Broaden Your Horizon! Play with Semantics via a Knowledge Graph-Based Approach

Pasquale Esposito[1][a], Crescenzo Mazzone[2], Maria Angela Pellegrino[2][b] and Vittorio Scarano[2][c]
[1]*Dipartimento di Studi Umanistici, Università degli Studi di Salerno, Fisciano (SA), Italy*
[2]*Dipartimento di Informatica, Università degli Studi di Salerno, Fisciano (SA), Italy*

Keywords: Lexical Semantics, Knowledge Graph, Semantic Web, Word Senses, User Evaluation, Italian.

Abstract: (Lexical) semantics is the study of the meaning of words by looking at either the word itself or exploring its neighborhood. Hence, lexicons, synonyms, and analogies can be easily represented as semantic networks, also known as knowledge graphs, to represent words and their connections. While knowledge graphs can be perceived as a natural and intuitive representation for modeling and exploring words, directly accessing them via standard query languages, such as SPARQL, is cumbersome, mainly for lay users. This article explores the possibility of "playing with semantics" via a knowledge graph-based approach to let end-users explore lexical-semantic relations without explicitly formulating SPARQL queries. We evaluated the accuracy and the coverage of users' expectations by inquiring about 27 Italian native speakers and compared quantitative and qualitative results. According to the performed evaluation, knowledge graphs have the potential to fulfill users' satisfaction, but multiple source results must be merged to guarantee high coverage and accuracy.

1 INTRODUCTION

Semantics is the study of the meaning of words and how linguistic signs mediate between concepts and forms (Pustejovsky, 2016). Semantics studies are divided into two sub-branches: logical and lexical semantics. The present study mainly focuses on the latter and investigates how the relations among units of meaning interact with their biological mental representations. In other words, this study relies on how native speakers perceive sense out of a combination of units of meaning organized in sentences. Since words are inventories of arbitrary signs, people can interpret words or their combinations differently. Semantics can provide a series of instruments to understand better complex cases of words with multiple meanings and connections in their lexical-semantic network.

Semantic networks' linguistic-traditional and formal representation can be considered similar to the information technology representation of semantic networks, a.k.a. Knowledge Graphs (KGs). Linguistics' lexical semantics establishes connections and similarities among words by looking at the neighborhood of the network, i.e., words that occur within natural sentences. Similarly, KGs represent semantic relations between concepts in a directed graph consisting of vertices, a.k.a. concepts, and edges, a.k.a. semantic relations between concepts (Sowa, 2006).

KGs, and Semantic Web technologies in general, are helpful in representing words and their surroundings as semantic networks to let users explore words in context, and they are crucial for knowledge management and information retrieval (De Donato et al., 2020). (Mitchell et al., 2008) showed that brain imaging studies have different spatial neural activation patterns while thinking about pictures or words. This phenomenon is widely debated in psycho-linguistic literature and massively explored by many experiments eager to explore neuronal semantic networks, such as those conducted by (Wang et al., 2022; Emma James and Henderson, 2023). However, KG query languages are complex for lay users (Vargas et al., 2019; Bellini et al., 2014). Hence, KG querying mechanisms should mask syntactical complexities, allowing users to pose queries easily to exploit semantic network content.

This paper explores the opportunity to "play with (lexical) semantics", meaning that users are supported in querying a word, retrieving its meaning, and exploring all the words connected to it as synonyms,

[a] https://orcid.org/0009-0006-3464-5861
[b] https://orcid.org/0000-0001-8927-5833
[c] https://orcid.org/0000-0001-8437-5253

Esposito, P., Mazzone, C., Pellegrino, M. and Scarano, V.
Broaden Your Horizon! Play with Semantics via a Knowledge Graph-Based Approach.
DOI: 10.5220/0012620700003693

In *Proceedings of the 16th International Conference on Computer Supported Education (CSEDU 2024) - Volume 1*, pages 380-387
ISBN: 978-989-758-697-2; ISSN: 2184-5026

