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A Comparative Study of Metadiscourse Markers in Geology Research Articles

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Abstract
Interest in metadiscourse markers use in Research Articles (RAs) of different disciplines has grown among discourse and genre researchers. Among the hard sciences, Geology and its' sub-disciplines have received scant attention. This is while Geology postgraduate students' original research findings fail to get published in high ranked journals of their specialty, partly due to their insufficient knowledge of the correct use of metadiscourse markers in their RAs. In the present study, using Hyland and Tse's theoretical framework (2004), we focused on the type and frequency of metadiscourse markers use in six main Geology sub-disciplines (i.e., Engineering Geology, Sedimentology, Seismology, Petrology, Palaeontology, and Geotechnics). To answer the research questions raised in the study, 180 RAs from 73 high ranked journals were selected from the main corpora. The results from the word by word analyses of the articles revealed that, except for endophoric markers, the six sub-disciplines demonstrated a statistically significant difference in the type and frequency of metadiscourse features. In addition, the results indicated that Petrology, Engineering Geology, and Sedimentology demonstrated a higher frequency in the employment of interactive markers compared to their three Geology counterparts. Contrarily, the three sub-disciplines, namely Seismology, Palaeontology, and Geotechnics showed a higher frequency in the application of interactional metadiscourse elements. The findings of the study have implications for genre researchers, ESP instructors, and Geology novice authors.

Keywords: discourse markers, interactional elements, interactive elements, geology, rhetorical organization

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Introduction

The "effectiveness" of a text, that is, the extent to which writers transfer their ideas “smoothly, accurately and quickly to any reader”, has led to many investigations on the structure of texts (Charney, 2002). Researchers, such as Connor and Kaplan (1987) have broadened their definition of “effectiveness” by carrying out research on different aspects of reading and writing, including the rhetorical nature of texts. As one of the rhetorical features of texts, metadiscourse has received a large amount of attention in the past few decades. This is because both rhetoric and metadiscourse are concerned with effective ways of producing a spoken/written text to persuade the audience as well as to share the speaker/author’s ideas and beliefs. The concept of metadiscourse is operationally defined as "the linguistic resources used to organize a discourse or the writer's stance towards either its content or the reader" (Hyland, 2000, p. 109). Regarding it as a rhetorical act, Crismore (1989) maintains that metadiscourse is “writing used to guide and direct the reader, to signal the presence of the author, and to call attention to the speech act itself” (p. 7).

It was in the 1980s that metadiscourse received more attention, and studies on metadiscourse features were developed by researchers such as VandeKopple (1985, 2002); Crismore (1989); Crismore and Farnsworth (1989, 1990); Hyland (1994, 1996, 1998, 2005) and Hyland and Tse (2004). Furthermore, metadiscourse has been investigated in various genres, e.g., academic RAs (Dahl, 2004; Hyland, 1999), postgraduate dissertations (Bunton, 1999), casual conversations (Schiffrin, 1980), school textbooks (Crimsone, 1989), and newspaper discourse (Dafouz-Milne, 2008; Le, 2004). Due to the importance of RAs in academic communities, studies on the role of metadiscourse in such an academic genre has received more attention. Researchers have become increasingly aware of the fact that differences in the use of metadiscourse should be understood not only in relation to the national culture of the writer, but also in relation to the genre and the immediate discourse community to which the text is addressed (Estaji &Vafaemehr, 2015). This is because disciplinary communities are like tribes (Becher, 1989) that have their own particular norms, categorizations, bodies of knowledge, conventions, and modes of inquiry (Bartholomae, 1986; Swales, 1990).There have been few research studies conducted on the use of metadiscourse across different disciplines (Atai & Sadr, 2008; Cao & Hu, 2014; Estaji & Vafaemehr, 2015; Farzannia & Farnia, 2016; Ghaemi & Sabadoust, 2017; Hyland, & Jiang, 2018; Jiang & Hyland, 2017; Keshavarz & Kheirie, 2012; Mur- Duenas, 2011; Pooresfahani et al., 2012). Yet, metadiscourse in Geology articles, as a hard science discipline, does not appear to have attracted the kind of genre-based research described above.

