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THE USE CONCEPT MAP TO ENHANCE TEACHING AND LEARNING IN CHEMISTRY

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Abstract

The aim of this paper is to explore the use of concept mapping to enhance teaching and learning in chemistry, focusing on its potential benefits, construction methods, and various applications in education. It highlights the importance of innovative teaching methods in chemistry education, emphasizing the role of concept mapping in preparing students for future careers and contributing to the advancement of scientific knowledge. The paper outlines the construction of concept maps, emphasizing their hierarchical nature and the flexibility to accommodate changes and additions. Modern advancements in educational technology, such as concept mapping software, are highlighted as facilitators of map creation and revision. Moreover, the application of concept maps in chemistry education is explored, including their role in meaningful learning, formative assessment, and evaluation. Concept maps serve as valuable tools for organizing information, assessing conceptual understanding, and identifying misconceptions among students. It concludes by emphasizing the transformative potential of concept mapping in chemistry education and recommending strategies for its integration into the curriculum.

Keywords: Concept Map, Chemistry Education, Teaching and Learning, Curriculum Integration, Educational Technology.

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Introduction

An innovative teaching method plays a crucial role in chemistry education and offers numerous advantages that improve the learning experience for students. By using innovation, educators can prepare students for future careers, address diverse learning styles, and contribute to the advancement of scientific knowledge (Ahmad & Arshad, 2018).

A concept map is a node-link diagram showing the semantic relationships among concepts. The technique for constructing concept maps is called "concept mapping". A concept map consists of nodes, arrows as linking lines, and linking phrases that describe the relationship between nodes. Two nodes connected with a labelled arrow are called a proposition. Concept maps are versatile graphic organizers that can represent many different forms of relationships between concepts (Schwendimann, 2021).

Concept maps, as we define them, are graphical tools for organizing and representing relationships between concepts, indicated by a connecting line between two concepts. Words in the line, called linking words or linking phrases, indicate the relationship between the two concepts. Concepts and statements are usually organized hierarchically, from the most general to the most comprehensive to the most specific. It's best to create concept maps related to a specific question we want to answer, which we call a focus question. The concept map can refer to a situation or event that we are trying to understand by organizing knowledge in the form of a concept map, thus providing the context for the concept map (Novak & Cañas, 2007).

One way to organize knowledge hierarchically in a rather simple and compact way is concept maps. In contrast to texts, concept maps represent visualized relationships between thematically- related information units (Krieglstein *et al.*, 2022).

Construction of Concept Map

Concept maps are typically hierarchical in nature, with the subordinate concepts coming from the main concept or idea. This type of graphic organizer always allows for changes and the addition of new concepts (Meijer, 2020).

Concept maps can be created using computer software available for download from either the freeware tool Cmap (http://cmap.ihmc.us/) or the subscription version, Inspiration (http://www.inspiration.com). Research shows that the use of Concept map software can facilitate the construction, revision and addition of hyperlinks and multimedia (Schwendimann, 2021).

Concept Map is a graphical tool that organizes, connects and synthesizes information. Concept maps show concepts in circles or boxes and one can show relationships between concepts by connecting lines or linking words.(Kilic, *et al.*, 2013). Figure 1 shows an example of a concept map describing the structure of an atom.

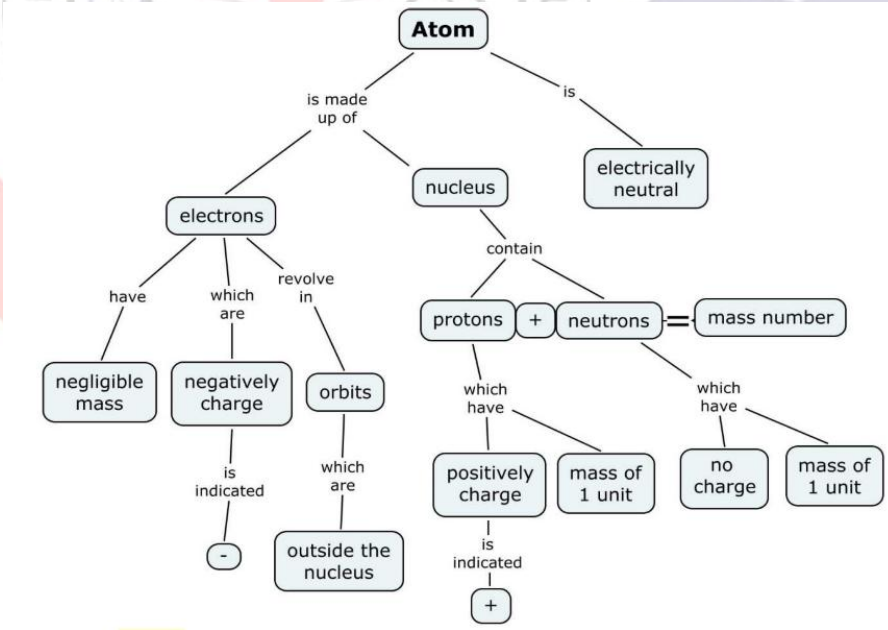

Figure 1: A Concept Map of Structure of Atom

Concept maps were developed based on Asubel's theory of meaningful learning. According to Asubel, learning is meaningful when the student understands the relationship between what has been learned and other knowledge. Only when we have fully absorbed the information can we remember it better. Therefore, meaningful learning is necessary for successful output (Kilic, *et al.*, 2013).