analogies, and hierarchies. This word exploration is enabled via a KG-based approach by implicitly posing SPARQL queries while masking underlying complexity. To verify if and to what extent the proposed prototype, referred to as `LexicalEngine`, satisfies users' expectations, we tested it on 27 Italian native speakers and collected their opinions via an online questionnaire. While `LexicalEngine` covers a wide range of semantic relations, such as definitions, synonyms, and word hierarchies, we focus on word senses in this contribution. In particular, we investigated if the semantics modeled via KGs can disambiguate terms by providing end-users with a complete and accurate pool of word senses sufficiently close to the one proposed by (adult) native speakers. We compared word senses automatically retrieved by KGs with those proposed by participants. We verified if `LexicalEngine` returns word senses suggested by adult Italian speakers by measuring the `coverage` metric. Supposing that there are word senses foreseen by Italian speakers and not returned by `LexicalEngine`, those words would affect the coverage metric. The higher the coverage, the greater the guarantee that an automatic KG-driven approach would also return any word sense suggested by an Italian speaker. Besides the coverage, providing learners with tip support and avoiding information load by proposing out-of-topic and inaccurate suggestions is crucial. Hence, we reflected on word senses proposed by `LexicalEngine` but not foreseen by Italian speakers. For those word senses, we asked participants to assess their `accuracy` by reporting if and to what extent users considered those meanings as valid. The higher the accuracy, the greater the inspirational power of the proposed prototype, able to propose valid meanings, even not immediately foreseen by native speakers. The higher the assessed metrics, the greater the guarantee that end-users, such as (young) learners, can be successfully supported in self-learning lexical semantics via a KG-driven approach. By formulating those directions as research questions (RQs), we explored the following aspects:

RQ$_1$ - To what extent do KGs cover word senses belonging to Italian native speakers' mental lexicon?

RQ$_2$ - Can KGs inspire end-users by proposing uncommon but accurate word senses? To what extent?

According to the collected results, `LexicalEngine` reaches a considerable coverage of users' expectations in terms of word senses envisioned by (adult) Italian native speakers by combining multiple KG lexical-semantic features and their data (RQ_1). On the contrary, participants are skeptical about uncommon word senses suggested by `LexicalEngine`, that require to be justified to be appreciated and understood (RQ_2). This article's contribution goes toward acknowledging the usefulness of exploiting KGs in playing with lexical semantics, envisioning applicability in self-learning and education settings.

The rest of the article is structured as follows. Section 2 clarifies the used terminology and overviews related work. Section 3 presents `LexicalEngine`. Section 4 describes the performed qualitative and quantitative assessment, while Section 5 and Section 6 report and discuss the collected results. Finally, the article concludes with final remarks and future directions.

2 BACKGROUND

This section defines terms that will be used in the following and overviews related work regarding sources and tools to support lexical semantics via KGs.

2.1 Terminology

- In linguistics, a **word sense** is one of the meanings of a word. For example, a dictionary may have different senses of the word `play`, each having a different meaning based on the context of the word's usage in a sentence. *Play* is generally defined as "be engaged in an activity for enjoyment and recreation rather than a serious or practical purpose". However, it may be used as *play a role* as a synonym of acting or in combination with a sport to mean take part in (a sport).
- **Hyponymy** and **hypernymy** refer to relationships between a general term and the more specific terms that fall under the category of the general term. For example, the colors red, green, blue, and yellow are hyponyms. They fall under the general term of color, which is the hypernym.
- In linguistics, **meronymy** is a semantic relation between a meronym denoting a part and a holonym denoting a whole. In simpler terms, a meronym is in a part-of relationship with its holonym. For example, the finger is a meronym for hand, which is its holonym. **Holonymy** is the converse of meronymy.
- **Synonymy** refers to words that are pronounced and spelled differently but share the same meaning, e.g., words like car and automobile are close synonyms that can be exchanged without compromising the conceptual meaning despite having different stylistic functions. Similarly, one can also have synonymic multi-word expressions as in the case of *play a role* which is a synonym of *acting*.

Table 1: Comparison between lexical KGs in terms of supported semantic relations and user interface.

	BabelNet	Wikidata	DBnary	DBpedia	ConceptNet
Word senses	✓				✓
Definition	✓	✓	✓	✓	✓
Synonyms	✓	✓	✓	✓	✓
Hypernymy	✓	✓	✓	✓	
Hyponymy	✓		✓		
Holonymy	✓		✓		✓
Meronymys	✓		✓		✓
Translation	✓	✓		✓	✓
Images	✓	✓		✓	
Emoticons	✓	✓			✓
Interface	Web, Mobile & APIs	SPARQL endpoint	Web	SPARQL endpoint	Web

- This study refers to **analogy** in its role as rhetorical figure. The analogical associative process is a conceptual-based comparison between different unit(s) of meaning, which, as a sort of semantic trait, transfer from one concept to another. We acknowledge that analogy is not included in the set of lexical semantic relations. However, in line with the procedure followed for the study, which is based on a language-based associative evaluation as the analogical comparison, it has been included for the purpose of furthering a line of reasoning or drawing an inference.

