strategies (Grainger 1997). Moreover, Americans were frequent metacognitive strategy users while being low users of affective and memory strategies (Green 1991).

However, recent research evidence strongly challenges such results that indicate positive relationships between ethnicity and learning strategy use. For example, Eastern ethnicity students used metacognitive strategies most and memory strategies least, including Chinese (Chang 1991; Qingquan et al. 2008), Koreans (Hong-Nam and Leavell 2007; Oh 1992) and Iranians (Riazi and Rahimi 2005; Rahimi et al. 2008). European students also tended to use the same low and high strategies that Eastern learners used. For example, Spanish students used traditional memory strategies (McGroarty 1987), while French students were average cognitive and metacognitive strategy users (Merrifield 1996). Abu Shmais (2003) conducted the single available study that examined patterns of strategy use among EFL Arab students. The findings indicated that metacognitive strategies were used most whereas compensation strategies were used least. This means most ethnicities use lower- and higher-order strategies at almost similar frequency levels, which casts doubts on the influence of ethnic culture stereotypes on learning strategy use.

Although prior research differences and even contradictions suggest no differences among ethnicities in English as a foreign or second language (EFL/ESL) learning strategy use, differences in sentence structure among heritage language groups suggest otherwise. For example, learners of subject–verb–object (SVO) structure group of languages such as Greek and French may find it easy to process EFL/ESL because SVO learners may use their native language learning strategies in processing the SVO English. In contrast, learners of subject–object–verb (SOV) structure group of languages such as Hindi and Japanese may find it difficult to process EFL/ESL because SOV learners perhaps process their native languages through learning strategies that differ from those used by SVO learners. However, such differences may arise between the SVO and SOV learners only in relation to EFL/ESL. This means SVO learners are more likely to find difficulty in processing SOV languages. By the same token, SOV learners are also more likely to find difficulty in processing SVO languages because of differences in structure that entail different learning strategies. This happens mainly because each group attempts a different structure language that makes language transfer between different structure languages more difficult than that between same heritage languages (Crystal 1997; Meyer 2009).

The differences between different heritage language groups in verb phrase (VP) structures may highlight the differences in learning strategy use between SVO and SOV languages in EFL/ESL. For example, the differences arise between European and Eastern learners when they process "early immediate constituency" of a sentence. European languages with SVO structures allow earlier identification of VPs whereas Eastern languages with SOV structures make language processing difficult before the identification of the final verb position (Hawkins 1994). As such, SVO and SOV language learners are more likely to use different sets of strategies so that each group can process incompatible language structures. This may cause differences between, for example, Eastern and European learners in processing English.

Strategy use and interdisciplinary curriculum and instruction

So far, no empirical research or theoretical evidence documented the relationship between patterns of strategy use and interdisciplinary differences in terms of curriculum diversification and differentiation. Diversification means offering several tracks of study (e.g., Humanities and Science) so that students can choose (Sifuna 1992). Being so, it involves paying "attention to the classroom with a heterogonous group of students; attending to special needs students; and helping to produce curricular adaptations for the diversification programme" (Saez and Carretero 1998, p. 727). Differentiation involves adapting courses to match specific student needs (Pollard and Triggs 1997). However, diversification involves differentiation within its tracks. For example, students can be diversified into Science and Humanities majors in secondary education who can be differentiated according to ability into slow or fast learners (Oakes et al. 1992). Through curriculum differentiation, students are categorized according to *learning ability* into mentally retarded, slow, average, fast and gifted or according to cultural or economic status into culturally or economically deprived. Students could be also grouped according to *overt behaviour* and *emotional stability* into predelinquent, delinquent, socially maladjusted and emotionally disturbed (Saylor and Alexander 1966).

Although some, such as Oxford (1996), favour deterministic relationships between particular ethnic cultures and learning strategy use, others including Holliday (2005) and Palfreyman and Smith (2005) view with suspicion such attempts. Alternatively, they indicate that influential factors, such as curriculum content, instructional strategies,

strategy training and individual differences (due to cognitive style and motivation), determine strategy use more than ethnic culture stereotypes. Research seems to take their side. For example, Chinese EFL learners used memory and cognitive strategies due to teacher-centred and information delivery instructional strategies. The study recommended changing curriculum content from fixed-type materials, such as textbooks, to multisource and authentic curriculum materials. It also recommended changes from teacher-centred and information delivery to communication-oriented and student-centred instruction (Yu and Wang 2009). Coyle (2007) and Liggett (2008) reached similar results. Although curriculum and instruction influence strategy use, this study was concerned with examining the relationship between different courses (interdisciplinary differences) and learning strategy use, by examining whether different programmes of study imply certain patterns of information processing.

