WHITE PAPER

A Game-based Learning Approach to Information Literacy

Learn how Drexel University incorporated the Knovel Academic Challenge to improve students understanding of technical concepts, critical thinking, cognitive monitoring and creative problem solving.

In fall 2016, the newly revamped Engineering Academic Challenge will feature information literacy challenges using Knovel and Engineering Village databases, with the intent to benefit academic research—unite librarians and faculty—and improve student research skills, through applied learnings found in this whitepaper, featuring the 2015 Knovel Academic Challenge.

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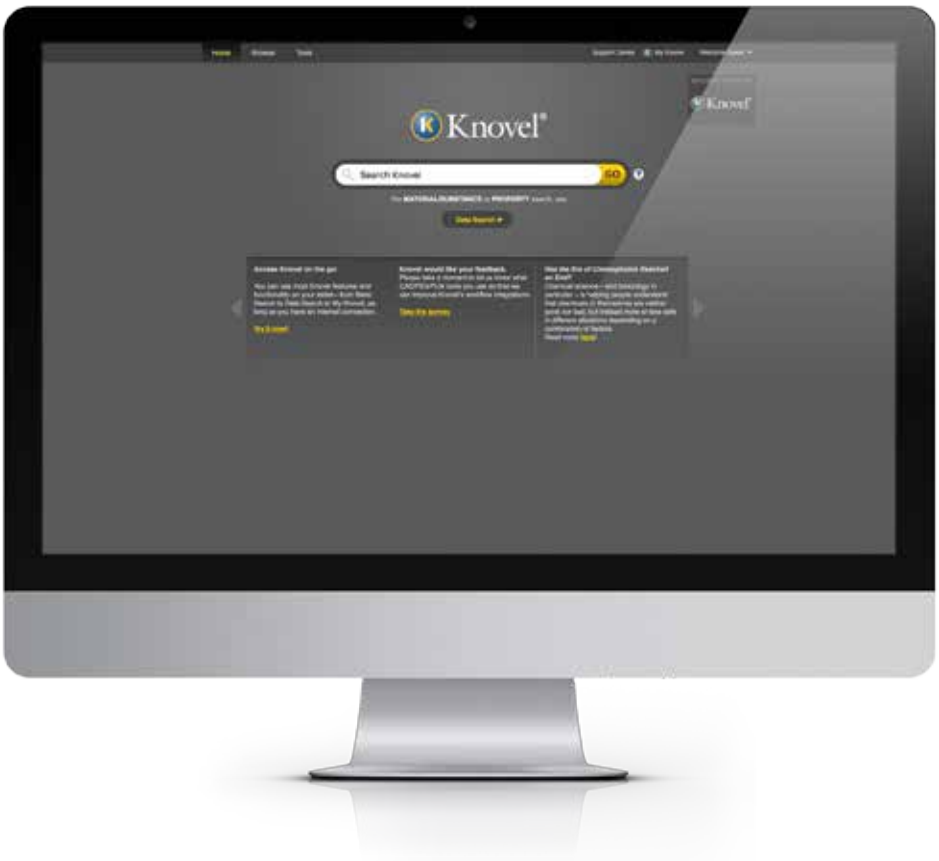
Introduction

Jay Bhatt, lead author on *A Game Based Learning Approach* and engineering librarian at Drexel University, serves on Elsevier's Academic Engineering Solutions Librarian Advisory Board. Jay has played an integral role in the planning and launch of Elsevier's fall 2016 Engineering Academic Challenge which incorporates both Knovel and Engineering Village databases. In this whitepaper, Jay and his co-authors, detail the benefits of game based learning within engineering at Drexel University as evidenced by their collaboration on the Knovel Academic Challenge in the previous years.

Abstract

In this work, we investigate how online games can be used to promote information literacy in engineering students. The Knovel database provides an online library of science and engineering-focused content, serving more than 700 customers worldwide, including over 400 universities. The Knovel Academic Challenge is a global game designed to highlight key features of the Knovel database, which includes 3500 reference items and 90,000 interactive tables, graphs, and equations. In previous years, challenge questions were comprised primarily of interactive equation references, unit conversions, derivatives, and periodic table lookups. For the Fall 2015 challenge, a committee of students at Drexel University developed a brand new set of questions based on contemporary engineering grand challenges. To generate on-campus engagement in the challenge, we organized a hackathon-inspired "Knovel Marathon" night in which a significant number of undergraduate and graduate students took part in solving the challenge, the vast majority using Knovel for the first time. We observed high levels of engagement, interaction with library staff, and enthusiasm during the marathon, demonstrating how games can be used to demonstrate key functionalities of databases and library resources, and their application to academic research workflows.