As ESP (English for Specific Purposes) instructors of Geology and related disciplines, the researchers have discovered that Iranian ESP learners, in general, and Geology students, in particular, fail to publish their up to date and original research studies in high ranked journals of their specialties partly due to their lack of knowledge on the correct use of metadiscourse markers in their RAs. This is while, Iranian Geology postgraduate students have made great new advances in Geological topics of research announced by their high ranked

journals. As a solution to their mere knowledge of the use of metadiscourse elements in RAs, Geology postgraduate students imitate the metadiscourse features used in the RAs of the neighboring disciplines of Geology, namely, Biology, Mining Engineering, Civil Engineering, Mechanical Engineering, and Electrical Engineering. Such imitation is due to Geology practitioners' presumption of the identical use of metadiscourse elements in all hard sciences. Consequently, the students receive major corrections or rejections on their manuscripts from high ranked journals of their specialties. This demonstrates the Iranian Geology postgraduate students' dire need to improve their writing skills in English in order to get published or to find the opportunity to present in international conferences. Therefore, to fill in the gap of genre studies on the type and frequency of metadiscourse markers in Geology RAs and to develop the Geology practitioners' awareness of the effective use of metadiscourse features in their RAs, the present study is intended to examine the kinds and frequency of use of metadiscourse markers in RAs of six major Geology sub-disciplines (Palaeontology, Engineering Geology, Sedimentology, Geotechnics, Petrology, and Seismology). Moreover, to develop our understanding of the commonalities or differences in type and frequency of use of metadiscourse markers among the above-mentioned hard sciences, the results of which will be further elaborated in light of the comparison of the research results with the previous findings on the type and frequency of use of metadiscoure features in the disciplines of Biology, Mining Engineering, Civil Engineering, Mechanical Engineering and Electrical Engineering. In this respect, the following research questions will be addressed:

1. What are the most common metadiscourse markers across Geology sub-disciplines?
2. Is there any statistical significant difference in the type and frequency of use of interactive metadiscourse markers in Geology research articles across its' six main sub-disciplines?
3. Is there any statistical significant difference in the type and frequency of use of interactional metadiscourse markers in Geology research articles across its' six main sub-disciplines?

The present article attempts to give a short and relevant review of the related literature, in which the most important sources as well as the studies done in the area are reviewed. Then, a detailed account of the method, including corpora, theoretical framework, procedures and data analysis measures employed will be presented. The next section of the article deals with the results of the study obtained. In the discussion section, following the results, there have been attempts to present a thorough discussion of the findings in light of the theoretical framework and the studies done. Conclusions and implications make the final section of the report.

Literature Review

The growing interest in metadiscourse and its subcategories has led to different research projects which mainly focus on the use of metadiscourse features by native and nonnative students in academic and disciplinary writing (Attarn, 2014; Ghadyani & Tahririan, 2015; Gholami & Ilgamit, 2016; Musa & Hussin, 2020; Shafqat et al., 2020). As mentioned above, there are few

disciplinary studies conducted on the use of metadiscourse markers within hard sciences.

Abdi (2002) investigated the use of interpersonal metadiscourse markers in the discussion sections of 55 research articles from the fields of social and hard sciences. To study interpersonal metadiscourse, Abdi studied three markers as attitude markers, boosters, and hedges. Through the analysis, it was found that social science writers used the interpersonal metadiscourse markers more than hard science writers. Although there was a significant difference between the two majors in the use of hedges and attitude markers, the results showed that there were little differences in the use of boosters.

In a study conducted by Keshavarz and Kheiri (2011) on 120 RAs of two disciplines of Applied Linguistics and Civil Engineering, they found that the writers from the two disciplines were significantly different in using metadiscourse elements collectively. With regard to different subcategories of metadiscourse, the results revealed that the four groups of writers from the two disciplines used different types of metadiscourse differently.

Zarei and Mansoori's (2011) study on the use of metadiscourse markers in 40 RAs in two disciplines of Applied Linguistics and Computer Engineering revealed that Applied Linguistics representing Humanities relied heavily on interactive elements rather than on interactional ones, compared with Computer Engineering representing non Humanities. The analysis attested that Humanities focus on the textuality at the expense of reader involvement.

In an attempt to examine the type, frequency and functions of intensity markers in RAs of two disciplines of Applied Linguistics and Electrical Engineering, Behnam and Mirzapour (2012) found that the overall distribution of intensity markers in Applied Linguistics articles is higher than those in Electrical Engineering ones. In addition, their research indicated that the Electrical Engineering writers tend to use more boosters in the conclusions sections than the abstract sections of their RAs.

Estaji and Vafaemehr's (2015) contrastive study on interactional metadiscourse markers in the introduction and conclusion sections of 42 Mechanical and Electrical Engineering RAs showed that although there were some minor differences in the frequency and type of these metadiscourse markers, there was no statistically significant difference across the disciplines, which can be attributed to the close nature of these fields. In a comparative study on the use of interactive and interactional discourse markers in 120 Chemical Engineering RAs, Ahmadi and Abdi (2016) found that Chemical Engineering authors tend to use evidentials, frame markers, and endophoric markers more than code glosses and transitions, which reveals that writers of the discipline are aware of the importance and contribution of such markers in RAs.

Farzannia and Farnia's (2016) study on metadiscourse markers in the introduction sections of 34 Mining Engineering articles demonstrated significant differences in the use of code glosses and evidentials. The utilization of boosters, engagements, and endophorics were approximately the same across the corpus. Finally, attitudes and self-mentions were the less frequent metadiscourse markers in the corpus. The authors relate the findings to the nature of hard sciences which are considered as objective and unbiased.