Previous research examined almost all possible influence on EFL learning strategy use, including proficiency, motivation, gender (Rahimi et al. 2008), high and low graders (Chen 2009), successful and unsuccessful students (Qingquan et al. 2008), monolingual and bilingual students (Hong-Nam and Leavell 2007) and tutored and nontutored students (Alptekin 2007). Despite such abundance on learning strategy use, very little research studied the relationships between ethnic culture differences and learning strategy use and that research findings contradicted each other (e.g., Hong-Nam and Leavell 2007; Grainger 1997; Qingquan et al. 2008). Moreover, student exam records show Science students outperform their Humanities counterparts in language learning and that the research examining the relationship between interdisciplinary differences and strategy use seems nonexistent. To address these concerns, the current study sought to answer these two research questions:

1. Do interdisciplinary course differences (Humanities and Science programmes) determine patterns of learning strategy use (memory, cognitive, compensation, metacognitive, affective and social)?
2. Are there differences between EFL Arabic speakers and other ethnic cultures in learning strategy use?

Method

Positivism was the appropriate paradigm to underlie this quantitative research design at the levels of ontology, epistemology and methodology (Fig. 1). At the ontological level, the study had standardized conceptualization of the research phenomena. This meant that strategy use, ethnicity and interdisciplinary differences were presented as standardized concepts (single reality). As such, the researcher's epistemological stance was that of detachment from rather than interactions with the subjects to maintain objectivity and impartiality.

As also shown in Fig. 1, the research ontological and epistemological standpoints demanded a nomothetic methodology that deals with standardized and collective rather than individual understandings of the same phenomenon. For these reasons, the study used nomothetic research strategy (survey), instruments (questionnaires) and data analysis techniques (multivariate analysis of covariance and analysis of variance). Survey research enabled the researcher to describe and interpret the status quo (what is)

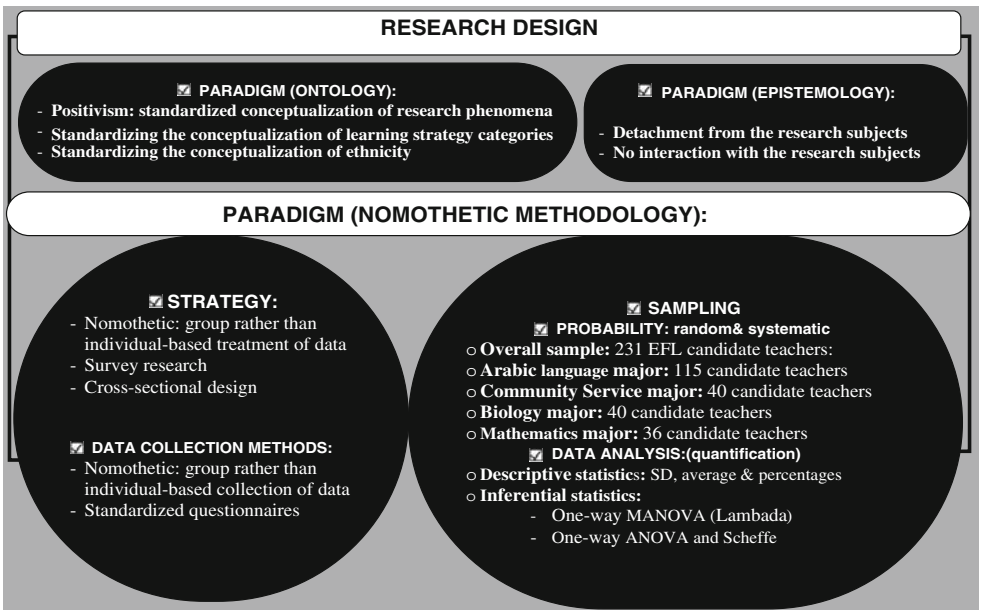

Fig. 1 Research design

concerning the most frequently used learning strategies among the subjects. A survey describes in collective terms what is going on better than other research strategies. The researcher used a cross-sectional design in particular to study different subjects at one point of time (Cohen et al. 2011; Lester and Lester 2010).

