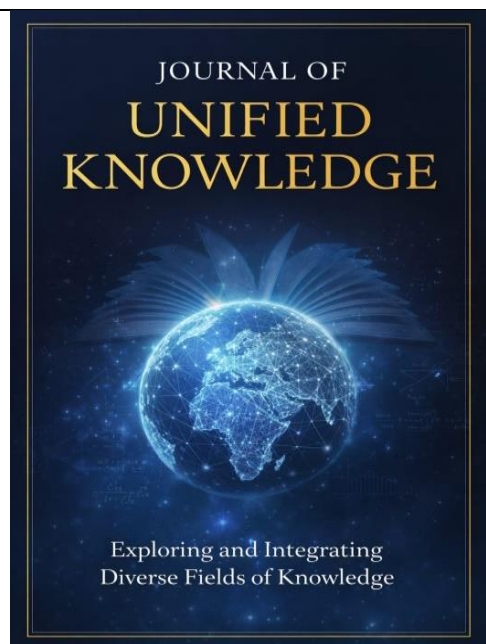




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Knowledge Graph and Its Importance in Education

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Abstract

Knowledge Graphs is a significant innovation in field of education. They represent knowledge through interconnected concepts, entities, and relationships. They can represent relation between different topics in educational content. Firstly this paper explains the concept of knowledge graph, its benefits and limitations. It also explains the meaning, structure, applications, and educational value of knowledge graphs. Paper discusses the utility of knowledge graphs in supporting personalized learning, intelligent tutoring systems, curriculum mapping, semantic search, and learning analytics. The paper also describes the benefits and challenges of using and implementing knowledge graph in education. Major challenges are data integration, standardization, scalability, and privacy. The paper highlights that knowledge graphs provide a strong semantic foundation for AI-enabled education and can improve both teaching effectiveness and student learning outcomes.

Keywords: Knowledge Graph, Education

Introduction

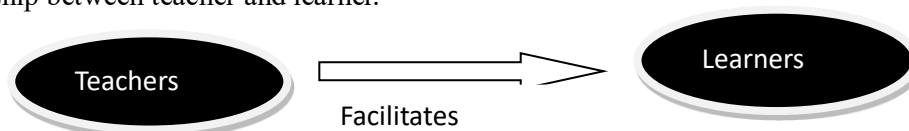
The digital development in field of education such as online courses, learning management systems, artificial intelligence tools, digital learning platforms has resulted in flood of educational data. Educational data often scatters across textbooks, lesson plans, videos, assessments and learner records. Previously information was stored in databases efficiently but it failed to represent deep conceptual relationships. Knowledge graph has emerged as a powerful tool to represent deep conceptual relationship between data. A knowledge graph organizes information in form of entities, concepts, and relationships, which allows machines and human users to understand how ideas are interconnected. The structured knowledge graph

enhances teaching, learning, and decision-making by making educational content meaningful, searchable, and adaptable.

Concept of Knowledge Graph

We can describe knowledge graphs (KGs) as a network that establishes connections between related entities and relationships between seemingly unrelated ones. Knowledge graph previously known as Semantic Networks is drawn from the field of semantics which refers to the study and interpretation of meaning. The term Knowledge Graph was coined by Google in 2012 to form a circle of understanding for a particular domain of study. This study was typically used to establish various connections in the field of Data Analysis and Artificial Intelligence. As knowledge graphs are used to represent complex knowledge, they enable us to understand the complicated logic and provide a graphical means to interpret relationships. This saves our time and energy used in navigating through extensive textual information constantly.

A knowledge graph is a semantic network in which nodes represent entities or concepts and edges represent the relationships between them. For example, to understand the concept of teaching and learning the concept "Teachers" maybe linked to "Learners" through relationship "facilitates". Teachers and Learners are nodes here and facilitates is edge which represents relationship between teacher and learner.



A knowledge graph reflects meaning and context in more effective way than conventional database. It allows all the information from structured and unstructured sources to be combined into one integrated representation. So, the knowledge graphs support in reasoning, pattern discovery, and intelligent recommendations.

Importance of Knowledge Graph-

To have critical understanding of previous work done in any field creation of knowledge graph plays an important role. As in this digital era there is flood of information in all domains including scientific, business, research and education generating millions of data every day. Sometimes it becomes very crucial to trace back previous data for certain reasons such as for any experiments, discovery, results etc. At this stage knowledge graph comes into picture and plays important role. Knowledge graph helps to pick any point from previous history and use it to retrace all related data using knowledge graph. So, the data gathered using knowledge graph would assist in further discoveries.

Benefits and Limitation of Knowledge Graph-

There are many benefits of Knowledge graphs but they have some practical limitations also. They are beneficial for organizing connected information, improving search and recommendations, and supports reasoning over complex relationships.

Benefits-

- They provide connection between related concepts clearly, so users can easily understand how ideas, people, topics, or resources are linked.
- Knowledge graph helps to improve recommendation systems, question-answering systems and information retrieval.