Moreover, Kahkesh and Alipour's (2017) investigation on the frequency of metadiscourse markers in the result and discussion sections of 40 Literature and Engineering RAs showed significant differences in the overall frequency of metadiscourse markers except for frame markers and boosters in both disciplines.

Hyland and Jiang (2018) explored whether and to what extent metadiscourse has changed in professional writing in four disciplines of Electrical Engineering, Biology, Applied Linguistics and Sociology over the past fifty years. Their analysis of the corpora showed that there has been a significant increase in interactive features and a significant decrease in the interactional types of metadiscourse markers. Their findings indicated that the interactional metadiscourse showed a marked decline in the soft knowledge fields and a substantial increase in the Science subjects. Following them, in a study conducted on 200 evaluative essays from hard and soft sciences Zali et al. (2020) discovered that soft science students used more interactional metadiscourse features than the students in hard sciences. They also found that students in both fields of studies prominently used self-mentions and hardly used any attitude markers in their academic essays.

Also, to the researchers' best knowledge, there are two studies conducted on the frequency of use of metadiscourse markers in Geology discipline. Sahragard and Yazdanpanah (2017) compared the use of English engagement markers in both Humanities (Psychology, Sociology, Economic, and Law) and Science (Geology, Mathematics, Physics, and Biology) RAs. Sixteen articles from each discipline were selected. The results indicated that Humanities RAs make use of more engagement markers than Science RAs. Also, the findings of their study suggest that directives are used more than other markers both in Humanities and Science RAs. Regarding the use of engagement markers in 1990s and 2000s, a significant increase in the use of engagement markers was observed with the passage of time, both in Humanities and Science RAs including Geology.

Among the research which focus on the use of metadiscourse elements by native and nonnative disciplinary authors Ebadi et al. (2015) examined the metadiscourse features in the discussion and conclusion sections of 30 Geology RAs written by Iranian and native English authors. The results showed that the native English writers used more interactional metadiscourse devices than the interactive metadiscourse features in the argumentative sections of their RAs. However, native Persian authors applied more interactive metadiscourse resources than the interactional ones in the discussion and conclusion sections of their RAs. The findings implied that although the native Persian writers well organized their discourse flow, they could not make an effective interpersonal relationship with their own readers. As the literature above indicates, there is a dearth of research conducted on the use of metadiscourse markers in Geology articles. Therefore, the present study aims to fill in this gap to ameliorate our understanding of the use of metadiscourse markers in such genre.

Method

Corpora

For the corpora to be representative of the genre, 29 Geology professors were consulted for the selection of each corpus. But, prior to the selection of the RAs, the course-specific professors were asked to introduce the high ranked journals within their specialties. They introduced 73 high ranked journals within their fields of studies. Based on the nature of each specialty, of course, the number of journals varied. The number of journals for each sub-discipline included: 19 for Seismology, 6 for Geotechnics, 13 for Engineering Geology, 9 for Sedimentology, 21 for Petrology, and 5 for Palaeontology. To compensate for the differing number of journals in each sub-discipline, care was taken to select the same number of RAs from each specialty. Therefore, 300 RAs, written in English, from 2012-2018 issues were randomly selected as the preliminary corpora. Then, thirty RAs for each sub-discipline were randomly selected by the professors. Consequently, the corpora included 180 RAs consisting of approximately 3,000,000 running words, excluding the abstracts, figures and tables' captions. The abstracts were not included due to their impact on the frequency and interpretation of interactional markers (Gillaerts & De Velde, 2010).

Theoretical Framework

The study employed Hyland and Tse's (2004) theoretical framework which distinguishes between interactive and interactional resources. In Hyland's definition (as cited in Hyland and Jiang, 2018), the interactive metadiscourse markers are concerned with ways of organizing discourse and reflect the writer's assessment of what needs to be made explicit to guide readers to what should be recovered from the text. The interactional metadiscourse is concerned with the writer's efforts to control the level of personality in a text and establish a suitable relationship to their data, arguments and audience, marking the degree of intimacy, the extent of reader involvement and the expression of attitude and commitments. According to the theoretical framework, the two groups of metadiscourse are classified as the following:

Interactive resources:

- *Transitions* comprise an array of devices, mainly conjunctions, used to mark additive, contrastive, and consequential relations between main clauses; such as *in addition, but, thus.*
- *Frame markers* are references to text boundaries or text structure, including items used to sequence, to label text stages, to announce discourse goals and to indicate topic shifts; such as *finally* and *to conclude.*
- *Endophoric markers* make additional material salient to the reader in recovering the writer's intentions by referring to other parts of the text; such as *see Fig,* or *noted above.*
- *Evidentials* indicate the source of information which originates outside the current text, mainly consisting of citations and explicit evidential markers; such as *according to,* or *Z states.*