Keywords: Information Literacy, Game-based Learning, Engineering



As the basis for life-long learning, information literacy can be considered the core literacy of the 21st century, a "kernel" for all other literacies.

Introduction

The "digital natives" (applied to those born after 1990) constitute the first generation to have grown up with the Internet and various forms of digital technologies[1]. As the most networked generation ever enters higher education, smartphones, text messaging, and various social media platforms pervade their daily activities. Despite their unquestionable technological savvy, an expanding body of information *literacy* studies indicates that most of these students lack fundamental *information literacy* skills upon entering higher education[2–5]. The American Library Association (ALA) defines Information literacy (IL) as

> "A set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively that information".[6]

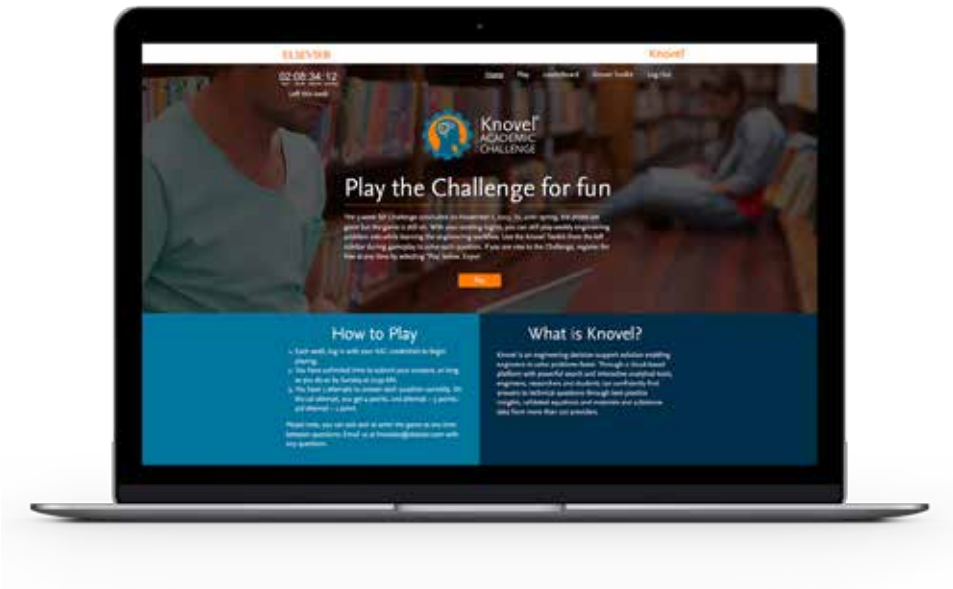
Information literacy is not merely an academic concern. As the basis for life-long learning, information literacy can be considered the core literacy of the 21st century, a "kernel" for all other literacies[7]. The American Library Association's 1989 Presidential Committee on information literacy called knowledge the "country's most precious commodity" and information literate individuals, thinkers, problem solvers, and inquirers—"America's most valuable resources"[8]. Citing a "crisis of authenticity" in which anyone can instantly publish an unverified claim or perspective, President Barack Obama proclaimed October to be "National Information Literacy Awareness Month", highlighting a key need for broad education in the skillset for separating signal from noise and fantasy from reality[9].

We explore how game-based learning strategies can be applied to actively engage engineering students in learning digital library search tools.

Most incoming college students exclusively use familiar open web resources for finding information needed to complete assignments, e.g. Google searches and Wikipedia lookups[2, 10-13]. Most search engine users never use the advanced search functionality or look beyond page two of the results, assuming that the search algorithm will always find the most relevant results for a given query[14]. While these approaches may have brought success in high school, this quickly creates difficulty in successfully completing academic writing and research assignments. It is broadly agreed upon that there is a "significant skills gap in information competencies" of incoming university students[15], such as identifying the type of information needed, finding journal articles, and developing advanced search strategies[16]. This does not necessarily render incoming students information illiterate, for they are demonstrating a capacity to find information that can be further expanded. In the case of engineering students, the incoming cohorts are initially unaware of the vast information resources and technical tools that enable university-level engineering research and development, in the form of journal articles, technical standards, handbooks, and material property databases[11, 17]. The traditional approach to information literacy education is the "one-shot" method, in which a faculty member invites a librarian to a classroom to discuss discipline-relevant resources and library services. This passive learning experience creates a latency between the time of instruction and the actual usage of a library resource and requires repeated contacts with students to be successful[18]. The influx of digital natives presents an opportunity to revamp information literacy education in new and engaging ways, creating active learning environments where students engage in meaningful dialog, interaction and exploration of various resources to complete their assignments.