2.2 Related Work

Literature offers some other examples of digital environments and web interfaces supporting lexical semantics exploration. Fabula (Martines, 2017) scaffolds professional writers to author stories supported by narrative suggestions pertinent to the user's typed words. Similarly, Communics (Rutta et al., 2020) supports the creation of comics with predefined sentences to overcome the "blank page syndrome". Novelette (Addone et al., 2021) offers a suggestion mechanism of analogies, synonyms, and rhymes based on a user-defined word by querying BabelNet (Navigli and Ponzetto, 2012) and WordAssociations[1].

Focusing on KGs modeling lexicon and semantics, Wikidata (Vrandečić and Krötzsch, 2014) and DBpedia (Lehmann et al., 2015) are free, open, and general-purpose KGs acting as central storage for Wikimedia project data. Besides general content, they can be easily queried to retrieve word synonyms, definitions, and taxonomies. (Rodosthenous et al., 2020; Rodosthenous et al., 2019) retrieve lexical relations via ConceptNet (Speer et al., 2018) which is a freely available commonsense KG and natural-language-processing toolkit that supports many practical textual-reasoning tasks over real-world documents and does not assume that words fall into "synsets", sets of synonyms that are completely interchangeable. Nevertheless, WordNet (Miller, 1995) assumes a synset-based word organization where a set of synonyms and their related senses are linked by semantic relations. Similarly, many other different linguistic semantic networks have been proposed directly relying on WordNet. To name a few, BabelNet (Navigli and Ponzetto, 2012) extends the notion of synset to contain multilingual lexicalizations. DBnary (Sérasset, 2012) models multilingual lexical data curating word senses and translations.

Table 1 compares different semantic networks regarding supported semantic relations and user interfaces to explore them. Most of them provide end-users with a web interface covering a wide range of semantic relations. Following this line, `LexicalEngine` automatically retrieves semantic associations and rhetorical figures by querying multiple KGs at once while masking technical challenges in posing SPARQL queries and providing end-users with a unified result which can be explored via a web interface. This approach detaches our research from the exclusive quantitative and metric-based assessment of KGs and includes the qualitative evaluation based on speakers' linguistic expectations which are subsequently assessed later in the process.

3 `LexicalEngine` - SEMANTICS VIA A KNOWLEDGE GRAPH-BASED APPROACH

The proposed prototype, `LexicalEngine`, is a web-based interface (freely available online[2] for testing and demonstrative purposes) and API mechanism[3] to let end-users and developers retrieve semantic relations, such as word senses, term defini-

[1] WordAssociations: https://wordassociations.net

[2] `LexicalEngine` demo: https://lexical-client.surge.sh

[3] APIs: https://lexical-engine.onrender.com

tions, synonyms, homonyms, hypernyms, hyponyms, meronyms, translations, images, and emoticons by implicitly querying semantic networks as BabelNet, Wikidata, DBpedia, DBnary, ConceptNet. The rest of this section describes the interface and the working mechanism of `LexicalEngine`, provides the reader with technical details, and outlines some scenarios in which `LexicalEngine` can be used.

Interface and Working Mechanism. A general workflow is graphically reported in Figure 1.

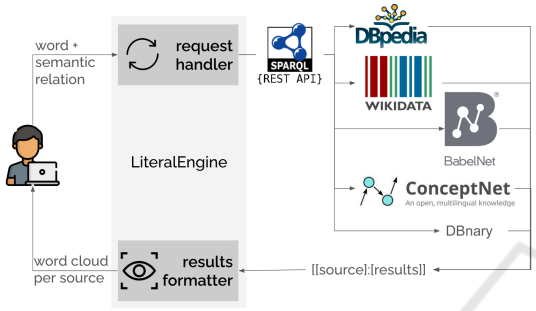

Figure 1: Workflow of `LiteralEngine` to retrieve word-related semantic relations by querying multiple KG and visually rendering results to end-users.