The researcher officially taught a compulsory university course to 290 first-year EFL Arabic-speaking students. The university provided the materials in the form of a coursebook. Teaching and testing revolved round areas of reading, writing, grammar and translation. By the end of the course, the students in group administration sessions voluntarily completed Oxford's (1990a) Strategy Inventory for Language Learning (SILL) questionnaire in order to understand how they process language learning. The researcher did not mention student names to maintain anonymity or reveal any information about their identities to assure confidentiality (Burns 2000; Burton 2000; Lester and Lester 2010). The teaching and data collection extended over a full semester.

Using systematic random sampling, the researcher drew four groups of 231 from the 290 students at four majors: Arabic Language (115), Community Service (40), Biology (40) and Mathematics (36). He first decided the sample size through the table of sample size from Cohen et al. (2011). For example, the Arabic major population of 160 students required a sample of 115. To determine frequency interval, he used this formula: F (frequency interval) $= N$ (population) $\div$ SN (required sample number). The calculation was 160 (whole Arabic major) $\div$ 115 (sample size according to sample size table) $= 1.4$ (rounded up to 1). The researcher put a number that represented each name in a vessel to choose the starting number randomly. Student number 18 was randomly selected as the starting point. Since frequency interval was 1, the researcher picked name number 18, skipped 19, chose 20, skipped 21, selected 22 and so on until the 115 Arabic Language sample was complete. The researcher followed the same procedure with the remaining three majors.

As shown in Fig. 1, the study examined patterns of strategy use among EFL Arabic-speaking learners through Oxford's (1990a) SILL (version 7), as both a framework and data collection method. Ellis (1994) describes the SILL as the most comprehensive tool of its kind. The SILL has been tested in different contexts and languages for almost 18 years. It is a self-scoring and paper-and-pencil Likert scale inventory, which requires subjects to self-report frequency of their strategy use on a scale from one to five. The SILL is reliable, having Cronbach's alpha between 0.93 and 0.98 (Ehrman and Oxford 1990) and being free of cultural bias through social reliability testing. In addition, students answer the SILL honestly (Oxford 1996).

Oxford classified the scale's 50 items into six categories of learning strategies: memory, mental processing (cognitive), compensation, organizing and evaluating (metacognitive), managing emotions (affective) and learning with others (social). Students use memory strategies (9 items) to store information into and retrieve it from memory and employ cognitive strategies (14 items) to analyse, revise and synthesize both new information and existing schema. Moreover, students use compensation strategies (6 items) to fill the gap between their communicative intent and language knowledge by means of guessing, using gestures, describing difficult vocabulary and switching to mother tongue. In addition, students use metacognitive strategies (9 items) to plan, organize, monitor and evaluate learning tasks while they use affective strategies (6 items) that comprise positive feelings, attitudes and motivation to decrease anxiety and internally motivate their own selves to carry on learning. As for social strategies (6 items), students use them to promote learning through interaction with others by asking questions and asking for clarification (Ehrman and Oxford 1990).

Owing to translating the SILL into Arabic, the researcher checked it for reliability to ensure that the subjects' performance on all the SILL items is not improved on some sections rather than others. Alpha coefficient was particularly suitable for this research because each item carried a different weight (Gall et al. 2006). Using SPSS (version 14), the calculation of 40 students' responses resulted in a 0.86 Cronbach's alpha (Coakes and Steed 2007). In addition, four EFL professors examined the SILL content and agreed it met the research purpose (Bloom et al. 2009). The "Data analysis" section shows the ways in which the data were analysed.

Data analysis

Data analysis covered two sections. Each section addressed one research question by testing the hypothesis posed for answering it.

Interdisciplinary differences and learning strategy use

This section addressed this first research question: *Do interdisciplinary course differences* (*Arabic, Community Service, Biology and Mathematics majors*) *determine patterns of learning strategy use* (*memory, cognitive, compensation, metacognitive, affective and social*)? Table 1 shows that the MANOVA homogeneity of variance was established, since the Box's M test was not significant ($p \geq 0.05$). Table 2 shows a number of significant multivariate/MANOVA tests (Pillai's trace, Wilks' lambda, Hotelling's trace and Roy's largest root) ($p \leq 0.05$). These