Academic librarians have launched multiple efforts to address 21st century information literacy needs of students and faculty, such as the usage of electronic resources. Several investigators[19, 20] highlight the need for tapping student curiosity and intrinsic motivations to inspire information literacy learning, making it relevant to learners while equipping them with tools to explore their interests. In recent years, gaming has been proposed as an engaging, interactive, and familiar (from the student perspective) way of structuring the learning experience. Herein, we explore how game-based learning strategies can be applied to actively engage engineering students in learning digital library search tools, in context of the global Knovel Academic Challenge, played by over 2000 students in 430 universities. We begin with a brief literature review of game-based learning principles and approaches.

Game-based learning refers to the application of game design principles in real-life settings to engage players.



Game-based learning

Game-based learning refers to the application of game design principles in real-life settings to engage players. In his 2003 monograph entitled *"What Video Games Have to Teach Us About Learning and Literacy"*[21] James Gee initiated the conversion on game-based learning, drawing parallels between game design principles and learning principles. The entry levels of a game pose challenges that are specifically designed to allow players to generalize a solution procedure for subsequent more complex challenges. Each successive cycle produces mastery of specific skills throughout the game. Good games are "challenging but doable", operating at the edge of the player's skill. Players receive "situationally relevant" information, "just-in-time" to further their goals in the universe of the game. In some games, players become producers, building the world of the game further which relates to the pedagogical notion of active learning. Meaningful game-based learning approaches prioritize long-term benefits to players over short term external rewards (e.g., a point system), providing positive impressions of out-of-game skills, in this case information literacy. Striking an optimal balance between extrinsic and intrinsic motivators is key in educational game design, for it is the intrinsic motivators that drive continued mastery of the learned skill in non-game contexts[22] and in the absence of extrinsic motivators[22].

In recent years, numerous digital and non-digital game-based learning implementations have been reported in library contexts[18, 23-26], in physical and digital forms. A University of Michigan team developed Bibliobouts[24], an online tournament style game which introduces players to a specific set of information literacy skills needed in a research workflow, from finding journal articles to assessing their relevance and managing references. "Doing Research"[25], the online game developed by a University of Illinois group, interactively guides students through the process of structuring of a search strategy, then allows students to pose their own research topic and find a relevant article in a digital database. Boudreau and Hanlan[27] describe a role-playing game in which engineering students assume various characters and lead a classroom reenactment of a historical engineering decision, using archival and digital research to argue their positions. An immersive virtual reality game *Blood on the Stacks* was created to increase student engagement during new student orientation, in which groups of students used digital and physical library resources to investigate the theft of an Egyptian artifact from the library [Donald, 2008].

The Knovel Academic Challenge (KAC) is a global game designed to demonstrate key features of the Knovel platform, which includes 3500 reference items and 90,000 interactive tables, graphs, and equations.

Knovel Academic Challenge

For engineers in particular, highly specialized technical information is often neither free nor available on the open world-wide web. Knovel database provides an online library of engineering-focused content, serving more than 700 customers worldwide, including over 430 universities. The Knovel Academic Challenge (KAC)[28] is a global game designed to demonstrate key features of the Knovel platform, which includes 3500 reference items and 90,000 interactive tables, graphs, and equations. In previous years, challenge questions were comprised of interactive equation references, unit conversions, derivatives, and periodic table lookups. We postulate that learning modules must be perceived as "relevant" in order to engage students in active learning. We also posit that students collaborating with liaison librarians are well-suited to crafting engaging library learning experiences[18, 29].

In this context, a team of four Knovel student ambassadors at Drexel University, from freshman to junior undergraduate students developed a set of nearly one-hundred original questions for the 10th Knovel Academic Challenge over a two month span. We partly based these questions on the National Academy of Engineering Grand Challenges for the 21st Century, such as affordable solar energy, improving urban infrastructure, and engineering the tools of scientific discovery[30]. Space exploration, advanced materials, robotics, data science, and autonomous vehicles were also included. Where possible, questions integrated concepts from multiple disciplines. All questions could be answered using multiple references in the database, relaxing the dependency on particular institutional subscriptions and better reflecting actual usage of the database.