`LexicalEngine` requires a user-defined word as input. Supposing that end-users want to explore *cuore*, the Italian translation of *heart*. In the learning mode, as visible in Figure 2, `LexicalEngine` also requires the semantic relation of interest. Let us hypothesize that end-users are interested in looking for synonyms. Each user-defined request is transformed into a set of SPARQL queries or API requests over all the KGs supporting the configured semantic relation, according to Table 1. In the case of synonyms, all the supported KGs are queried in parallel. Results are asynchronously collected by keeping the correspondence between the source and results. Results are parsed by a dedicated module, referred to as `results formatter` in Figure 1 that takes care of visually rendering results to end-users via unsorted lists or word clouds, as widely explored in the literature to engage learners (Shu et al., 2020). Back to our example,

Figure 2 reports the interface looking for Italian synonyms of `heart`, showing that it can be interpreted as a center, a metaphor for love, or the heart as an organ.

Not all the semantic relations are covered by all the KGs, as reported in Table 1. In that case, only KGs supporting the user-requested semantic relation are queried. Moreover, even if a service is supported by a given source, the reply should not be given for granted. For instance, it may happen that the user-defined word is not covered by all the sources, as happens in the reported use case. Looking at Figure 2, only two KGs returned results, even if synonyms is a service covered by all the queried KGs.

Technical Details. As a web-interface, `LexicalEngine` logic is written in JavaScript. The web interface relies on the `LexicalEngine` API mechanism. Hence, any user request performed by the visual interface is converted in an `LexicalEngine` API call of the corresponding service. For each semantic relation relying on multiple KGs, KG queries are run in parallel. At the moment, English, Italian, French, German, and Holland are supported, but introducing other languages only requires dealing with a few translations of the interface components, such as the covered semantic relations and setting options. However, it is crucial to check the language coverage of the queried sources. Besides the ones that are currently supported, sources can be customized by verifying semantic relations covered by the introduced KG and performing a dedicated call accordingly. `LexicalEngine` distinguishes between learning and inspiring mode as a result of the performed evaluation. While in learning mode, end-users are aware of the semantic relation that links suggestions to the user-defined request, in the inspiring mode, suggestions derived from different semantic relations and sources are just merged together. No sorting is applied. The source code of `LexicalEngine` is freely available on GitHub[4].

Use Cases. The synonym lookup scenario is an example to improve writing skills and avoid repetitions. Moreover, in the evaluation stage, we also asked participants about the application context of `LexicalEngine` they foresee. Surprisingly, participants envisioned exploiting the proposed prototype to edit text, learn semantics and novel word senses, and argue. Moreover, such a system has been proposed by teachers to overcome the blank page syndrome in storytelling, where suggestions are not merely considered as an opportunity to avoid repetitions but should inspire storytellers by letting them play on words and explore semantic relations. Supposing that the educators assign a topic to learners that can be summarized in a single word, e.g., *field*, and learners can investigate suggestions automatically generated by `LexicalEngine`, such as landing field, battlefield, lines of business, or even field of operation.

[4]Interface: https://github.com/Crex99/lexicalClient.git, API: https://github.com/Crex99/enchancingLexical.git

