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GOAL TREES AS STRUCTURING ELEMENT IN A DIGITAL DATA-DRIVEN STUDY ASSISTANT

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ABSTRACT

The Future Skills Report about the future of learning and higher Education (Ehlers & Kellermann, 2019) defines a variety of skills in which the active learner plays a central role. Starting from this perspective, our idea is to promote future skills with a digital data-driven study assistant for. As a theoretical foundation research about constructivism, self-regulation and goal-setting is reviewed and the concept of Goal Trees as structuring element of a software is derived. On a psychological level we show how Goal Trees may increase motivation and simplify study planning. On the level of user interface design, we show how Goal Trees may be used as structuring element of a digital data-driven study assistant. Consequently we outline how functionalities derived from research about goal-setting and self-regulation can be implemented in a study assistant. Finally advantages and challenges of implementing such a system are discussed.

KEYWORDS

Goal Trees, Goal Setting, E-Learning, Digital Assistant, Self-Regulation, Higher Education

1. THEORETICAL BACKGROUND

Ehlers and Kellermann (Ehlers & Kellermann, 2019) define "future skills" as the "ability to act successful on a complex problem in a future unknown context of action". As future skills related to the learners themselves and their individual development the authors identify autonomy, self-initiative, self-management, need or motivation for achievement, personal agility, autonomous learning competence and self-efficacy. The authors predict a change in higher education towards "active learning and autonomy" and a trend towards personalized curricula. Such learning conditions challenge the learner to set individual learning goals, maintain and pursue them and self-regulate their behavior based on success or failure in goal achievement.

In face of such a definition of crucial skills for the future, constructivism, a view which is around since decades, seems to be highly relevant again. Loyens and Gijbels (Loyens & Gijbels, 2008) state the core assumption of constructivism: Knowledge is constructed by an active learner. They further characterize the process of knowledge generation as "active sense-making and knowledge construction" (Gijbels & Loyens, 2009). We assume that personal interest and commitment to an education goal form a more solid foundation for active sense-making and knowledge construction than commitment by curricular obligations. Personal interest and commitment cannot be prescribed but instead must originate in the learner. Therefore, individually meaningful learning goals should be the roots of education.

Others have found that today, students entering the higher education system may often even not be able to name their personal education goals (Olos, Hoff, & Härtwig, 2014). This may originate from the fact that throughout elementary, middle, and high school students still often do not have many choices concerning learning content. Ex-cathedra teaching and other formats limiting exploratory learning are still very common. Thus, there is still a huge gap between ideal and reality of the educational system. The question arises how university students can be supported, such that autonomy, self-management and self-efficacy are increased. We propose a digital study-assistant as a tool to accompany university students in developing these skills.

The concept of self-regulated learning is explainable from different theoretical perspectives and has a self-oriented feedback loop as central feature (Zimmerman, 1989). In this loop, the learner actively develops and applies learning methods and strategies and monitors this process, the application of those and the effectiveness in terms of goal-achievement. The question arises, how the self-regulatory feedback loop can be realized in a learning software. We assume, that actively formulating learning methods, strategies and

specific actions and the corresponding specific learning goal are the first half of the loop. The second half, namely a reflective process arises when goal and strategies are evaluated. We propose Goal Trees as a structuring element for the self-regulation feedback loop in our study assistant.

Goal Setting Theory by Locke and Latham has been developed since 1975. It led to knowledge about the relationship between goal setting and performance. (Locke & Latham, 1990, 1991) The underlying mechanisms of successful goal-setting according to Locke and Latham (Locke & Latham, 2002) are:

1. the direction of attention and effort towards goal-relevant actions
2. the mobilization of resources and effort for goal-relevant actions
3. the maintenance of goals over time support enduring goal striving
4. goal-directed actions as a consequence of task-relevant knowledge and strategies

Morisano and her co-workers have established a goal setting program for the context of academic learning which was evaluated with "struggling" students at McGill University in Montreal, Canada. The software-based goal setting program led to a significant increase in General Point Average (GPA) reduced negative affect, increase in self-efficacy (Morisano, Hirsh, Peterson, Pihl, & Shore, 2010). This research show that a software built on the foundation of goal-setting research has the potential to increase not only study success measured in grades, but also lead to beneficial effects on affect and self-efficacy.

