Applying the Gaming Concept of Skill Trees to Taxonomize Real-World Skills and Arrange Them in Incentivized Paths of Learning

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Abstract

This position paper explores how a new learning system could be created using structure inspired by the gaming concept of skill trees. It analyzes skill trees and other gaming concepts, then combines them with other theories and concepts from fields like psychology, education, and design. Research and literature further discuss how the concepts can be applied to this new system. The paper then discusses how the skill tree concept could apply to real-world skills, how they can be arranged in incentivized paths of learning, and how real-world skills can be taxonomized into a curated system representing human knowledge.

This position paper explores potential within applying various concepts to create a new system of learning. The system, inspired by skill trees and other gaming concepts, also requires consideration of concepts from various other fields. The scope of this discussion fluctuates between macro and micro levels and across industries. While it does not offer a complete blueprint, this paper attempts to build the foundation of a new approach to the way we design interactive learning experiences.

Problem Statement

In the field of Instructional Design, stakeholders in the design process develop solutions for applications across industries, for varied demographics, and in significantly different formats. Organizational training can include concepts as varied as teaching about how tires are designed and constructed, how to follow OSHA or FDA regulations, how to operate equipment, or the process guiding a financial service. In K-12 schools and higher education, online education formats have expanded, but the COVID-19 pandemic drove emergency adaptations that forced more educators than ever to learn about distance education and to create learning solutions that project goals from their curriculum. As a supplement to formal education, independent companies have created applications like Homer for reading and Prodigy for math.

Across industries, each design team creating each solution makes choices based on the frame in which it works. From the perspective of user experience, an individual navigating these lessons must process what may seem like an endless variety of formats with no way to tangibly visualize their whole progress.

Educational experiences are often designed using strategies focused at a micro level on completing individual lessons, units, or courses. To create an environment of greater continuity, real-world skills must be taxonomized to be identified throughout. Skills could be arranged progressively to facilitate paths of learning. Gamification concepts could be applied to create incentives consistent with current cultural trends.

How expansive and universal could such a system become? If a system were created to organize real-world skills that individuals learn over the course of a life, what would it look like? If the system were organized to accommodate progression of understanding within paths of learning, how would it work? How would the creation of such a system begin? Would the theory behind its construction be applicable at the micro level in a way that could benefit all instructional designers?

Purpose Statement

To begin to answer these questions and conceptualize such a system, I suggest consolidating essential concepts from a variety of disciplines to envision something new. The most prominent of these is a concept from the field of game design called the "skill tree". Combining the concepts of skill trees, reward systems, psychological motivations, and educational theories, I propose the beginnings of a framework that could revolutionize the way we perceive education on the scale of a lifetime.

Significance of the Study

The experience of a learner from birth to death takes the learner through myriad educational frameworks. If one unified system acted as a guide, each individual may experience a greater sense of continuity between lessons learned, a greater ability to recall information, and a greater ability to see systems of information as a whole.

While such an ambitious task is currently conceptual and out of immediate reach, deconstructing the theoretical elements of this possibility may also benefit instructional designers on a micro level. As working models are created and refined on a small scale, perhaps a greater, more expansive practical design can be reached.

Research Question

Can the gaming concept of skill trees be applied to taxonomize real-world skills and arrange them in incentivized paths of learning?

Theoretical Framework

Gaming Concepts

Defining Skill Trees

To begin assembling the concepts used in this system, the concept of skill trees must be defined and their various iterations in gaming systems analyzed. Academic analysis of skill trees, not only in their potential application in education but even in their normal use in games, is almost entirely non-existent (Ghozali, 2019). A skill tree (or talent tree) is a game mechanic that presents as a type of decision tree through which a player progresses from an initial point and follows paths of the tree to unlock other points, which are commonly referred to in game design as “nodes”. Nodes are unlocked by either completing certain milestones in the game or by earning a sort of currency like a “skill point” that can be used to buy access to the node. Each node unlocked can affect the player’s character in different ways, thereby modifying the gameplay. For example, a node may unlock a new ability like being able to craft a first aid kit, to augment an ability like extending the duration a player can swim underwater, or to augment attributes like increasing the player’s strength or health.

Skill trees can be an effective tool in game design for several reasons. A skill tree is a tangible representation of the growth of the character. Nodes representing skills are not presented all at once, but in manageable quantities and consistent with the character's current growth. As players progress through the skill tree, nodes that were previously dark and empty illuminate, providing reward stimuli. Completing branches of the tree provides a sense of completion and accomplishment.