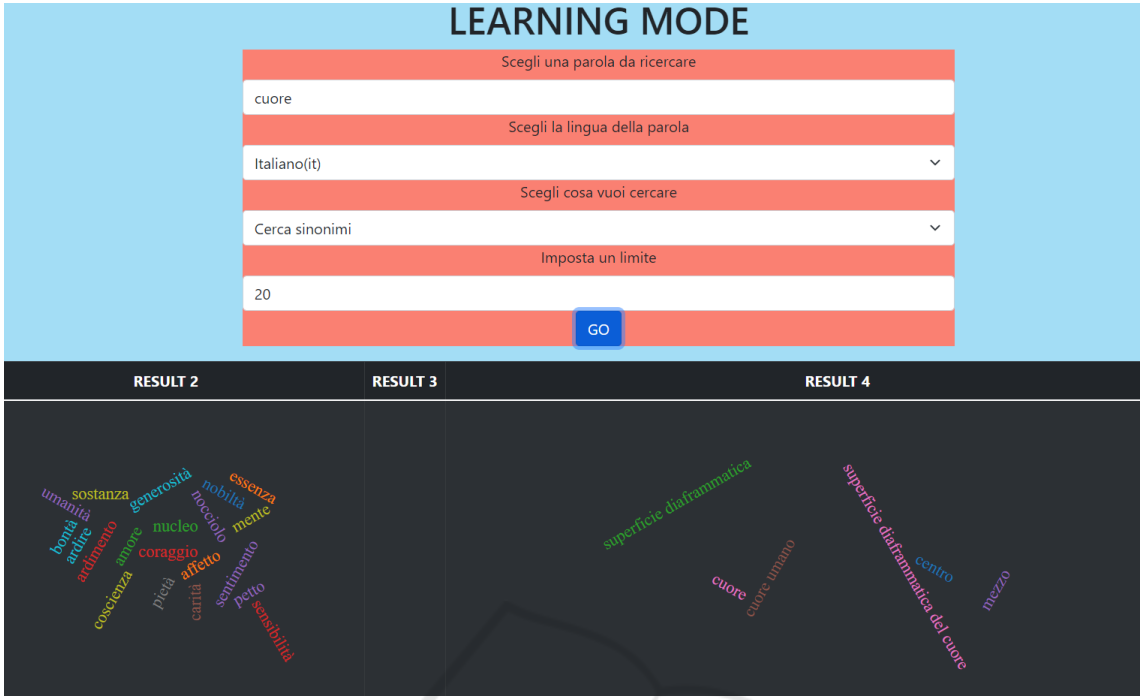

Figure 2: `LiteralEngine` interface while looking for synonyms of *heart* (*cuore* in Italian).

4 EVALUATION

This section reports the methodology, participants, and metrics of the performed evaluation aiming to verify if KGs can automatically propose complete (RQ_1) and accurate (RQ_2) word senses if compared with those foreseen by (adult) Italian native speakers.

4.1 Participants

The evaluation has been performed asynchronously by collecting participants' replies via an anonymous questionnaire administered via Google Forms[5]. The link to the questionnaire has been sent to the authors' contacts by encouraging them to share it. 27 Italian native speakers joined the evaluation, voluntarily and for free, 52% females. The sample is heterogeneous in terms of regions of provenance: 70% from the Campania region, 18% from the Lombardia region, and 11% from the Lazio region. The sample is heterogeneous also concerning the age range ranging from 18 to over 50, mainly between 18-25 (41%) and over 50% (22%), while the remaining is equally distributed over the remaining age range. The educational qualification of the participants corresponds at least to the diploma, and they are students or workers in a wide range of companies or institutions. Hence, the sample is heterogeneous regarding age, profession, educational title, and provenance to reduce as many biases as possible in the evaluation results. All the participants assessed their interest in using sophisticated language, grading it at least 3 out of 5. It emphasizes that participants are interested in curating their vocabulary even if they are not linguists by profession.

4.2 Methodology

The authors agreed on 10 Italian words for the evaluation, choosing among those frequently occurring in written and spoken language provided with multiple word senses. Literal translations of the evaluated words are `tree`, `field`, `organ`, `time`/`weather` (both `tempo` in Italian), `star`, `heart`, `sun`, `fishing`/`peach` (both `pesca` in Italian), `belief`/`cupboard` (both `credenza` in Italian), and `wing`. For each word, word senses have been retrieved by querying BabelNet and ConceptNet, while synonyms have been retrieved by querying DBpedia, Wikidata, DBnary, BabelNet, and ConceptNet. Participants are first invited to think about word senses for each proposed word without any support. Subsequently, they are asked to evaluate senses returned by `LiteralSearch`. The assessment phase involves qualitatively evaluating the word units from the speaker's perspective. The consequent grad-

[5]https://doi.org/10.5281/zenodo.10687619

ing of the proposed ones relies on the participants' perspective as native speakers. The grading is based on a three-value scale: 0 value if unrelated, 0.5 if partially related, and 1 if wholly related. Finally, participants are invited to quantitatively summarize their opinions at an overall level regarding coverage of their expectations, gaining inspiration, originality, and the perceived completeness for the proposed word senses on a 5-point Likert scale, and free to leave a qualitative opinion via open-ended questions.

4.3 Metrics

As a result of the conducted protocol, for each of the 10 tested words, we have two pools of word senses: those proposed by participants (WS_P) and those retrieved via `LexicalSearch` (WS_{LS}). The two pools are not disjoint. Hence, we have the following sets:

- S_1 a set of word senses matching participants' meaning expectations and covered by `LexicalSearch`, i.e., $WS_P \cap WS_{LS}$;
- S_2 a set of word senses matching participants' meaning expectations but uncovered by `LexicalSearch`, i.e., $WS_P \setminus WS_{LS}$;
- S_3 a set of word senses proposed by `LexicalSearch` but absent in participants' lexical perspective, i.e., $WS_{LS} \setminus WS_P$;.