The Application of Concept Map

1. **Concept Map and Learning**

   Concept mapping is a technique for visually representing the structure of information, concepts and their relationship. Research studies in the field of science education show that concept mapping can be used as a successful teaching-learning strategy from elementary school to university. Concept maps are used as a tool for meaningful learning, assessment, lesson planning, and identifying alternative concepts or misconceptions of the learner (Cheema & Mirza, 2013).

2. **Concept Map and Assessment**

   Concept maps are great tools for use in class as feedback to students on their conceptual understanding. They have a strong role to play in formative assessment. If used effectively for assessment, the important criteria are; to polish the structural nature of students' knowledge, to help improve the students' understanding of contents (Strautmane, 2012).

3. **Concept Map and Evaluation**

   Concept maps have various uses, including as advance organizers, evaluation tools, and entry behaviors. They can be used by students to summarize what they have been taught and evaluate their understanding. Teachers can also use concept maps to

summarize lessons and assess student learning (Markham *et al.*, 1994; Rosas & Ridings, 2017).

Benefits of Concept Maps to Students and Teachers

When students are engaged in new chemistry concepts, they embark on a cognitive process of constructing meaning and making sense by consciously or subconsciously integrating these new ideas with their existing knowledge. Concept maps provide a unique graphical view of how students organize, connect and synthesize information. As a result, concept mapping offers benefits to both students and teachers (Meijer, 2020). The following summarizes the benefits of concept map to students and teachers:

1. Concept mapping helps students organize and represent their knowledge of a topic so they can visually see the relationships between concepts and how they are connected.
2. Concept maps serve as a visual organizer that enriches students' understanding of new concepts by breaking them down into specific topics. This visual representation helps understand and retain information.
3. Concept mapping develops critical thinking skills as students analyze and evaluate the relationships between concepts, identify patterns, and make connections. It promotes higher-order thinking and helps students develop a deeper understanding of the topic.
4. Concept mapping facilitates collaborative learning and teamwork because students can share and discuss their concept maps, which promotes communication and the exchange of ideas. It promotes active participation and engagement among students.
5. Concept mapping can be used as an assessment tool to assess students' understanding and knowledge of a topic. It allows educators to assess depth of understanding, identify misunderstandings, and provide targeted feedback for improvement.

Conclusion

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In conclusion, concept mapping presents a revolutionary approach to chemistry education, offering educators a versatile tool to effectively organize and convey complex concepts. By visually illustrating the relationships between concepts, concept mapping enables students to deepen their understanding and navigate the complexities of chemistry with expertise. To fully harness the benefits of concept mapping, ongoing research, professional development, and curriculum integration are crucial. By embracing innovation, educators can unlock new opportunities for student engagement and achievement, shaping a future where every learner is equipped to thrive in the dynamic world of science.

Recommendations

To further enhance the integration of concept mapping in chemistry education, these recommendations are proposed:

1. **Professional Development**: Educational institutions should prioritize professional development programs to equip educators with the necessary skills and knowledge to effectively utilize concept mapping in their teaching practices. Workshops, seminars, and online courses can provide valuable training opportunities for educators to master concept mapping techniques and pedagogical strategies.
2. **Curriculum Integration**: Concept mapping should be integrated into the chemistry curriculum as a central instructional tool across various educational levels. Educators should incorporate concept mapping activities into lesson plans, laboratory exercises, and assessment tasks to reinforce conceptual understanding and promote active learning.

3. **Technology Integration**: Institutions should invest in educational technology resources, including concept mapping software such as Cmap and Inspiration, to facilitate seamless integration of concept mapping into the curriculum.
4. **Assessment Alignment:** Assessment practices should be aligned with the objectives of concept mapping to effectively evaluate students' conceptual understanding and critical thinking skills. Educators should design assessment tasks that require students to create, analyze, and revise concept maps, providing feedback that promotes continuous improvement and deep learning.
5. **Research and Evaluation:** Continued research and evaluation are essential to assess the effectiveness of concept mapping in chemistry education and identify areas for improvement. Institutions should support research initiatives that investigate the impact of concept mapping on student learning outcomes, engagement levels, and retention of chemical knowledge.

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