- *Code glosses* signal the reworking of ideational information; such as *namely, for example, for instance.*

Interactional resources:

- *Hedges* withhold the writer's full commitment to a statement; such as *might, perhaps, about.*
- *Boosters* express certainty and emphasize the force of propositions; such as *in fact, it is clear that.*
- *Attitude markers* express the writer's attitude to propositions, conveying surprise, obligation, agreement, importance, and so on; such as *I agree, surprisingly.*
- *Engagement markers* explicitly address readers by focusing their attention or including them in the text through second person pronouns, imperatives, questions and asides; such as *consider,* or *note.*
- *Self-mentions* explicit reference to authors; such as *I, we, my, you.*

Procedure

After the random selection of 180 RAs from the main corpora, a preliminary list of discourse markers based on Hyland and Tse's theoretical framework (2004) was developed. As metadiscourse is essentially an open category, and due to insider opacity, the analyst may never recover all intended metadiscoursal meanings (Hyland & Jiang, 2018); thus, a list of each element's synonyms was collected through wordnik.com online thesaurus. Subsequently, the synonyms were checked by the framework's definition on each category of metadiscourse markers. Consequently, a total of 402 metadiscourse markers were listed and classified into 10 sub-categories. Some examples for each sub-category of metadiscourse extracted from the corpora are presented below:

- **Transitions:** although, hence, however, since, so, yet, and, also, moreover
- **Frame markers:** another, first of all, here, in regard to, in summary, turn to, to repeat
- **Endophoric markers:** as follows, previously, in this chapter, referred to, the list below
- **Evidentials:** (19--), according to, cited, following, in a later article
- **Code glosses:** in fact, like, namely, such as, that is, which means
- **Hedges:** almost, argue, claim, fairly, from my perspective, in most cases, perhaps
- **Boosters:** actually, believe, distinguish, it is clear, emphasized, obviously, the fact that
- **Attitude markers:** appropriate, convincing, easily, hopeful, interesting, it is better, prefer
- **Self-mentions:** author, I, in my case, my, our, we, writer
- **Engagement markers:** allow…, consider…, let…, look at…, note that

Next, due to the variability in the size of the articles' sections in each sub-discipline, the frequency of metadiscourse markers for each section of the articles was calculated per 1,000 words. This was to assure comparability of the results (Crismore et al., 1993).

Then, the researchers analyzed the articles manually through a word by word analyses of the 180 RAs and classified each element into the metadiscoursal subcategories presented in the theoretical framework. The same procedure was independently done by a genre analyst who was an expert in discourse and discourse markers analysis. Subsequently, an inter-rater reliability estimate was gained between the three raters' data, which was estimated as 0.82 (Kappa) indicating a good reliability index. Moreover, since the present authors were not specialists in Geology, everything was double-checked by asking Geology professors who were reviewers of Geology high ranked English journals to recheck the analysis after the reliability had been estimated.

Data Analysis

After detecting, coding, and counting the distribution of metadiscourse markers in the RAs the data were analyzed for the type, frequency and percentages of each sub-category of interactive and interactional metadiscourse markers within the articles of each Geology sub-discipline. Then, to investigate the research questions the variables were examined for normal distribution through Shapiro-Wilk test. Since the variables did not exhibit a normal distribution, the non- parametric Kruskal-Wallis test was applied to analyze the data. The analysis procedure was done through SPSS program version 26.

Results

The results indicated that the interactive features were used more frequently in Petrology (M = 90.39), Engineering Geology (M= 83.16), and Sedimentology (M= 102. 62) RAs; whereas, Seismology (M = 96.96), Palaeontology (M = 124.62), and Geotechnics (M = 111.68) demonstrated a higher frequency of use of interactional metadiscourse features by their authors. The results on the first group of interactive markers indicated that the most transitions used in Geology RAs is the connective 'and' which is in common among the six variations. Also, the Kruskal-Wallis test demonstrated a statistical significant difference (H < 0.05) in the use of transitions among the six sub-disciplines with Sedimentology possessing the highest and Geotechnics possessing the lowest application of transitions among the six sub-disciplines (Table 1).

Table 1
Results on Use of Transitions among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Transitions	Petrology	30	88.47	117.063	5	0.001
	Engineering Geology	30	42.35			
	Seismology	30	83.28			
	Palaeontology	30	135.72			
	Geotechnics	30	41.37			
	Sedimentology	30	151.82			

The results on the percentages of each frame marker in each sub-discipline illustrated that the most frame markers used in the Geology RAs are ‘first’, 'second’, 'third', 'after', and 'then'. Also, the Kruskal-Wallis test indicated a statistical significant difference (H < 0.05) in the use of frame markers among the six variations. In addition, the results showed that the highest and lowest application of frame markers among the six sub-disciplines belong to Seismology and Sedimentology, respectively (Table 2).