- They help to integrate data obtained from different sources into one structured view.
- They reveal hidden relationship in data and support better decision-making.
- New entities and relationships can be added without redesigning the whole system as knowledge graphs are flexible.

Limitations

- Knowledge graph require high-quality data. If data is messy, inconsistent, or incomplete then their usefulness is reduced
- Relationships must be defined and updated carefully, so building and maintaining knowledge graph can be time-consuming and expensive
- Large knowledge graphs may face scalability and performance issues when queries become complex.
- As real-world information changes often knowledge graph need continuous updates.

Knowledge Graph in Education-

Knowledge graphs organize concepts, resources, and relationships in a way that supports better learning, teaching, and curriculum planning, so they play very important role in the field of education They can be especially utilized for personalized learning, curriculum design, concept mapping, semantic search, and educational recommendations.

Importance of Knowledge Graphs in Education-

- Knowledge graph shows how topics are connected, so students can understand a subject as an integrated unit instead of isolated facts.
- Knowledge graph helps teachers to design curriculum paths, sequence lessons and spot gaps in what has been taught.
- They provide students personalized recommendations by matching learning resources to student's level and needs.
- They visualization of concepts makes difficult ideas easier to understand and recall.
- They help learners to find relevant content faster by means of smarter search and question answering.
- Knowledge graphs help educators to map learning outcomes to topics, resources, and assessments. They also help to identify areas where student have difficulty in understanding and support data-driven interventions. This helps in improving lesson planning, reduce content overload, and make learning more adaptive.

As Knowledge graphs turn scattered information into a structured learning network that improves understanding, personalization, and teaching efficiency. So, they play an important role in field of education.

Challenges of using knowledge graph in field of education-

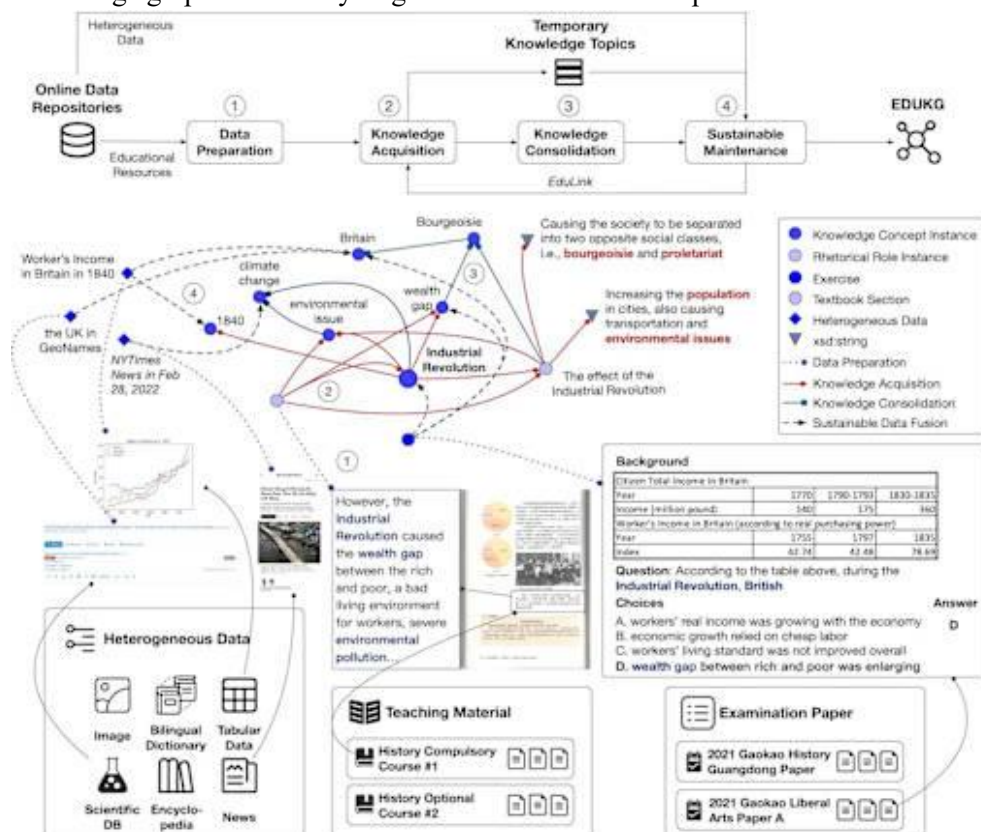
Though there are many benefits of using knowledge graph in education but there are many challenges in implementing them in field of education.

- **Complexity of Knowledge Graph Construction:** To create an educational knowledge graph it is required to identify educational entities such as students, teachers, courses, concepts, learning outcomes, assessments, and resources, and then to define accurate relationships among them. This process is complex and time-consuming.