According to the RQs, we measured both the coverage of users' expectations and the accuracy of unforeseen word senses through a qualitative analysis of the data provided by the `LexicalSearch`. The metrics chosen to evaluate the results obtained with the assessment are based on cognitive sciences and mental lexicon principles. Citing (Read, 1993), native speakers have remarkably stable patterns of word association, which can be taken to reflect the sophisticated lexical semantic networks they have developed through language acquisition. While the coverage has been computed by comparing S_1 with WS_P, the accuracy is computed by looking at grades assessed by participants concerning S_3. For each word, we checked the overlap between users' defined word senses and those retrieved by `LexicalSearch`. If the ones returned by `LexicalSearch` do not cover a user-defined word sense (S_2), we checked if synonyms cover it. For each word sense proposed by `LexicalSearch` and not foreseen by any evaluator (S_3), we collected users' opinions on its accuracy and checked official Italian dictionaries (Devoto, 2016; Sabatini, 1997; De Mauro, 1999)[6] to see if the word sense could be justified.

[6] *Grande dizionario italiano dell'uso* accessible online at https://dizionario.internazionale.it

5 RESULTS

Coverage (Connected to Rq_1). All the participants proposed at least a word sense for each word, with a maximum of 5 proposals. By aggregating the word senses proposed by all the participants, at least two word senses are collected for each word. Figure 3 reports the coverage of users' expectations. It is worth noting that the evaluated words are on the x-axis on the chart represented in Figure 3, and its column models the percentage of users' expectations satisfied by word senses and those covered by synonyms and the percentage of not satisfied expectations. Each user-defined word sense is weighted in terms of people suggesting the same word sense.

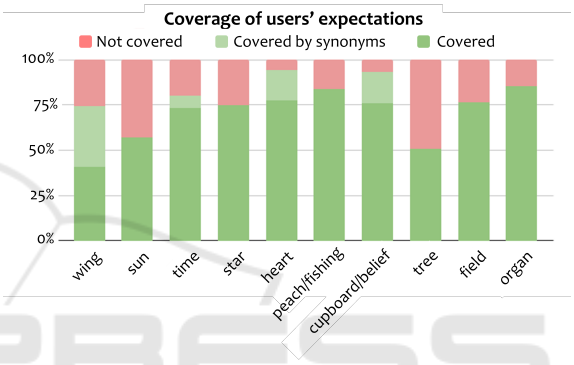

Figure 3: Users' expectations coverage.

Not all user-defined proposals can be correctly considered word senses as they also cover synonyms and analogies. To name a few examples, some participants attached brands to some words, such as *All stars* to `star` or the name of a laundry detergent or oranges to `sun`, or proper names of song authored by the Italian singer Al Bano to `sun` or the one of the romances authored by De Amicis to `Heart`. After naming some word senses, evaluators usually moved to metaphors or analogies referring to famous sayings. For instance, some of them attached *handsome* to `sun` referring to the saying *You are as beautiful as the sun*, or they attached *money* to *time* referring to the saying *Time is money*. Some proposals went in the direction of analyzing the anatomy of the words. For instance, some evaluators attached *palindrome* to `wing` as its Italian translation, `ala`, is a palindrome. Those cases negatively affected the coverage.

Accuracy (Connected to Rq_2). Only in two cases `LiteralSearch` returned a proposal not covered by any evaluator. In both cases, evaluators considered them not related. However, by exploring the reason at the basis of the proposals, we discovered that the suggestion attached to `ala` is *hat* as it is the name of

the *hat brim* and the suggestion attached to `pesca` is a specific fishing net traditionally used in an Italian region. Hence, both proposals are considered valid.

Overall Assessment. Participants graded inspiration, satisfaction, originality, and coverage using a 5-point Likert scale. The mean value is close to 4 and the confidence interval reaches a minimum close to 3.5 in all the cases, as reported in Table 2.

Table 2: Statistics of the overall grades auto-assessed by participants reported in terms of minimum (min) and maximum (max) score, mean value, standard deviation (st.dev.), and confidence interval (C.I.) with $\alpha = 0.05$.