Table 2
Results on Use of Frame Markers among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Frame markers	Petrology	21	91.31	63.041	5	0.001
	Engineering Geology	30	56.1			
	Seismology	21	120.26			
	Palaeontology	21	42.69			
	Geotechnics	30	85.88			
	Sedimentology	21	40.05			

As the third category of interactive metadiscourse features, the percentages for each endophoric marker in each Geology variation illustrated that the most endophoric marker used in the Geology RAs is the word 'Figure', such as in Figure 2. Moreover, the Kruskal-Wallis test results indicated no significant difference (H > 0.05) in the use of endophoric markers among the six sub-disciplines (Table 3).

Table 3
Results on Use of Endophoric Markers among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Endophoric markers	Petrology	30	68.68	10.108	5	0.072
	Engineering Geology	30	86.03			
	Seismology	30	100.65			
	Palaeontology	30	93.33			
	Geotechnics	30	107.62			
	Sedimentology	30	86.68			

The fourth category belongs to evidentials. The results on the percentages for each evidential in each sub-discipline illustrated that the most evidentials used in the Geology RAs are references and in-text citations, e.g., Johnson, 1992, which belong to Sedimentology. Additionally, the results from the Kruskal-Wallis test indicated a statistical significant difference (H < 0.05) in the use of evidentials among the six variations. Also, the results show that the highest and lowest application of evidentials among the six sub-disciplines belong to Sedimentology and Seismology, respectively (Table 4)

Table 4
Results on Use of Evidentials among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Evidential	Petrology	31	84.02	57.508	5	0.001
	Engineering Geology	30	66.53			
	Seismology	31	46.35			
	Palaeontology	31	121.89			
	Geotechnics	31	106.95			
	Sedimentology	30	129.62			

As the last group of interactive discourse markers, the results on the percentages of code glosses revealed that the most frequently used code glosses in the Geology RAs include *e.g., such as*, and *i.e.* In addition, the Kruskal-Wallis test indicated a statistical significant difference (H < 0.05) in the use of code glosses among the six sub-disciplines. Also, the results show that the highest and lowest application of code glosses among the six sub-disciplines belong to Engineering Geology and Seismology, respectively (Table 5).

Table 5
Results on the Use of Code Glosses among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Code glosses	Petrology	30	119.48	130.437	5	0.001
	Engineering Geology	30	164.83			
	Seismology	30	39.93			
	Palaeontology	30	71.22			
	Geotechnics	30	42.57			
	Sedimentology	30	104.97			

The results on the percentages of the first group of interactional markers, i.e., hedges, illustrated that most hedges used in the Geology RAs are 'probably' and 'seem'. Moreover, the results on the Kruskal-Wallis test indicated a statistical significant difference (H < 0.05) in the use of hedges across the six sub-disciplines. Further, the results show that the highest and lowest application of hedges among the six sub-disciplines belong to Palaeontology and Engineering Geology, respectively (Table 6).

Table 6
Results on Use of Hedges among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Hedges	Petrology	30	123.68	128.554	5	0.001
	Engineering Geology	30	24.07			
	Seismology	30	39.07			
	Palaeontology	30	136.55			
	Geotechnics	30	126.93			
	Sedimentology	30	92.7			

The results obtained from the percentages of boosters in Geology RAs demonstrated that the most frequently used boosters in the Geology RAs include 'clearly', 'it is clear', 'in fact', and 'positively'. In addition, the results from the Kruskal-Wallis test indicated that there is a statistical significant difference (H < 0.05) in the use of boosters across the six variations. Also, the results show that the highest and lowest application of boosters belong to Geotechnics and Petrology, respectively (Table 7).

Table 7
Results on Use of Boosters among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Boosters	Petrology	30	42.22	81.608	5	0.001
	Engineering Geology	30	71.32			
	Seismology	30	100.98			
	Palaeontology	30	68.33			
	Geotechnics	30	150.85			
	Sedimentology	30	109.3			

The results on the percentages of attitude markers illustrated that the attitude markers used most frequently in the Geology RAs are 'x notes', 'I agree', 'x asserts' and 'surprisingly. Additionally, the results from the Kruskal-Wallis test indicated a statistical significant difference (H < 0.05) in the use of attitude markers among the six sub-disciplines. Moreover, the results show that the highest and lowest application of attitude markers among the six sub-disciplines belong to Palaeontology and Petrology, respectively (Table 8).

Table 8
Results on the Use of Attitude Markers among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean rank	H	df	Sig
Attitude markers	Petrology	30	50.63	129.131	5	0.001
	Engineering Geology	30	62.93			
	Seismology	30	136.28			
	Palaeontology	30	160.05			
	Geotechnics	30	58.8			
	Sedimentology	30	74.3			

The results obtained on the percentages of the engagement markers showed that the most frequent engagement marker used in the Geology RAs is 'consider'. Furthermore, the results from the Kruskal-Wallis test revealed that there is a statistical significant difference (H < 0.05) in the use of engagement markers across the six main sub-disciplines. Also, the results show that the highest and lowest application of engagement markers among the six sub-disciplines belong to Sedimentology and Petrology, respectively (Table 9).