Designs of skill trees vary. Most skill tree systems arrange nodes in one tree for the entire game. Nodes with certain themes are often grouped within branches of one skill tree. Sometimes, as in *The Elder Scrolls V: Skyrim*, the nodes are separated into different skill trees altogether. In *Skyrim*, 18 skill trees are designed as constellations where each node is a star, and each constellation represents the skill modified by the skill tree (e.g. an anvil for the Smithing skill).

In *Far Cry 3*, as portions of the skill tree are completed, the character fills out tribal tattoos in a supplemental screen that tell stories of the character's experiences, similar to the style of the Polynesian tatau tradition. This unique example specifically illustrates how completion of a skill tree can represent the learner's experiences over the course of a lifetime.

In game design, skill trees are used as a tool for immersion, a way to provide the player with choice about how their character develops through skills in the game world. This paper explores applying the skill tree concept to real-world skills, both as a method to track skill development and to organize instructional content.

Reward Systems: Badges, Achievements, & Trophies

Analysis of skill trees without discussion of badges, achievements, and trophies would be incomplete. The completion of each node on a skill tree triggers rewards, and badges (individually designed icons) offer similar reward stimuli.

Nodes in skill trees like those in *Skyrim* do not have individual designs. They are only individually remarkable by their title and the effect they unlock. Many skill trees in top tier games like *Shadow of the Tomb Raider*, however, feature an individual icon or badge designed specifically for each node. By doing so, the badge for each node provides additional visual information reinforcing the meaning behind unlocking the node and enriching the visual impression of the skill tree.

With a custom badge, title, and description for what the node unlocks, such a skill tree system presents the main elements of Microsoft's achievement system and Sony's trophy system. In these systems, a badge (or achievement or trophy, depending on the system) is unlocked once the player completes a defined task. Triggers to unlock an achievement/trophy may include actions like defeating a boss, completing a mission, collecting all of a type of item, discovering a secret, or petting all the cats in a village.

Hamari and Eranti (2011) provide an analysis for the mechanics behind design and operability of achievements, as well as a look at the way the concept has permeated retail culture. In gaming culture, entire databases exist to guide players through completing achievements. Through widespread efforts for gamification in various industries, badges have become a common tool in training programs.

While these forms of badges may seem modern and fresh in the digital age, the concept is not new. In the military, medals and ribbons are awarded for completion of real-world achievements and mastery of skill. In the Boy Scouts and Girl Scouts of America, badges and patches are awarded in a similar fashion. Some badges are meant to be completed in a sequence. Drawing these connections reinforces the potential behind using skill trees to represent real-world skill mastery.

Additionally, where both nodes on a skill tree and achievements share properties of reward stimuli, a collection of achievements lacks structure. With achievements, there is no given sequence or effort to present goals in manageable quantities. Skill trees provide the structure to organize skills in paths of learning, incentivizing completion by providing a reward system that drives learners through psychological motivation.

Psychological Motivation

Self-Determination Theory

Cheema & Velez analyzed what motivates learners to complete tasks to unlock digital badges, "According to SDT (Self-Determination Theory), intrinsically motivated behaviors arise from the satisfaction of three psychological needs: *competency*, the feeling of mastery over outcomes; *autonomy*, the feeling of choice; and *relatedness*, the feeling of connectedness with others" (2021, p. 94).

In both achievements and skill trees, players can complete tasks for rewards and achieve a resulting sense of competency. By choosing what achievements to pursue or what branches to follow in a skill tree, they exercise autonomy. In gaming culture, players compare achievement and skill tree completion. Doing so generates discussion as each badge or node represents an experience from the game that players share.

Completionism and the Zeigarnik Effect

In gaming culture, there is a phenomenon in which some players feel strong compulsion to unlock achievements and trophies, while other players do not. Informally, those who follow this compulsion are referred to as "completionists". Those who experience completionism are often also compelled to complete other aspects of the game, like completing every mission on every difficulty, gathering all items of a collection, and unlocking every node on a skill tree.

This compulsion to complete the incomplete is not unique to games. In 1927, Bluma Zeigarnik suggested that incomplete tasks are recalled more than completed ones. Decades of research suggest that some individuals obsess over incomplete tasks (Fox, 2020). This natural intrinsic motivation may drive learners to see tasks and lessons through to entirety.