The literature on goal setting makes a distinction between proximal and distal goals (Latham & Brown, 2006) which differ in their effects on performance, motivation, activity and self-efficacy. Latham and Brown (Latham & Brown, 2006) have shown that challenging distal outcome goals may be discouraging and decrease perceived self-efficacy if they are not combined with proximal learning goals. They also showed that distal outcome goals in combination with proximal goals lead to a higher GPA than distal goals alone (Latham & Brown, 2006). Using abstract distal goals, Storch and Krause (Storch & Krause, 2007) have developed a goal setting program called the "Züricher Ressourcen Modell" (Zurich Ressource Model, ZRM) in which they use abstract distal goals they call "Motto-Goals". This kind of goals has been shown to increase motivation and activity (Storch & Krause, 2007). Using proximal goals, Doran (Doran, 1981) suggests that goals which are specific, measurable, achievable, realistic and time-related are more realizable than abstract goals. According to these attributes he calls such goals "S.M.A.R.T.". It will be shown how the advantages of distal and proximal may be combined by Goal Trees.

2. THE CONCEPT OF GOAL TREES

The main research question or our research is: How can findings from former research on constructivism, goal-setting, self-regulation and self-monitoring be applied in a digital data-driven study assistance software?

Our central idea is to represent goal systems as "Goal Trees" in a software to assist University Students in the acquisition of future skills. We define Goal Trees as tree-shaped directed graphs originating in one root goal, splitting up into branch-like sub-goals until the branches terminate in leaf-like goals. The leaves are in the best case proximal goals which are specific, measurable, achievable, realistic and time-related. So the resulting network of goals has a tree-shaped structure with one goal as its root, several layers of intermediate sub-goals as branches and finally actions or S.M.A.R.T. goals as its leaves.

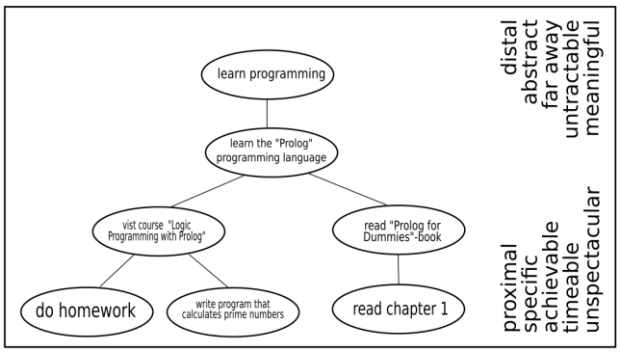

Figure 1. A practical example

A practical example (figure 1): Imagine, a student has the goal to learn the programming, which is an abstract distal goal. A sub-goal may be to master the programming language Prolog. The student may formulate the further sub-sub-goal to take the university class "Introduction to Logic Programming in Prolog", the sub-sub-goal to work through the book "Prolog for Dummies". These sub-sub-goals may be further split until actions, such as "do the homework" or "read chapter 3" result. The border between goals and actions is fluent and a question of granularity.

2.1 Advantages on the Conceptual Level

From a conceptual perspective the benefits of such Goal Trees are numerous:

- On the root level they contain distal goals of personal relevance which may lead to an increase in motivation and activity.
- The possibility to define inspiring root goals, with high personal relevance without yet knowing how to specify them, may empower students to select meaningful education goals.
- The tractability of distal goals is increased by splitting up into intermediate goals and concrete actions.
- Proximal goals may gain personal relevance because of their connection to inspiring distal goals.
- In case of conflicting actions under constraints a prioritizing according to the importance of the underlying distal goals is straight-forward.
- Action sequences can be derived by browsing the leaf level of goal trees.
- Revision of goal trees allow self-regulation by reflecting which actions/strategies led to goal achievement and which did not.
- Mechanisms from Goal Setting Theory are supported as goal maintenance is given and generation of new sub-goals and actions implement the direction of attention and strategies.