	Inspiration	Satisfaction	Originality	Coverage
Range	1-5	1-5	1-5	1-5
Min	2.00	3.00	2.00	2.00
Mean	3.77	4.15	3.81	3.96
St. dev.	0.91	0.78	0.98	1.00
Max	5.00	5.00	5.00	5.00
C.I.	[3.42, 4.12]	[3.85, 4.45]	[3.43, 4.19]	[3.58, 4.34]

6 DISCUSSION

At Least Half of the Users' Expectations Are Satisfied. RQ_1 verifies if word senses automatically retrieved by querying KGs cover users' expectations belonging to Italian native speakers' mental lexicon. As visible in Figure 3, at least half of the users' expectations are satisfied in all cases, and the percentage of coverage is at least equal to 75% if we consider both word senses and synonyms. It lets us assessing that word senses automatically retrieved by KGs guarantee sufficient/high coverage of adult Italian native speakers' expectations. It becomes crucial in the case of at-a-distance learning to ensure that (young) scholars can be effectively supported by automatic tools without requiring the support of adults.

Suggestions Require Rationales. `LiteralSearch` proposed word senses not foreseen by native speakers in just a few cases. However, those suggestions have been considered inaccurate by participants (RQ_2), even if they can be justified by looking at Italian dictionaries. It suggested that it is not always obvious to understand why any out-of-context word is proposed as a word sense by `LiteralSearch`.Hence, suggestions should be attached to exemplary sentences or definitions to better understand the link between the user-selected word and the returned suggestion. This insight will drive future enhancements of the `LiteralSearch` prototype.

Not a Single Winner! Looking at the suggestions returned by each KG, there is no single resource able to satisfy users' expectations fully. Hence, it is necessary to combine results returned by multiple KGs to reach the current coverage of users' expectations. It is worth noting that according to how the evaluation has been performed, `LiteralSearch` compared with each queried source. Since suggestions from multiple KGs outperforms each resource queried in isolation, `LiteralSearch` outperforms related works.

Inspiration Requires Relaxing Semantic Relations Classification. By both considering suggestions returned as word senses and synonyms, we reached a wider coverage of users' expectations. In fact, native speakers also often jump among word senses, analogies, and synonyms without separating semantic relations. While in the learning setting, scholars must have a clear definition and unambiguous examples of semantic relations, when we hypothesize to use `LiteralSearch` to overcome the blank page syndrome, suggestions returned by different semantic relations might be merged into a unified set to inspire users without any hard classifications. Consequently, learning and inspiration modalities have been separately proposed in `LiteralSearch`.

7 CONCLUSIONS

This article explores the coverage and accuracy perceived by Italian native speakers in playing with lexical semantics via a KG-based approach. The performed evaluation relies on `LiteralSearch`, a web-based interface to retrieve semantic relations starting from a user-defined word, which reaches a good level of coverage of users' expectations (RQ_1). Hence, KGs are promising sources to learn and inspire original meanings while letting them learn unforeseen word senses (RQ_2). Being an interface for searching lexical semantic repositories in a very user friendly fashion, our approach represent a starting point approach to word-networks exploration. As seen in (Emma James and Henderson, 2023), it is well-established that prior knowledge affects new learning and semantic neighbors also affect the acquisition of new words. Hence, the proposed approach can broaden learners' horizons by suggesting novel meanings and word interpretations by exploiting word senses and synonyms. Learning lexical semantics via KGs has the potential to be useful also for young learners or foreigners to explore and learn about word meanings and to get inspiration to overcome the blank page syndrome in storytelling. To conclude, this

study envision a bidirectional human-to-data effort to both enhance speakers linguistic competence and KG data access. Moreover in detail, the former is justified by a high-quality support to explore, retrieve, and learn about word senses and lexical relations. On the other side, synsets do not distinguish formalism, suggesting as synonyms words that cannot really be used as alternatives. Further human efforts are required to explicitly tag words in synsets by their formalism.

Limitations and Future Directions. KGs are usually well-curated for English speakers. Even if the queried KGs aim to provide end-users with multilingual semantic networks, further effort should be invested in wider coverage of other languages, such as Italian. As already stated while discussing results, suggestions require to be contextualized and justified. It will result in enhancing `LiteralSearch` suggestions by providing users with examples, descriptions, or justifications in terms of retrieved semantic relation in the direction of explaining proposed suggestions.

REFERENCES

Addone, A., Donato, R. D., Palmieri, G., Pellegrino, M. A., Petta, A., Scarano, V., and Serra, L. (2021). Novelette, a usable visual storytelling digital learning environment. *IEEE Access*, 9:168850–168868.

Bellini, P., Nesi, P., and Venturi, A. (2014). Linked open graph: Browsing multiple SPARQL entry points to build your own LOD views. *Journal of Visual Languages & Computing*, 25(6):703–716.