Chunking Theory

Virtually all skill trees present the player with only a select few nodes to choose from near the base of the tree, which is the beginning of their experience. This makes early decisions manageable for players, aligning with George Miller's theory about chunking information. "Before information is stored in long-term memory it is processed by a filter known as Working Memory. Working Memory can only retain about 7 (plus or minus 2) bits of information at a given moment in time. Organizing these bits of information into meaningful patterns of information make them easier to store" (Bates, 2019, p. 74). Even the game *Path of Exiles*, notorious for having a skill tree with over 1,000 nodes, presents its skill tree nodes in a limited sequence at first.

One benefit of a skill tree design is that while a user can typically see the entire scope of the skill tree at once, the next available options are still manageable in number. Using chunking theory to present nodes of a real-world skill tree is important to avoid extinguishing learner motivation by overwhelming learners with choices.

Scaffolding Theory and the Zone of Proximal Development

By controlling the availability of nodes in a skill tree and providing progressive access based on completion, common skill tree models create a learning environment that aligns with Lev Vygotsky's scaffolding theory and the zone of proximal development. As players progress, the skills they acquire in earlier nodes build into more complex skills in later modes. The effects are cumulative.

Further, the gameplay and challenges throughout the course of a game increase with complexity in harmony with the increased power and complexity of unlocked skills. A well-balanced game will provide players with more basic skills needed before confronting them with complex challenges for which they would otherwise not be prepared. According to Vygotsky, "…when learners were in the Zone of Proximal Development, they developed an understanding of a subject that may have been beyond their previous level of comprehension" (Bates, 2019, p. 48).

In the classroom, corporate training, or elsewhere, a lesson or unit designed using a skill tree should take care to arrange skills in a sequence that scaffolds content appropriately to help keep students in the zone of proximal development as much as possible.

User Interface Design Process

The nature of the design and interactivity of skill trees requires considerations of the user interface design process. "The user interface design process encompasses four distinct framework activities: (1) User, task, and environment analysis and modeling; (2) Interface design; (3) Interface construction; (4) Interface validation" (Faghih et al., 2013, p. 788). In games, the player navigates between nodes with a controller and makes selections as appropriate.

In an educational application, a designer must consider exactly what the nodes represent, how they are arranged, and exactly how a student interacts with the skill tree. At its simplest, a skill tree could be a static decision tree that teachers print out. Students fill in hollow nodes once they master a skill or concept. This low-tech approach places trust in students to self-govern and allows teachers to begin right away. This format also easily applies to in-person training where demonstration and assessment is done through physical action, yet the skill tree still provides a tangible representation of progress and completion.

At the opposite end of the spectrum, an interactive skill tree can be devised where each branch is a lesson within a unit. As learners progress through the lesson, they complete assessments that test their understanding of concepts. With these assessments being connected to the skill tree, as they complete the assessments, the nodes of the skill tree are completed.

Related Research and Literature

Merit and Efficacy

Decoding Academic Value in Video Game Design

Video games suffer from a stigma problem. Due to their inherent nature as games, they are seen primarily as entertainment, non-academic, and, often, a waste of time. Yet the video games of the last ten years have come lightyears from their origins in games like *Pong*, *Asteroids*, and *Super Mario Brothers*. Today, hundreds of millions of gamers support an industry that brings in billions of dollars in revenue. Robust games like *Red Dead Redemption 2* and *The Legend of Zelda: Breath of the Wild 2* spend over five years in development before being released to the public. This interactive medium once disregarded in academia is starting to be analyzed with increasing depth.

One educator leading the academic analysis of video games is James Paul Gee, who wrote *What Video Games Have to Teach Us About Learning and Literacy*. From Metalevel Thinking about Semiotic Domains Principle to Committed Learning Principle to Achievement Principle, Gee (2003) outlines 36 principles for how video games encourage and reinforce positive learning.

Another figurehead of video game academia is Jane McGonigal (2011), who suggests games have had the potential for positive influence on society since the times of Herodotus. She outlines a variety of ways we can harness the millions of hours humans spend gaming each year to leverage positive, real-world change.

