Development of a Digital Goal Setting Companion for Higher Education

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Abstract: Goal setting is known to be an effective way to guide behaviour and plays an essential role in self-regulated learning. Goals can serve as benchmarks for the evaluation of behaviour. Recently, research on goal networks instead of isolated goals has received growing interest. In this paper, we present a goal setting intervention that guides university students a) to develop personal educational goals and b) to derive sub-goals, actions and strategies to make those high-level goals tractable. The results are hierarchical goal systems connecting high-level goals to concrete actions. We illustrate the technical implementation as web-based application. Explorative data analysis of data from a paper-pencil preliminary study (n=8) and a first pilot study with a web-based software prototype (n=17) is presented. We conclude with an outlook on further development steps.

Keywords: Goal Setting, Hierarchical Goal Systems, Digital Assistant, Web Technologies

1 Introduction

Goals can be understood as concrete manifestations of motivation. Goal Setting has been shown to affect outcomes such as performance, activity, academic performance, well-being and vitality. Considering goals as "internal representations of desirable states" [VA96], almost every human behaviour can be viewed as being goal-directed. In this section the significance of goals in the context of learning will be introduced.

Locke and Latham could demonstrate that the right degree of challenge has remarkable effects on performance [LL19]. The more challenging the goal, the higher is the performance. This correlation holds until the threshold of subjective ability is exceeded. Beyond this point performance decreases. In the domain of education these findings are essential because students need to find personal goals with the right degree of challenge.

Ryan and Deci have outline a taxonomy of motivation and self-regulation styles in their self-determination theory (SDT) [RD00]. SDT distinguishes a continuum between

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cbe doi:18.18420/provided-by-editor-02

amotivation, different stages of external motivation and intrinsic motivation. The process of goal internalization depends on self-endorsement, self-congruence and personal interest. This indicates that guiding students in the development of personally meaningful goals may lead to an increase of intrinsic motivation, which is not only beneficial for learning but also fo well-being, health and personal development.

In cyclic models of self-regulated learning, active learners play an essential role by regulating their behaviour in iterative loops of planning, acting and reflecting learning processes. In these models individual learning goals are an essential building block because they are a foundation for planning and benchmarks for evaluation [Zi89].

Recent studies have shown that elaboration on goals and intensive writing about goals and ideal future can significantly increase academic performance [Mo08] [Sc20]. The study of goal systems and the kinds of relations between goals are an emerging research area [LPZ07] [We19] [KS20]. These findings imply that students can benefit from digital interventions that assist them in the development of personal educational goals and goal systems. The goal of this project is to develop a digital assistant for a) the discovery of intrinsically motivated educational high-level goals and b) the construction of hierarchically organized structures of goals in a web application. In the current stage of development the goal setting and planning phase is already covered, while the dynamics of learning processes and goal pursuit remains to be covered in the future.

2 Methods

The core idea of the project presented in this paper is to help students to organize their educational goals as hierarchical goal systems, which are tree-shaped goal systems. An abstract and distal root goal is split into sub-goals, a procedure that is recursively repeated until actionable goals occur at the deepest level. Although hierarchical goal systems are restrictive in the sense that only subgoal relations are modeled, they have the following functional advantages:

- Personal goals as roots of goal hierarchies allow maintenance over time and the dynamic adaptation of sub-goals, actions and strategies, which can affect performance by goal mechanisms as outlined by Locke and Latham [LL02].
- The connections between personally meaningful long-term goals to concrete tasks in academic everyday-life are highlighted. Having important life goals and understanding higher education as a means to their achievement can increase academic achievement [Sc19].
- Task selection and prioritization can be organized by picking tasks from the bottom layer. If the priorities of root goals are known, the task prioritization problem can be solved easily.

The following two development steps towards a goal setting web application, based on HGS have been taken so far: Firstly, to explore potential difficulties that students have with naming personal educational goals and with constructing hierarchical goal systems, a paper-pencil pre-study was conducted. Secondly, a digital prototype was developed and a tested in a digital pilot study.

2.1 Paper-Pencil Pre-Study

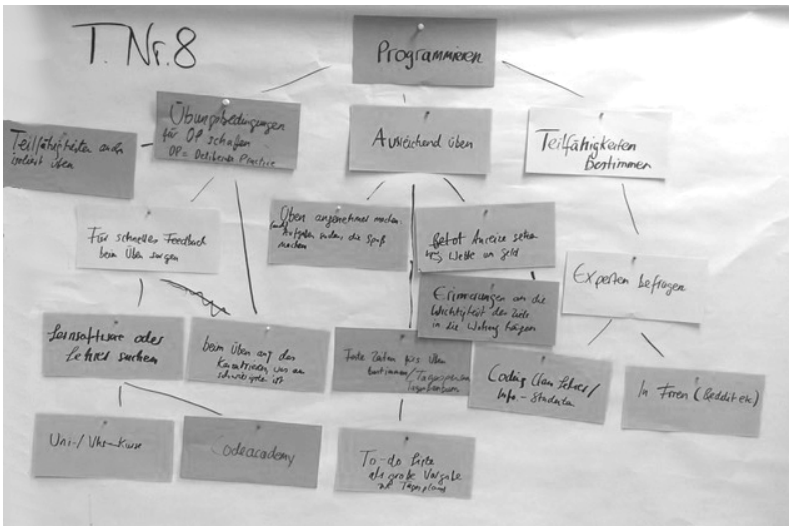

Fig 1: This example shows how a participant extended the root goal of learning how to program into a hierarchical goal system. The crossed link at the left is remarkable because it indicates a "forbidden" cross-link causing a goal to have two superordinate goals.