Figure 1. The user-interface and example challenge questions. The "Knovel tookit" on the left directs players through Knovel's functions. Players receive instant feedback on their responses, with a hint displaying if the initial answer is incorrect.

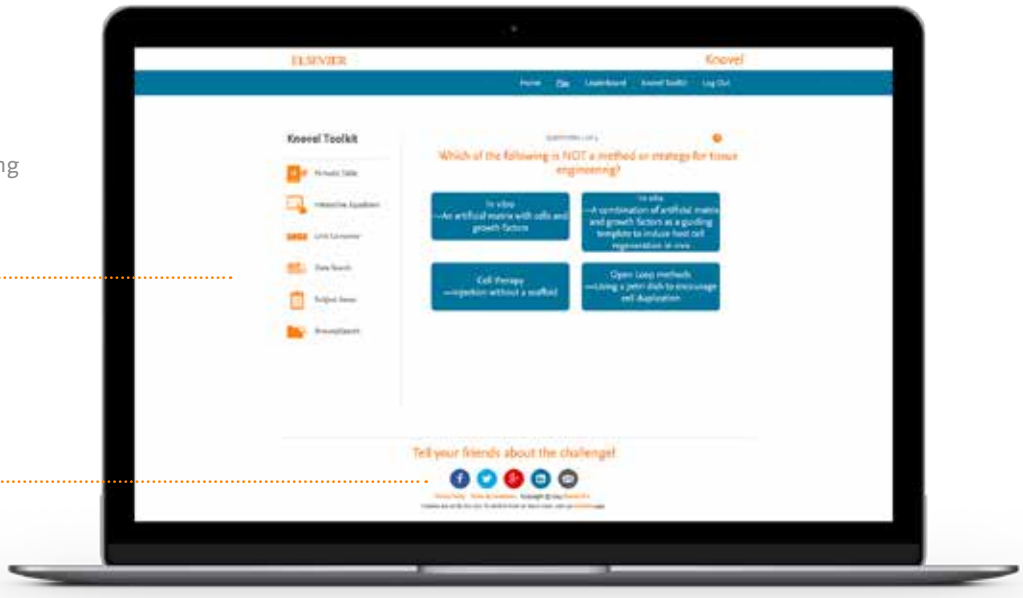


Figure 2. Leaderboard with university rankings.

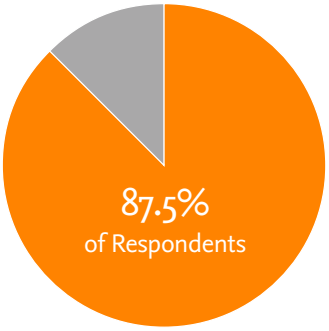
Adopting a common game design element[21], questions progressively increased in difficulty. The "beginner" stage required the definition of a keyword, while the "intermediate" stage required a lookup of a single equation with perhaps a simple calculation or a material property. The "advanced" stage would constitute a calculation question with multiple steps involved or qualitative understanding of a general concept cast in a context different from the original presentation. Players received instant feedback on their answers, with a hint automatically displaying if an incorrect answer was chosen. A toolkit on the left side of the interface directly linked players to key features of the Knovel database needed in the challenge, as shown in Figure 1.

Marathon Night

High engagement levels were observed during the Knovel marathon night hosted on our campus, a "hackathon" inspired event hosted in the university library, including food, music, and prizes to incentivize participation. Approximately 35 students attended, from undergraduate to PhD levels—all of them using Knovel for the first time. Four perfect scores were recorded from this cohort, with an average of 14 points (out of 20 possible). Even several non-engineering students played the challenge. Numerous participants during the marathon night described the challenge as surprisingly "addicting", with one remarking "I don't know why I care so much, but I do."

We interpret these qualitative findings to mean that students felt this experience was unlike any prior library leaning experience, which in the Drexel College of Engineering is the traditional "one-shot" tutorial. We attribute the engagement levels to several factors. The questions themselves were structured around contemporary engineering challenges, such as the design of Elon Musk's proposed "Hyperloop" transportation system, autonomous vehicles, and space exploration. By designing the questions in this way, they were perceived as relevant to the learner and better reflected actual engineering usage of the database. The more difficult challenge questions recast engineering concepts into new settings, such as a series of questions in which students had to first reference fundamental systems engineering principles within the database, then synthesize this information to envision the human body as a system. We also included "trivia-style" questions asking for particular facts not readily found through basic Google searches.