2.2 From Theory to Practical Implications for the Graphical User Interface

On the user interface level, Goal Trees (with zoom functions to increase focus) may be used as central structuring element. Consistently with constructivist learning theories, the students actively construct their individual Goal Trees, each originating in a meaningful individual root goal, such as "learn programming". The metaphor of a tree is fruitful because it reflects the growing, ongoing process of goal generation. During the ongoing iterative construction process, the study assistant may assist with hints, questions and dialogues. The following interactions are based on Locke's & Latham's goal mechanisms (Locke & Latham, 2002):

- When the student creates new goals, a dialog will ask him or her to generate concrete actions. This is a direct implementation of the goal mechanism of directing attention and effort to goal-relevant activities.
- When the student creates an action, the study assistant will ask him or her to mobilize times for the action which is a direct implementation of the goal mechanism of mobilizing time and resources for goal-relevant activities.
- The study assistant will store Goal Trees persistently and regularly remind the student to review and extend them. This is a direct implementation of the goal mechanism of goal persistence.

The following interactions are based on the goal setting program by (Morisano, 2008):

- The study assistant may ask students to define inspiring individual study goals for the distant future.
- If students have difficulties to define individual study goals, the assistant may ask them to elaborate on their ideal future, qualities admired in others, things to do better, career in the future, things to learn about and habits to be improved.
- To increase goal commitment and motivation for specific goals, the study assistant may ask the users to elaborate on impacts of the goal if achieved.
- If students have difficulties to generate sub-goals and actions, the assistant may ask them to elaborate on goal attainment, sub-goals, strategies and concrete plans and actions.
- To support goal achievement, the study assistant may ask students for potential obstacles and possible ways to overcome them for specific goals.
- To support students in self-regulation, the study assistant may ask students to define benchmarks of success for specific study goals. If due dates are mentioned in the definition, the study assistant may send reminders.
- The study assistant may ask students to rank the root goals of their Goal Trees in an order. This allows for prioritization of possibly conflicting actions.

To assist in self-regulation, the study assistant may regularly remind the student to review the Goal Trees. This is a technical implementation on self-monitoring. During review of Goal Trees, students may actively

- evaluate success or failure of applied actions / strategies
- monitor themselves whether they invested time and resources according to the Goal Tree or not
- derive new sub-goals and actions (methods, strategies and behaviors in terms of self-regulated learning)

  An important aspect for self-monitoring is critical review of strategies that failed. For this purpose it will not be possible to simply delete goals in the review process. Rather the software will encourage students to reflect why a goal could not be reached or why it does not make sense anymore. This persistence of goals may lead to meta-cognitive learning processes.

3. CONCLUSION

Goal Trees are a contribution which may serve as foundation for a graphical user interface for a study assistant that has the potential to empower students to realize, maintain and pursue meaningful education goals. At the same time, such a study assistant may convey important meta-cognitive skills.

One crucial limitation is the usage of the study assistant. A software can only be as effective as its users are motivated and consequently invest time and effort. As there is a broad variety of software available to university students, it will be a major challenge to convince students to regularly use another software. Goal attainment itself may be perceived as rewarding and our study assistant can even increase this effect by gamification and (self-set) rewards.

The potential of a goal setting tool for higher education is to empower students to think about individual inspiring education goals, to develop self-regulation abilities and increase self-efficacy. In a constructivist sense such a study assistant may help to implement a shift from curricular-driven learning for exams to interest-driven learning for life.

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