Table 9
Results on Use of Engagement Markers among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Engagement markers	Petrology	30	39.3	116.827	5	0.001
	Engineering Geology	30	46.22			
	Seismology	30	134.03			
	Palaeontology	30	114.68			
	Geotechnics	30	67.13			
	Sedimentology	30	141.63			

As the last group of interactional metadiscourse markers, the percentages on self-mentions illustrated that the most frequent self-mention used in the Geology RAs is the pronoun 'we'. Additionally, the results from the Kruskal-Wallis test indicated that there is a significant difference (H < 0.05) in the use of self-mentions among the Geology six variations. Moreover, the results show that the highest and lowest application of self-mentions among the six sub-disciplines belong to Geotechnics and Engineering Geology, respectively (Table 10).

Table 10
Results on Use of Self-Mentions among the Geology Sub-Disciplines

Metadiscourse markers	Sub-discipline	N	Mean Rank	H	df	Sig
Self-mentions	Petrology	30	90.25	148.646	5	0.001
	Engineering Geology	30	15.97			
	Seismology	30	74.45			
	Palaeontology	30	143.53			
	Geotechnics	30	154.73			
	Sedimentology	30	64.07			

According to the results, the answer to the second research question (*Is there any statistical significant difference in the type and frequency of use of interactive metadiscourse markers in Geology research articles across its' six main sub-disciplines?*) is that, except for endophoric markers (H > 0.05), the six main variations of Geology demonstrate a statistical significant difference (H < 0.05) in the use of transitions, frame markers, evidentials, and code glosses. Moreover, the results on the third research question (*Is there any statistical significant difference in the type and frequency of use of interactional metadiscourse markers in Geology research articles across its' six main sub-disciplines?*) indicate that the six main sub-disciplines demonstrate a significant difference (H < 0.05) in the use of five subcategories of interactional markers.

To summarize, our analysis identified clear cross sub-disciplinary differences in the use of metadiscourse markers. In addition, the results

indicate that the most frequent metadiscourse markers used among the Geology variations belong to Sedimentology RAs. It was also indicated that the lowest number of metadiscourse features used among the Geology RAs belongs to the Petrology variation. This reveals that, among the Geology authors, the Sedimentology writers use a heterogeneous array of cohesive and interpersonal features to relate text to context and assist readers to connect, organize, and interpret content in a way which they prefer (Hyland & Tse, 2004).

Discussion

The findings from the results indicated that the writers in the six variations were significantly different in applying metadiscourse elements in the articles of their specialties. This is rather surprising since the variations are all sub-branches of one discipline. The cohesiveness resulting from the dominant use of interactional markers in the RAs of three variations of Paleontology, Geotechnics, and Sedimentology RAs clearly shows their authors' awareness of the readers' active involvement in the discourse. This, according to Gholami and Ilgamit (2016), is considered as a motivating factor in organizing the RAs. It also suggests that the authors in these sub-disciplines are more successful on convincing their readers of what they have accomplished. On the other hand, the higher frequency of use of interactive markers in the three sub-disciplines of Seismology, Sedimentology, and Engineering Geology demonstrate the authors' awareness of their readers' reading requirements. Thus, they provide their readers with an organized text (Gholami & Ilgamit's, 2016) through the prevalent use of connectives, transitions, evidentials, and code glosses.

The difference in the type and frequency of the use of interactive and interactional metadiscourse features between the six sub-disciplines could be due to their authors' shifts towards rhetorical issues (Gillaerts & Van de Velde, 2010). That is, the higher frequency of employment of interactional markers in Paleontology, Geotechnics, and Sedimentology RAs compared to their Geology counterparts might be due their writers' attempts to establish scholarly credibility through using cautious expressions of scientific claims (Gillaerts & Van de Velde, 2010). However, as the Iranian Geology postgraduate students consider metadiscourse features used in the RAs of five disciplines of Biology, Mining Engineering, Civil Engineering, Mechanical Engineering, and Electrical Engineering as good metadiscourse sources for Geology articles, the results will be further discussed in comparison with the findings on these five neighboring disciplines of Geology.

Transitions as conjunctions and adverbial phrases which signal logical relations in the writer's thinking and help readers interpret connections between clauses and steps in an argument (Hyland & Jiang, 2018) had the highest frequency of use in Sedimentology RAs which illustrates its writers' stance towards logical relations compared to other Geology variations. The finding is in line with Gholami and Ilgamit's (2016) and Hyland and Jiang's (2018) discoveries on the use of transitions in Biology and Electrical Engineering RAs. However, the findings are not in agreement with their research findings on the use of transitions in the other five Geology variations

which could indicate that the authors in Seismology, Geotechnics, Palaeontology, Petrology, and Engineering Geology are less proficient in making semantic relations within the text (Hyland &Tse, 2004).