Game-based learning approaches that promote competition rather than collaboration in the learning environment may have the unintended consequence of discouraging certain students (e.g., minority, transfer, non-traditional, shy individuals). The Knovel Academic Challenge pits institutions, rather than individuals against each other, through a dynamically-updating institutional leaderboard (Figure 1). This fosters a collective drive to perform well on the challenge, promoting cooperation and encouragement among peers. In our observations during the marathon night, the randomization element allowed for genuine collaboration, in which peers would discuss the questions and formulate search terms together, and divide the task of searching the database.



Raised awareness and understanding of Knovel's capability as a search engine

Impact of the Global Knovel Academic Challenge

To assess the impact of the Knovel Academic Challenge, we gathered feedback from students, librarians, and faculty from around the world. From 56 total responses, 49 (87.5% of respondents) indicated that the challenge had raised awareness and understanding of Knovel's capability as a search engine. Two indicated that it had not, and five were unsure if their understanding improved. Next, we provide in Table 1 a sampling of student feedback on what they liked about the Knovel Academic Challenge.

Table 1: Student feedback on what they liked about the Knovel Academic Challenge.

Please tell us what you liked about the Knovel Academic Challenge?
I liked the fact that it offered interesting facts about real world problems
The questions were varied and allowed me to explore/learn about many different subjects/topics
I liked the variety of questions
Some questions were fun to answer
Learning different things and searching different fields of engineering
It was a fun challenge to look up solutions to problems which I might never otherwise encounter and learn new things from it
I loved the challenge It made me work
Challenging to find the answers

Three major attributes emerge in the students' responses—fun, challenging, and interesting content about "real world" problems, which generally reflects the characteristics of educational games done well. Through broad coverage of engineering disciplines, we delivered an engaging and perceived relevant active-learning experience for engineering and even some non-engineering students alike. We also asked students to indicate what they learned through the Knovel challenge, a representative selection of answers shown in Table 2.

Table 2: Noteworthy student responses on what they learned from playing the Knovel challenge.

Please tell us what the Knovel Academic Challenge has taught you.
How to make better searches
Interactive methods to problem solving
How to use Knovel as a tool
That Knovel is a great tool
How to refine search terms when looking for a specific phrase, concept
We want more challenges!
Capabilities of Knovel
Ability to search and re-search
Not afraid to make mistakes while searching for solutions

In response to the same question, librarians and faculty (Table 3) indicated that the breadth of engineering topics covered enabled their efforts to introduce hundreds of students at their institutions to the Knovel platform in a fun, engaging way.

Table 3: Feedback from librarians and faculty on three things learned from the Knovel Academic Challenge.

Please tell us 3 things the Knovel Academic Challenge has taught you.
Engineering students in our school enjoy participating in the challenge
There has been new interest from engineering students and teachers
It is nice to see that you are providing activities for librarians and teachers
The easy and efficient approach of searching
The vastness of subject areas available in Knovel
The amazing utility of data search
The very wide range of topics covered by Knovel

The challenge also exposed players to the advanced search features in Knovel, such as material property lookup and interactive equations. In designing the questions, we purposefully made an effort to address contemporary topics in a broad cross-section of engineering disciplines, which we deem a success based on this feedback.

Elsevier's Knovel and Engineering Village[31] databases will partner to launch a new game, the Engineering Academic Challenge, which will integrate both products for the very first time.

Conclusion & Future Directions

Technological savviness alone does not produce a society of information literate, critical thinkers. The same technology that enables the rapid proliferation of unverified information in the "24/7 news cycle" also enables an unprecedented level of access to the tools and resources to incorporate reputable information into daily decision-making. As digital natives enter higher education, opportunity is ripe for development of innovative and engaging approaches to information literacy learning. The Knovel Academic Challenge constitutes a large-scale game-based learning approach facilitating active information literacy learning for science and engineering students. Challenges of this nature could be used to augment or supplant traditional "one-shot" library instruction for a wide range of library resources. We plan to explore the idea of short informative videos directly paired with a set of challenge questions developed based on game-design principles, facilitating instant feedback. Students completing such modules could be given certificates in the form of a digital badge in information literacy, shareable on social media platforms such as Facebook and Twitter. Moreover, in 2016 Elsevier's Knovel and Engineering Village[31] products will partner to launch a new game, the Engineering Academic Challenge, which will integrate both products for the very first time, producing the added challenge of identifying the appropriate database to efficiently solve a challenge question. Faculty and librarians can prepare students for skillful, efficient problem solving through game-based learning. The experiences outlined here provide further evidence that game-based learning approach actively engages engineering students in applying core information literacy skills to 21st century engineering problems.