Table 1 Tests of equality of covariance and error variance

Box's *M* test (MANOVA)			Levene's test (ANOVA)				
Box's *M*	*F*	Sig.	Strategy	*F*	*df*1	*df*2	Sig.
93.925	1.399	.060	Memory	.094	3	226	.964
			Cognitive	2.643	3	226	.050
			Compensation	.561	3	226	.642
			Metacognitive	.257	3	226	.857
			Affective	.587	3	226	.624
			Social	1.872	3	226	.135

Table 2 Multivariate analysis of variance (MANOVA) tests

Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept					
Pillai's trace	.970	1,176.222[a]	6	221	.000
Wilks' lambda	.030	1,176.222[a]	6	221	.000
Hotelling's trace	31.934	1,176.222[a]	6	221	.000
Roy's largest root	31.934	1,176.222[a]	6	221	.000
Group					
Pillai's trace	.197	2.616	18	669	.000
Wilks' lambda	.807	2.736	18	625	.000
Hotelling's trace	.234	2.852	18	659	.000
Roy's largest root	.208	7.734[b]	6	223	.000

[a] Exact statistic

[b] The statistic is an upper bound on *F* that yields a lower bound on the significance level

tests indicate a multivariate relationship exists between course diversification across the four groups and student use of the six learning strategy categories (Coakes and Steed 2007).

Since all MANOVA tests were significant, the researcher used ANOVA to determine which course significantly differed from the others on each of the six variables (Gall et al. 2006). Table 1 also shows that ANOVA homogeneity assumptions were not violated, since the Levene's test was not significant for the six dependent variables ($p \geq 0.05$) apart from a marginal value (*cognitive*: $p = 0.05$). Furthermore, population normality was not violated because the four groups showed neither skewness nor kurtosis as both approached zero. Using a Kolmogorov–Smirnov statistic with a Lilliefors significance level resulted in a significance greater than 0.05, which assumed the four groups were drawn from a normally distributed population.

Table 3 shows insignificant ANOVA *F* ratios ($p \geq 0.05$) for *memory*, *cognitive*, *metacognitive*, *affective* and *social* (but not *compensation*) strategies (dependent variables). Given these *F* ratios, the null hypothesis stating equal *memory*, *cognitive*, *metacognitive*, *affective* and *social* strategy use across the four groups was accepted. This indicated that Humanities major students (Arabic and Community Service) did not differ in their strategy use from the Science major counterparts (Biology and Mathematics). Nor did it indicate differences in strategy use within both majors. In other words, programme diversification did not result in differences between the Humanities and Science majors in student use of *memory*, *cognitive*, *metacognitive*, *affective* and *social strategies*. Moreover, all students who shared the same programme were also similar in their use of these strategies.

In contrast, Table 3 shows a significant ANOVA *F* ratio for the *compensation* strategies variable ($p \leq 0.05$). This provided evidence to accept the alternative hypothesis indicating differences between the four groups in their use of compensation strategies. The possible differences between the four groups on this dependent variable (compensation) were examined further via the Scheffe post hoc test to determine where the differences lie and the direction of differences. It should be noted that there was no need to make post hoc multiple comparisons for the other five dependent variables (*memory*, *cognitive*, *metacognitive*, *affective* and *social strategies*) because ANOVA values were not significant. Post hoc multiple comparisons are drawn only to determine the direction of differences if they exist in the first instance. As such, Table 4 shows significant *F* ratios ($p \leq 0.05$) that indicate differences in *compensation* strategy use (dependent variable) between the four groups as follows:

Table 3 Analysis of variance (ANOVA) *F* ratios

	Sum of squares	*df*	Mean square	*F*	Sig.
Memory					
Between groups	106.716	3	36	1.324	.267
Within groups	6,072.866	226	27		
Cognitive					
Between groups	500.749	3	167	2.513	.059
Within groups	15,010.834	226	66		
Compensation					
Between groups	280.170	3	93	6.523	.000
Within groups	3,235.674	226	14		
Metacognitive					
Between groups	24.419	3	8	.160	.923
Within groups	11,485.412	226	51		
Affective					
Between groups	85.821	3	29	1.835	.142
Within groups	3,522.771	226	16		
Social					
Between groups	84.107	3	28	1.208	.308
Within groups	5,246.193	226	23		

- There are differences in compensation strategy use between Arabic (group 1) and Biology (group 3) in favour of Biology students.
- There are differences in compensation strategy use between Community Service (group 2) and Biology (group 3) in favour of Biology students.
- There are differences in compensation strategy use between Community Service (group 2) and Mathematics (group 4) in favour of Mathematics students.