Frame markers as the second subcategory of interactive markers had the highest frequency of use in Seismology, which shows the Seismology authors' tendency to label up-coming segments of text, shift in direction or the sequencing of material (Hyland& Jiang, 2018). According to Hyland and Jiang (2018), the use of frame markers has had the heaviest increase in Electronic Engineers' RAs during the past 50 years which is in line with the study's finding. However, this increase in the application of frame markers is contrary to the results on Civil Engineering (Keshavarz &Kheiri, 2011) and the other five sub-disciplines of Geology under study.

On the contrary, endophoric markers did not display any differences among the six sub-disciplines which shows that all writers in the six variations are explicit in elaborating concepts, spelling out connections between ideas, and clarifying associations between text entities (Hyland & Jiang, 2018). This is in line with the Biology (Gholami & Ilgamit, 2016), and Civil Engineering (Keshavarz & Kheiri, 2011) authors' use of endophoric markers. It also confirms Hyland and Jiang's (2018) discoveries on the use of endophoric markers in Electrical Engineering and Biology articles during the past 50 years, which, according to them, has risen up to 69% and 32%, respectively. Opposite to their findings are the results on the use of endophoric markers in Mining RAs (Farzannia & Farnia, 2016) which, compared to other interactive markers, are less frequent in the discipline.

Evidentials, as the fourth subgroup of interactive markers, demonstrated their highest application in Sedimentology compared to other Geology variations. The result is in agreement with Hyland and Jiang's findings (2018) on the use of evidentials in Electrical Engineering RAs which indicate that the use of evidentials has particularly increased since 1968. This is the same for Mining Engineering RAs (Farzannia & Farnia, 2016). It is rather noteworthy that, in the use of evidentials, the two other sub-disciplines of Geology, namely Palaeontology and Geotechnics, are in the next rankings, respectively. This is evidenced in their generous use of references and text citations. Such generosity can reach up to 90-180 references in some Sedimentology, Palaeontology, and Geotechnics' RAs. This is more compelling when the number of references in such articles is compared to the number of citations in Seismology RAs where the number could approximately reach up to a maximum of 14 in most of the Seismology corpus. This, in Hyland's view (as cited in Hyland & Jiang, 2018), "showcases [the Sedimentology, Palaeontology, and Geotechnics authors'] extensive use of external sources to keep closer ties of research to the particular topics under discussion" (p. 21). The results, however, are in contrast to Keshavarz and Kheiri's (2011) findings on the use of evidentials in Civil Engineering RAs where they report a low frequency of the use of such metadiscourse markers.

Code glosses as the last subcategory of interactive markers had the highest frequency of use in Engineering Geology variation. This is in line with Hyland and Jiang's findings (2018) on the use of code glosses in the Electrical Engineering and Biology disciplines which show a tremendous increase (52%,

122%, respectively) in the past 30 years. On the other hand, the results are inconsistent with the results on the use of code glosses in Civil Engineering where Keshavarz and Kheiri (2011) report on its low level of frequency in such RAs.

Regarding interactional metadiscourse features, hedges were demonstrated to be the most frequently used in the Palaeontology corpus. This shows that Palaeontology authors are the most judicious authors, as they allow themselves to mark their claims as provisional and subject to current objections and future revisions (Hyland & Jiang, 2018). Although the research results on Palaeontology sub-discipline are in line with Estaji and Vafaimeher's (2015), Hyland and Jiang's (2018), Gholami and Ilgamit's (2016), and Farzannia and Farnia's (2016) findings, they are, nevertheless, contrary to Kehavarz and Kheiri's (2011) discoveries on the use of hedges in Civil Engineering RAs. In a study on 120 Civil Engineering RAs, they discovered that hedges are the least common discourse markers used in such articles. This may be due to the Palaeontology, Electrical Engineering, Mining Engineering and Biology authors' orientation to what Hyland and Jiang (2018) call "scientism" compared to authors in Sedimentology, Seismology, Petrology, Geotechnics, Engineering Geology and Civil Engineering.

Boosters as the next subgroup were found to have their highest use in Geotechnics' RAs, which is in agreement with Hyland and Jiang's (2018) findings on the use of boosters in Electrical Engineering articles, in which the use of boosters is said to have gradually increased during the past 50 years. This demonstrates the Geotechnics' authors preferences in shifting from commitments expressed as personal beliefs towards those which seek to convey more objective, data supported assurances (Hyland & Jiang, 2018), which is less observed in Civil Engineering (Keshavarz & Kheiri, 2011) and other Geology variations.