- **Integration of Heterogeneous Data:** Educational data comes from different sources which may include Learning Management Systems (LMS), student information systems, digital libraries, online courses, assessment platforms, and institutional databases. To integrate data obtained from these different sources into a unified knowledge graph is a challenging task.
- **Data Quality and Consistency:** If educational data is incomplete, outdated, duplicated, or inaccurate it can reduce the reliability of a knowledge graph. Maintaining high-quality and consistent data is essential for knowledge graph.
- **Privacy and Data Security:** Educational knowledge graphs may contain sensitive student information, including academic performance and learning behaviour. To protecting student privacy and ensuring secure and appropriate use of such data is a major concern and challenge.
- **Scalability:** When the number of students, courses, concepts, and learning resources increases, the knowledge graph can become extremely large. Appropriate infrastructure is needed for efficiently storing, querying, and updating large educational knowledge graphs which is a big challenge.
- **Technical Expertise:** Many educational institutions may lack professionals with these `specialized skills like expertise in different areas like ontology engineering, semantic technologies, databases, artificial intelligence, and data science which is essential for designing and managing knowledge graphs.
- **Acceptance by Teachers and Learners:** Successful implementation of knowledge graph depends on teachers' and students' willingness to use knowledge-graph-based systems. Lack of awareness, digital skills, or trust in AI-based recommendations may limit adoption and is a big challenge

Some existing knowledge graphs in field of education

EDUKG: In the field of education, it is a heterogeneous, sustainable K-12 educational knowledge graph with a very large scale of entities and triplets. `



The construction framework of EDUKG.

Knowledge Engineering Group of Tsinghua University proposed and maintains the EDUKG. It is a knowledge graph with an interdisciplinary and fine-grained ontology. This repository consists of **38** well-constructed knowledge graphs (more than **252 million** entities and **3.86 billion** triplets) under the ontology.

EduKG -It is an educational knowledge graph standard and framework that models learning points, resources, and pedagogical rules. This standard is provided by "IEEE Guide for Architectural Framework and Application of Educational Knowledge Graph". It defines a comprehensive framework for representing, integrating, and utilizing knowledge graphs in the domain of education. Taking it as a standard we can create our own knowledge graph in field of education.

K12-Knowledge Graph: It is a curriculum-aligned knowledge graph derived from textbooks in mathematics, physics, chemistry and biology. It represents concepts, skills, experiments, exercises, sections, chapters and books, with relationships such as prerequisites and pedagogical sequence. They serve as a recent 2026 research resource.

Applications of knowledge graph

In education knowledge graphs are mainly used for personalized learning, curriculum design, concept mapping, and educational content recommendation systems. They help teachers and institutions to organize knowledge in a connected way so it becomes easier to manage learning resources, topics, and prerequisites.

Personalized Learning-Knowledge graph can represent what a student already knows, what he has studied or mastered and what problem he has in understanding a topic. Thus, it can help in matching content to student's level, interest and gaps in understanding

Curriculum Design-A knowledge graph (KG) can play an important role in curriculum design by representing various curriculum elements namely subjects, topics, concepts, competencies, learning outcomes, prerequisites, assessments, and learning resources in form of interconnected network. This allows curriculum designers to visualise not only what content should be taught but also how different parts of the curriculum are related to one another. They organize all curriculum elements so teachers can plan lesson sequences more effectively

Concept mapping- Knowledge graph formally represents concepts and relationships in form of nodes and edges. They visually organize subject concepts and their relationship so that difficult topics can be easily understood.

Educational content recommendation.

Connecting information about learners, concepts, learning objectives, prerequisites, and educational resources knowledge Graph (KG) can play a vital role in educational content recommendation. A knowledge graph recommends content not only because it is popular or similar to previously viewed material instead it can recommend resources based on what the learner knows and what they need to learn.

Semantic Search- Knowledge graph help search system to recognise user's query by understanding its context, concept and meaning rather than carrying out search on keywords only.

Learning analytics-By relating and connecting data about learners, learning activities, curriculum concepts, assessments, and educational resources in a structured and meaningful way knowledge graph can improve learning analytics more efficiently. In traditional mode of learning isolated data - such as marks, attendance, or LMS activity were used for learning analytics. A knowledge graph helps reveal the relationships among these data points. They can support in managing analysis of student progress and identifying weak areas for intervention which is very beneficial for learner.

Research shows that educational knowledge graph works in same manner in higher education and are used notably in computer science, mathematics, and engineering. Data sources often usually comprise of course materials, student learning behaviour, and online encyclopaedias. We can say that a knowledge graph in education is an important tool and is a smart map of learning. It shows how concepts, resources, and learners are connected and facilitates teachers teach better and help to improve efficiency of students.

Conclusion-

Knowledge graphs are playing very important role in field of education because they transform scattered educational information into meaningful, connected knowledge. There are many applications of knowledge graph in present educational scenario. They play an important role in personalized learning, tutoring, curriculum mapping, semantic retrieval, and analytics which make them highly valuable for modern education system. Even though there are many challenges in implementing knowledge graphs in educational field yet it provides a robust foundation for AI-supported teaching and learning. So use of knowledge graph and their continued development can contribute to more adaptive, inclusive, and effective education systems.

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