Given these significant *F* ratios, the null hypothesis indicating equal use of compensation strategies across the four groups was rejected. The alternative hypothesis assuming differences in the use of compensation strategies between these groups was therefore accepted. This finding showed that students who followed Humanities majors (Arabic and Community Service) used compensation strategies less than their counterparts who followed Science majors (Biology and Mathematics).

On the other hand, these *F* ratios ($p \leq 0.05$) in Table 4 indicate no differences in compensation strategy use between students of the same major as follows:

- No differences exist between Arabic (group 1) and Community Service (group 2) (Humanities major) in compensation strategy use.

Table 4 Scheffe multiple comparisons between four groups on compensation strategy use

Dependent variable	(*I*) group	(*J*) group	Mean difference ($I - J$)	SE	Sig.	95 % Confidence interval	
						Lower bound	Upper bound
Compensation	1=	2	.94	.69	.610	−1.0172	2.8955
	1<	3	−2.11*	.69	.028	−4.0672	−.1545
	1=	4	−1.86	.73	.093	−3.9183	.1966
	2=	1	−.94	.69	.610	−2.8955	1.0172
	2<	3	−3.05*	.85	.005	−5.4331	−.6669
	2<	4	−2.80*	.88	.018	−5.2668	−.3332
	3>	1	2.11*	.69	.028	.1545	4.0672
	3>	2	3.05*	.85	.005	.6669	5.4331
	3=	4	.25	.88	.994	−2.2168	2.7168
	4=	1	1.86	.73	.093	−.1966	3.9183
	4>	2	2.80*	.88	.018	.3332	5.2668
	4=	3	−.25	.88	.994	−2.7168	2.2168

* Significant differences exist between the variables

- No differences exist between Biology (group 3) and Mathematics (group 4) (Science major) in compensation strategy use.

This means that same major students used almost the same compensation strategies. In other words, students who join Science majors tend to make more use of compensation strategies whereas those who join Humanities majors tend to make little use of compensation strategies. Although differences were found generally between the Humanities major and Science major in favour of the Science major, no significant F ratio ($p \geq 0.05$) was found between the Arabic major (Humanities major) and Mathematics major (Science major) in their use of compensation strategies.

Ethnicity and patterns of learning strategy use

This section addresses the second research question: *Are there differences between EFL Arabic speakers and other ethnic cultures in learning strategy use*? Table 5 indicates that Arab students were upper-intermediate users of *metacognitive* and *social* strategies (64 %), whereas being intermediate users of *compensation*, *cognitive*, *memory* and *affective* strategies (59, 56, 55 and 54 %, respectively). These results clearly indicate that Arabic-speaking learners tend to use almost all the six strategies at a moderate level in their attempt to learn English. However, the results show that these learners tend to favour metacognitive and social strategies most. This section answers the second research question with regard to Arabic-speaking students' patterns of strategy use only, but does not answer how they differ from other ethnicities. This part would be answered by comparing this study's empirical findings in this section (Ethnicity and patterns of learning strategy use) with those of previous research in section "Ethnicity and patterns of learning strategy use" of the discussion.

Discussion and conclusions

The research purpose was to examine the relationships between interdisciplinary (curriculum diversification) and ethnic culture differences and cognitive functioning (learning strategy use) among EFL college Arab students. Section "Interdisciplinary differences and learning strategy use" discusses interdisciplinary findings while section "Ethnicity and patterns of learning strategy use" discusses ethnic culture results.

Interdisciplinary differences and learning strategy use

Course/curriculum diversification did not result in differences between or within the Humanities and Science majors in memory, cognitive, metacognitive, affective and social learning strategy use. However, there were differences in favour of the Science major in *compensation* strategy use. Why did Science major students use compensation strategies in particular more than Humanities major counterparts? A possible justification perhaps points to student analytic learning style. For example, when science major students process verbal tasks such as those in language learning, they find them incompatible with their analytic style. To overcome this, Science students use compensation strategies because these strategies involve guessing, working out meaning from context and use of paralanguage. Such processes may relate more to their analytic style. For example, working meaning from context demands that students make some analysis and deduction. This involves reading the word before and after, reading the whole sentence that involves the word, reading the sentence before and after and even reading the whole paragraph. This could also account for less use of compensation strategies by Humanities students because language tasks concur with their verbal learning style. This could be also the reason for these students to join Humanities majors. That said, these are just speculations that need confirmation by future researchers.