The third subcategory, attitude markers, possess their highest rankings in Palaeontology RAs. This illustrates the writers' preferences for writing more based on the facts, employing a strong tone (Estaji &Vafaeimehr, 2015) compared to other Geology sub-disciplines. As a variation of hard sciences, this contradicts the results reported by Kehshavarz and Kheiri (2011) on Civil Engineering, Estaji and Vafaeimehr (2015) on Mechanical and Electrical Engineering, and Farzannia and Farnia (2016) on Mining Engineering where they indicated that the least amount of metadiscourse markers used in Mechanical, Electrical, and Mining Engineering RAs belong to attitude markers. Further, the finding is in contrast to Hyland and Jiang's (2018) findings on the two disciplines of Electrical Engineering and Biology where they reported a tremendous fall in Electrical Engineering and Biology RAs' use of attitude markers in the past 50 years. This, in their view (2018), shows the authors' tendency for strong authorial standpoints on issues.

The fourth subgroup, engagement markers, show their most frequencies in Sedimentology, Seismology and Palaeontology RAs, with the Sedimentology variation holding the first position in the ranking. This, according to Hyland and Jiang (2018), demonstrates the three sub-disciplines authors' ability to explicitly step into the text to focus readers on a particular aspect of the data or argument and guide their interpretations. While the

findings are in line with Hyland and Jiang's (2018), and Gholami and Ilgamit's (2016) results on the use of engagement markers in Electrical Engineering and Biology RAs, they do not confirm the results gained by Keshavaraz and Kheiri (2011) on the use of engagement markers in Civil Engineering RAs. More importantly, there is a slight contrast between the study's results and Sahragard and Yazdanpanah's (2017) findings on the use of engagement markers in Geology RAs. They report that Science RAs, including Geology, contain fewer engagement markers. According to the present study, the findings on the use of engagement markers in the three sub-disciplines of Sedimentology, Seismology, and Palaeontology do not agree with Sahragard and Yazdanpanah's (2017) results. Nonetheless, their results confirm the present study's findings on the use of engagement markers in the three other variations of Geology including Geotechnics, Petrology, and Engineering Geology. The contradiction might be due the small number of samples (16) from the Geology RAs chosen for Sahragard and Yazdanpanah's study (2017) which clearly had not embraced all the six main variations of Geology.

The last subgroup of metadiscourse markers, i.e., self-mentions, possess the highest frequency of use in Geotechnics' RAs which represent a significant aspect of rhetorical persuasion in Geotechnics' academic writing through which they gain credit for their research claims (Hyland, 2004). The undistinguishable application of the self-mention marker 'we' across all Geology variations showcases the authors' tendency for explicit presence of themselves in the discourse (Gholami & Ilgamit, 2016) which is the highest among Geotechnics' authors. This is in line with Hyland and Jiang's (2018) findings on the use of self-mentions in Electrical Engineering and Biology RAs, the frequency of which, according to them, has risen up to 50% during the last 50 years.

Overall, the results from interactive and interactional metadiscourse markers investigated in the study showed that the interactive features were used more frequently in Petrology, Engineering Geology, and Sedimentology RAs. This illustrates their writers' understanding of the importance of providing the propositional information to their readers through an organized text (Gholami & Ilgamit's, 2016). On the other hand, their Geology counterparts, i.e., Seismology, Palaeontology, and Geotechnics writers demonstrated a higher use of interactional metadiscourse features. It seems that, according to Gillaerts and De Velde (2010), the authors in these variations are more oriented towards dropping the role of an 'omniscient' academic, and instead act as a scholar who deliberately expresses his/her scientific claims.

Conclusion and Implications

The study, adopting an intradisciplinary perspective, was conducted to fill in the gap of genre research on the type and frequency of metadiscourse markers within Geology discipline. The results approved that experts practicing in different sub-disciplines may have different priorities and rhetorical norms which could vary depending on the size of their discourse community, the gatekeepers in that community, and how conventionalized the community is (Swales, 1990). In addition, the findings revealed that the same field of study, either Science or Engineering, does not prescribe the use of the same type of

metadiscourse features in all neighboring disciplines. As Trowler et al. (2012) note "disciplines have real epistemological characteristics that knowledge structures do condition practices in quite real ways" (p. 246). Therefore, disciplinary writers should be admonished on the correct use of metadiscourse features applied both within their disciplines and in related disciplines.

The findings also have pedagogical implications. Overuse or misuse of metadiscourse features can make the text long-winded and clumsy (Crismore & Abdollahzadeh, 2010). Thus, designing authentic exercises by ESP instructors and materials developers geared to the students' specialties can raise students' awareness on the correct use of both metadiscourse categories. Our results will be further refined by research on the type and frequency of metadiscourse features in Geology abstracts as 'mini-articles'. Moreover, research on the effect of cultural factors on the use of metadiscourse elements in Geology context will improve our understanding of the diversity of metadiscourse employment in the six main variations of Geology.

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