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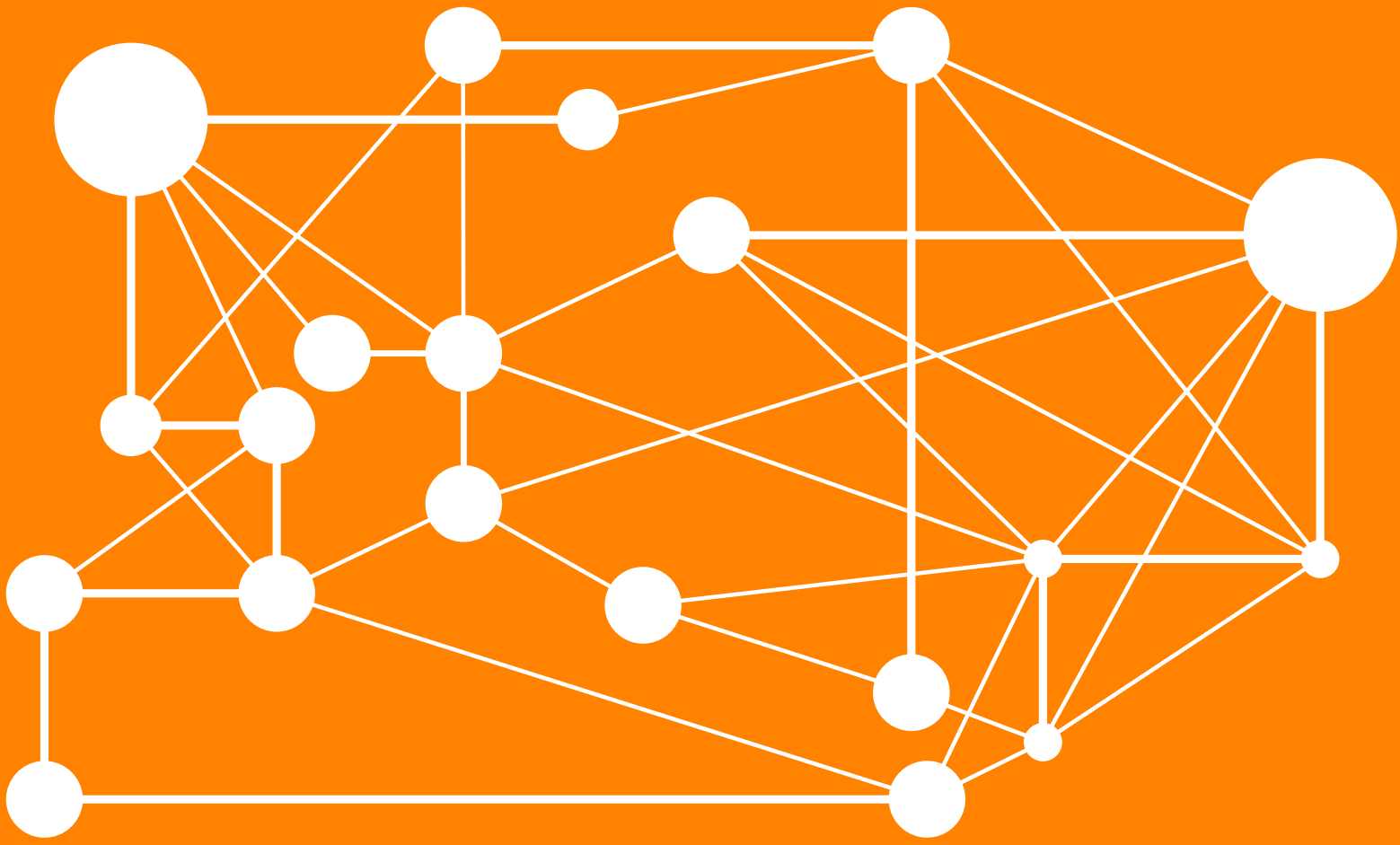

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