The analogue pre-study was conducted as an interview to identify difficulties and user requirements for the construction of hierarchical goal systems. Participants (n=8) were recruited by emails distributed over a mailing list and incentivized by test subject hours which are mandatory in certain study programs. In a second email participants were instructed to think about their educational goals and fill out an online questionnaire, inspired by the future authoring program by Morisano [Mo08]. As a result of the online questionnaire, participants wrote down a list of personal goals, as potential root nodes. Then appointments for an interview in person were made. In the interview students were instructed how to pick goals from their list of personal goals and extend them to hierarchical goal systems. This was done on a pinboard with paper cards, as the example in figure 1 shows. Participants were encouraged to talk about difficulties during the construction process. The interviewer gave supportive advice as required by participants and recorded observations about difficulties and user behaviour. Participants constructed

hierarchical goal systems, within the given time, 12 in total.

Participants reported difficulties with the "rule" that a goal can have only one parent. They stated that some goals have synergetic effects or in other words serve more than one superordinate goal, so participants wished to form cross-links. How to deal with goals beneficial to more than one higher goal remains an open issue. Crosslinks would make the resulting structure less clear. The alternative solution to have more than one representation of the same subgoal, leads to redundant representations. Under the perspective of prioritization, goals serving more than one superordinate goal are interesting because their payoff in terms of goal progress is higher.

In some cases of personal goals, participants reported that the interviewers' presence was perceived as disturbing. This point constitutes an advantage of a digital assistant which allows participants to be alone during the goal setting process.

2.2 Digital Pilot Study

Based on the analogue pre-study a web-based software prototype was implemented using the Django web framework [Dj13], and the d3.js javascript library [BO11] for the visualizations. Participants were invited by emails with the URL of the web application.

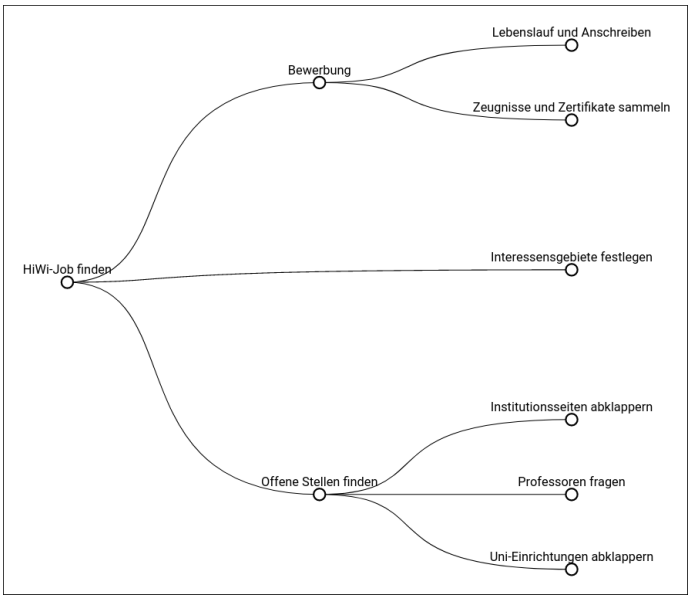

Fig 2: Example tree from the digital pilot that shows an increase of concreteness and actionability top-down.

In the web app, users are guided through a sequence of a consent form, a pre-questionnaire with demographic questions, instructions and an example goal hierarchy, personal goal hierarchy construction and finally a post-questionnaire (NASA Task Load Index plus open question). In total 17 participants generated 25 goal hierarchies with 281 nodes in total. The branching for each node ranged from 1 to 5, the number of nodes per goal system varied from 4 to 20 and the depth of the goal hierarchies ranged from 1 to 6.

participants	17
goal systems	25
goals	281
root goals	25
intermediate goals	103
actions/leaf nodes	153
minimal depth	1
maximal depth	6
average depth	2.50
minimal branching	1
maximal branching	5
average branching	2

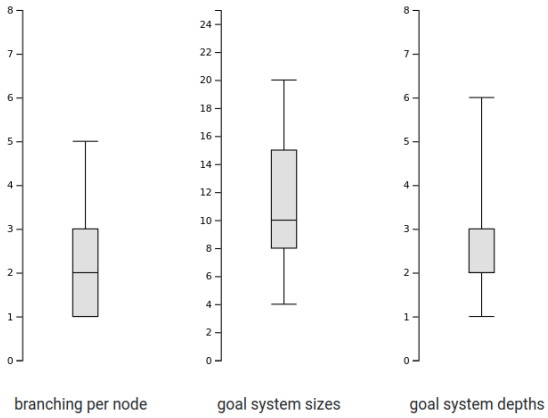

Fig. 3: Structural characteristics of the goal systems from the digital pilot study.

Exploratory analyses of the goal systems showed that goal concretenes seems to correlate with depth in the goal system. In the open questions, participants reported that the task was demanding but the intervention helped to gain clarity and get a better overview. One participant reported difficulties to develop subgoals in domains that are yet unknown. That is an aspect from which we expect beneficial effects because clarification may occur when thinking hard about means for goal achievement.

3 Conclusion and Outlook

In this paper, we have summarized the current state of the development of an innovative web-based goal setting intervention for university students, based on the concept of hierarchical goal systems. The results indicate that the approach is suitable to support students to derive increasingly concrete and actionable goals.

The next development steps will be to use different types of visualizations for hierarchical data, such as treemaps, sunbursts, dendrograms and circlepacking to represent HGS. We will evaluate changes in usability and possible effects on structural properties of the resulting goal systems and characteristics of the resulting goals.

The final version of the software is intended to guide students during planning, learning and evaluation phases by providing dynamic hierarchical goal systems, suitable to monitor goal progress, reflect on goal progress and learning strategies and dynamically adapt goal systems to new situations. Once this stage of development is reached, longitudinal studies will shed light onto effects on educational goal pursuit.

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