Efficacy of Badges in Educational Programs

In a study exploring efficacy of badges in educational programs, Abramovich et al. “found evidence of improvements in interest and decrease in counter-productive motivational goal from a system using educational badges. Further (they) find evidence that earning various badges can be associated in increases in expectations for success but also increases in counter-productive educational goals” (2013, p. 229). They say students with high rates of achievement in unlocking skill badges began to express higher expectation in achievement. “…the number of badges earned was highly correlated with an increase in expectancy to do well at math ($r = 0.49$, $p < 0.01$ …)” (2019, p. 229). Meanwhile, students who had low rates of achievement began to express lower expectations in achievement.

Research currently remains thin regarding badges in educational programs. This study by Abramovich et al. suggests overall engagement from learners, but lower engagement with those who came to expect failure more often.

Intentional Gamification

Gamification, the practice of applying game mechanics to increase motivation and engagement, has grown from a novelty in some fields to a well-established strategy embraced by marketing and design teams. Gamification exists more than ever in instructional design, but so does user indifference to these strategies. Generally, attempts at gamification fail when designers add mechanics without intention or understanding behind what makes the mechanics successful.

Creating a system using skill trees to apply them to real-world skills would be a form of gamification incorporating multiple game mechanics. To do so successfully, designers must research various types of gamification and what makes them successful.

Villegas et al. (2021) conducted an in-depth analysis of game mechanics that can be used in gamification. They list 58 game mechanics. Skill trees incorporate at least five of these mechanics, including “Branching choices”, “To visualize the progress”, and “Levels/Progression”.

Are Students Receptive to Gamified Content?

Huang and Hew (2021) surveyed empirical literature and found inconsistent results regarding efficacy of gamification in an educational setting. Given that some organizations implement game mechanics without a thoughtful analysis of game design, this inconsistency is not indicative that gamification does not work.

Huang and Hew conducted their own research on three cohorts of students, using their own designs to gamify courses for two of the cohorts. The results were positive to gamification, including that "89% of the students preferred to study in a gamified environment, and that 11% would opt to learn in a gamified environment if a more competitive leaderboard was introduced" (2021, p. 61).

Discussion

Designing Skill Trees

Creating Skill Trees

Skill trees, in a static state, often present as structurally indistinguishable from a decision tree or a concept map. Nesbit and Adesope (2013) evaluate concept maps and knowledge maps as mediums for visually representing information, describing seven reasons for effectiveness of concept maps, including "Balancing visual and verbal processing".

As described earlier, skill trees can be designed so their arrangement aids the user in visually processing information. Skill trees and concept maps can be designed using the same programs, even though there are fundamental differences between formats. SmartDraw and Lucidchart provide adaptable templates that can meet needs of most designs.

Skill trees with the level of dynamic interactivity seen in games are developed using code like C++, C#, and JavaScript, depending on the implementation (L. Winkler, personal communication, May 6, 2022). A system designed on a macro level would need to have dynamic capabilities to present information in manageable quantities.

Defining Nodes of a Skill Tree for an Educational Application

Designers must intentionally plan each node and branch of the skill tree. The skills taught in the classroom or on the job must be taxonomized to fit logically in the frame of a skill tree.

Here we arrive at a hard truth: some nodes are much easier to define and assess than others. For example, it can be easy to assess whether a student accurately knows the definitions of 20 vocabulary words or can name the first 30 elements in the periodic table and their atomic mass.

Abstract concepts present a greater challenge. “It is useful to differentiate between a construct, such as a competency, and its measurement. Social scientists and human resource managers routinely measure a competency, such as leadership, in a variety of ways, ranging from a self-report Likert scale to a workplace performance appraisal or an inbox test” (Hilton & Pellegrino, 2012, p. 25). When constructing the parameters of a trigger that signals completion of a node representing an abstract skill, designers must find a way to assess completion.

A designer can easily begin planning a skill tree by creating a tree in which each node represents an assessment in a unit or curriculum that has already been established. From there, the instructor can drill down to finer detail to define individual skills, concepts, etc. Through this process, designers may find themselves emphasizing minor skills more than in other formats since each skill may have a tangible representation.

Designers must also remember to group nodes within branches appropriately, presenting them in an order of logical progression.

Variations of Scope

This paper begins by discussing difficulties from the perspective of user experience when a learner must navigate myriad frameworks for learning. I proposed a system that taxonomizes real-world skills in a way that would provide continuity across industries and subjects. The game *Path of Exiles* has over 1,000 skill tree nodes. In reality, a system that taxonomizes real-world skills across industries would have far more, which could leave learners overwhelmed and disengaged. The key to approach this problem is to develop skill trees at various scopes.