Another finding about the differences in compensation strategy use between Humanities major and Science major students in favour of Science students is that such differences were between the Humanities and Science majors rather than between or within the two groups of each major. What is surprising about this finding is that despite reaching differences in compensation strategy use between

Table 5 Learning strategy use ranks and frequency

Strategy	*N*	Items	Lower limit	Upper limit	Sum	%	Mean	Rank	Frequency use
Metacognitive	231	9	2,070	10,350	6,597	64	39	1	Upper-intermediate
Social		6	1,380	6,900	4,439	64	29	1	Upper-intermediate
Compensation		6	1,380	6,900	4,054	59	25	2	Intermediate
Cognitive		14	3,220	16,100	9,014	56	19	3	Intermediate
Memory		9	2,070	10,350	5,706	55	18	4	Intermediate
Affective		6	1,380	6,900	3,698	54	16	5	Intermediate

the two majors, no differences were found between the Arabic major (Humanities major) and Mathematics major (Science major). Why was that? Since there were differences between the Humanities major and Science major in favour of the latter, the researcher also expected to find differences between the two groups in the Humanities major and their counterpart groups in the Science major in favour of each group in the Science major. Surprisingly, this was not the case between the Arabic and Mathematics majors, although there were differences between Arabic and Biology, Community Service and Biology and Community Service and Mathematics.

The null hypothesis stating no differences between Humanities and Science majors in strategy use was therefore accepted for memory, cognitive, metacognitive, affective and social but not compensation strategies. Since this study has no justification for lack of differences between Arabic and Mathematics students, future research may account for this contradiction. Moreover, because the researcher could not locate a study that examined the differences between academic majors and strategy use to compare findings, future researchers may verify the present research results.

Ethnicity and patterns of learning strategy use

As regards the relationship between ethnicity and patterns of strategy use (second research question), the findings indicated Arab learners are upper-intermediate users of metacognitive and social strategies while being intermediate users of *compensation*, *cognitive*, *memory* and *affective* strategies. These results concurred to a large extent with Abu Shmais (2003) who found EFL Arab learners high users of metacognitive strategies, upper-intermediate users of social, affective, cognitive and memory strategies, while low users of compensation strategies. Such findings probably showed Arab students as effective language learners for using metacognitive strategies most. This concurred with previous research findings, since frequent users of metacognitive strategies academically outperform memory strategy users (e.g., Cotterall and Murray 2009; Kasper 1997; Oxford 1990b; Qingquan et al. 2008).

Arab students were upper-intermediate metacognitive and social strategy users while being intermediate users of *compensation*, *cognitive*, *memory* and *affective* strategies. These results disagreed with O'Malley and Chamot (1990), Peacock and Ho (2003), Politzer and McGroarty (1985), Rasekh and Ranjbary (2003) and Yu and Wang (2009) who found Eastern EFL learners lower-order strategy users. This study also disagreed with Grainger (1997) and Green (1991) who claimed European and American students outperform Eastern counterparts in higher-order strategy use because Arab students, who are Eastern, were frequent users of higher-order strategies (metacognitive) as in the present and Abu Shmais's (2003) research. Moreover and contrary to O'Malley and Chamot (1990), Peacock and Ho (2003), Rasekh and Ranjbary (2003) and Yu and Wang (2009), Eastern ethnicities even use higher-order (metacognitive) more than lower-order (memory) strategies (e.g., Chang 1991; Hong-Nam and Leavell 2007; Oh 1992; Qingquan et al. 2008; Rahimi et al. 2008; Riazi and Rahimi 2005).

Contrary to Grainger (1997) and Green (1991), European students used the same lower- and higher-order strategies that Eastern learners used. For example, Spanish students used memory strategies most (McGroarty 1987), while French students were average cognitive and metacognitive strategy users (Merrifield 1996). Although the current findings agreed with Abu Shmais's (2003) conclusions about Arab students, research is far from linking strategy use to ethnic culture even within the same culture. For example, Abu Shmais found Arab students use compensation strategies least, whereas this study's Arab students were moderate compensation strategy users. Since all ethnicities use lower- and higher-order strategies at almost similar frequency levels, the current findings disagreed with, for example, Oxford (1990a) and Watson-Raston (2002) who alleged that unmediated deterministic relationships exist between national/ethnic culture and strategy use. The study, however, agreed with Holliday (2005) and Palfreyman and Smith (2005) who view with suspicion the attempts to establish deterministic relationships between particular ethnic cultures and learning strategy use.