De Donato, R., Garofalo, M., Malandrino, D., Pellegrino, M. A., and Petta, A. (2020). Education meets knowledge graphs for the knowledge management. In *Methodologies and Intelligent Systems for Technology Enhanced Learning. Workshops*, pages 272–280.

De Mauro, T. (1999). *Grande dizionario italiano dell'uso*. UTET, Torino.

Devoto, G. (2016). *Il Devoto-Oli : vocabolario della lingua italiana / Giacomo Devoto, Gian Carlo Oli ; a cura di Luca Serianni e Maurizio Trifone*. Le Monnier, Milano, 3. ed edition.

Emma James, M. Gareth Gaskell, G. M. J. T. and Henderson, L. M. (2023). Word learning in the context of semantic prior knowledge: evidence of interference from feature-based neighbours in children and adults. *Language, Cognition and Neuroscience*, 38(2):157–174.

Lehmann, J., Isele, R., Jakob, M., Jentzsch, A., Kontokostas, D., Mendes, P. N., Hellmann, S., Morsey, M., van Kleef, P., Auer, S., and Bizer, C. (2015). Dbpedia - A large-scale, multilingual knowledge base extracted from wikipedia. *Semantic Web*, 6(2):167–195.

Martines, F. (2017). Fabula. https://www.scribis.it/fabula/index.html. [Online, Last access January 2024].

Miller, G. A. (1995). Wordnet: A lexical database for english. *Communications ACM*, 38(11):39–41.

Mitchell, T. M., Shinkareva, S. V., Carlson, A., Chang, K. M., Malave, V. L., Mason, R. A., and Just, M. A. (2008). Predicting human brain activity associated with the meanings of nouns. *Science*, 320(5880):1191–1195.

Navigli, R. and Ponzetto, S. P. (2012). BabelNet: The automatic construction, evaluation and application of a wide-coverage multilingual semantic network. *Artificial Intelligence*, 193:217–250.

Pustejovsky, J. (2016). *Lexical semantics*, page 33–64. Cambridge University Press.

Read, J. (1993). The development of a new measure of l2 vocabulary knowledge. *Language Testing*, 10(3):355–371.

Rodosthenous, C., Lyding, V., König, A., Horbacauskiene, J., Katinskaia, A., ul Hassan, U., Isaak, N., Sangati, F., and Nicolas, L. (2019). Designing a prototype architecture for crowdsourcing language resources.

Rodosthenous, C., Lyding, V., Sangati, F., König, A., ul Hassan, U., Nicolas, L., Horbacauskiene, J., Katinskaia, A., and Aparaschivei, L. (2020). Using crowdsourced exercises for vocabulary training to expand ConceptNet. In *Proceedings of the Twelfth Language Resources and Evaluation Conference*, pages 307–316. European Language Resources Association.

Rutta, C. B., Schiavo, G., Zancanaro, M., and Rubegni, E. (2020). Collaborative comic-based digital storytelling with primary school children. In *Proceedings of the 19th International Conference on Interaction Design and Children, IDC*, pages 426–437. ACM.

Sabatini, F. (1997). *DISC : Dizionario italiano Sabatini Coletti.* Giunti, Firenze, 1 edition.

Sérasset, G. (2012). Dbnary: Wiktionary as a lmf based multilingual rdf network. In *Proc. of the 8th International Conference on Language Resources and Evaluation (LREC)*, pages 2466–2472.

Shu, X., Wu, J., Wu, X., Liang, H., Cui, W., Wu, Y., and Qu, H. (2020). Dancingwords: exploring animated word clouds to tell stories. *Journal of Visualization*, 24:85–100.

Sowa, J. F. (2006). *Semantic Networks*. American Cancer Society.

Speer, R., Chin, J., and Havasi, C. (2018). Conceptnet 5.5: An open multilingual graph of general knowledge.

Vargas, H., Aranda, C. B., Hogan, A., and López, C. (2019). RDF explorer: a visual SPARQL query builder. In *International Semantic Web Conference (ISWC)*, volume 11778, pages 647–663. Springer.

Vrandečić, D. and Krötzsch, M. (2014). Wikidata: a free collaborative knowledgebase. *Communications of the ACM*, 57(10):78–85.

Wang, A., De Deyne, S., McKague, M., and Perfors, A. (2022). Core words in semantic representation. In *Proceedings of the Annual Meeting of the Cognitive Science Society*, volume 44.