Per Lesson, Unit, and Course

At its smallest unit, the skill tree of a single lesson would itemize the skills being learned. The skill tree would define each term learned, each operation mastered, etc.

Scaling back, a learner could see the lesson itemized along with the rest in a unit. Scaling back farther, a learner could see all units and lessons in an entire course. If the course were an English Language Arts course for Grade 8, the student could see the entire year at a glance and gain an overall understanding of progress.

A key concept to the way this structure works is that the skills may be itemized, but they are not taxonomized. That is, the skills are not classified according to their relations to each other. They are not necessarily categorized or ordered according to their properties. This structure represents, instead, paths of learning. Each branch of the tree represents a path the learner takes to successively experience content.

Beyond One Course

If a skill tree existed for a student, custom-tailored to that student's year at school, it could contain branches for each subject and extracurricular activity. When drilling down to greater detail, the tree could morph into a version unique to that subject or lesson. Taken again from the perspective of one student in one year, the scope could be expanded to include multiple years of study (middle school, high school, undergraduate college). From the expanded view, a student can plan for courses and keep track of progress toward multi-year goals.

Further, if the skill trees for courses were connected between courses, teachers and guidance counselors could have a precise picture of exactly what skills a student mastered in a previous course. Khuziakhmetov and Sytina (2016) discuss the importance of advising students on individual educational paths to plan for learning activities at the undergraduate level. The first steps in this process include conducting a needs analysis of the student and an analysis of the available resources. With a wide-ranging, consistent system based on the skill tree concept, students may be able to navigate their options with greater confidence and agility.

Again, in this example, the skill tree represents paths of learning by which students experience content. It does not taxonomize skills. Once students reach the end of formal schooling, life continues, but the continuity of these paths of learning ends.

This is not unique to formal school. Just as the paths of learning in school have a beginning and end, so do experiences working at an organization or exploring an activity like scuba diving or cooking. The key to bringing continuity to skill acquisition across industries and subjects is to taxonomize skills.

Taxonomizing Skills

Building an entire system to taxonomize skills for a school experience would be a monumental task, yet conceivably possible. Existing curriculum could serve as a guide starting in one subject, in one classroom. The same holds true for skills within an organization or for certain activities. Enough training exists with objectives and goals already written to accelerate the creation of a system here imagined.

For life unconstrained by the categories of schools or organizations, real-world skills taxonomized into skill trees could produce branches taking the shape of such broad categories as Food Preparation, Fashion, Fitness, Home, and Recreation. Food Preparation could lead a user on a guided path of learning from basic cooking skills to cooking complicated dishes in various styles, how to source or grow the food, the science behind taste and good food pairings, and more. The Home path could include what users need to know as first-time renters or home buyers, the systems that make up a home, how to maintain those systems, how to remodel rooms, the basics of interior design, and how to design and build their own house.

Inevitably, some skills and branches will share categories. Nutrition has connections to chemistry, biology, agriculture, and fitness. The interconnectivity of skills is a challenge that may be solved through a system similar to the way meta data or tags are applied to images in a database. A benefit from doing so could mean that as a learner explores a branch in Gardening, when encountering an area about Nutrition, certain nodes are already completed from the Nutrition branch where earlier skills were learned.

Such a concept may seem to entertain infinite nodes for skills and concepts, but while it may be beyond current comprehension, the *useful* possibilities are essentially finite, and the system is conceivably possible.

Bertrand Russell examines the limitations of understanding in *Human Knowledge*. “The community knows both more and less than the individual: it knows, in its collective capacity, all the contents of the Encyclopaedia and all the contributions to the Proceedings of learned bodies, but it does not know the warm and intimate things that make up the colour and texture of an individual life” (Russell, 1948/2009, p. 9). Limitless data and information can be compiled about nearly any topic, but to create a truly effective system of taxonomized skills, designers must distill skills and concepts to their essential forms. With these nodes established, designers must then organize them in a logical, progressive path and establish interconnectivity.

Conclusion

The gaming concept of skill trees incorporates a variety of game mechanics that, if applied through careful analysis and intention, could be implemented to gamify course designs. The skill tree concept can be a guide for instructional designers to taxonomize real-world skills, arranging them in incentivized paths of learning that keep students engaged and motivate them to complete educational goals. Finally, such utilization of the skill tree concept can be implemented to create a system in a scope as small as a lesson or unit, or as expansive as a curated guide to human knowledge.

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