Therefore, this study rejected the two-tailed hypothesis that indicates differences between cultural groups in strategy use because the differences between ethnicities are contradictory even within the same culture. In contrast, the alternative hypothesis, stating no differences between cultural groups in strategy use, was accepted. This study could explain neither why Arab learners use metacognitive strategies most nor why they differ from other cultural groups, because learners from both Eastern and Western ethnicities use almost the same high-order (metacognitive) and lower-order (memory) learning strategies. Such dissonance in research findings calls for further research. As such, the present study cast serious doubts on those attempts seeking to establish unmediated deterministic relationships between national/ethnic culture and cognitive functioning.

Given this research evidence, this study made four conclusions: (1) Interdisciplinary differences in terms of course/curriculum diversification rarely influence EFL student memory, cognitive, metacognitive, affective and social strategy use. (2) In contrast, interdisciplinary differences influence Science students to use compensation

strategies more than Humanities counterparts. (3) EFL Arab students are frequent metacognitive and social strategy users while being average users of other strategies. (4) No relationship exists between ethnicity and strategy use since different ethnicities use both lower- and higher-order strategies at similar frequency levels.

Future practice and limitations

This research recommends more recognition to complex and diverse influences of particular educational experiences more than ethnic culture stereotypes. Issues of curriculum designs, instructional strategies and strategy training determine what strategies students develop and use more than ethnicity. By structuring instruction in particular ways, students can develop particular strategies. Research findings (e.g., Coyle 2007; Liggett 2008; Shawer 2010c; Yu and Wang 2009) show lower-order cognitive functioning results mainly from curriculum and instruction issues. For example, memory strategies develop as a result of teacher-centred and information delivery instruction and use of fixed-type materials, such as textbooks. By moving to strategy-based, communication-oriented and student-centred instruction, students can develop and use higher-order learning strategies. For example, when teachers ask students to achieve small research projects and assignments, they will have to use higher-order strategies through this learner-based instruction. The students will, for example, have to use metacognitive and social strategies. They will use metacognitive strategies to overview different readings, pay attention to particular relevant sections, plan their work, set goals and objectives to complete each part of the plan, organize work, self-monitor and assess learning and document progress. In a similar vein, they will use social strategies through group work to complete tasks. They will, for example, organize their work, debrief their discussions and ask one another questions for clarification.

Future research should therefore examine the influence of course materials, teaching strategies, and assessment types and tools in order to spot why and what strategies students use rather than others. For example, instruction and assessment based on lower-level thinking (e.g., remembering) result in development and use of lower-order learning strategies, whereas those based on higher-order thinking (e.g., evaluating and synthesis/creativity) help students to develop and use higher-order strategies. Reaching causal relationships between particular strategy use and improved performance between and within ethnic groups, genders and courses should guide curriculum and instructional designs. For example, if research shows Humanities students are low cognitive and metacognitive strategy users, Humanities programmes should find ways to help students develop and use such strategies. As such, identifying problems of strategy use due to programme nature of study could improve curriculum and instructional designs, information processing and ultimately learning outcomes.

Since the researcher was unable to find studies examining the relationship between academic majors and strategy use, future researchers may challenge the current findings. Although this research went against a relationship between ethnic culture and patterns of strategy use, comparative studies should clear the dissonance among previous research findings. Future researchers should assess learning strategy use through think-aloud and performance rather than self-reporting measures to avoid spurious reporting and misrepresentation. Researchers need to use qualitative or mix qualitative and quantitative research designs to allow students to spell out what strategies they use while processing language tasks. Researchers may also examine the differences in EFL strategy use between ethnicities due to sentence structure among heritage language groups. For example, they may compare SVO language learners with SOV language learners in their EFL strategy use.

Finally, generalizing these research findings to other, including Arab, contexts should be done with caution since the research sample represented one institution. Moreover, the study assessed strategy use through self-reporting measures, which opens the door to possible false reporting and misrepresentation. In addition, data collection in this quantitative study was through a single instrument and without giving the opportunity to the subjects to explain or justify responses. Hence, mixed-method research designs can provide richer evidence.

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