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A Conceptual Feedback Model of Performance Dynamics

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Abstract

Human behavior is extremely complex and influenced by a large variety of factors. Psychologists are given the challenge of constructing models that do justice to this complexity. In this study, we constructed a conceptual model of performance dynamics. We specifically focused on how the GPA of a student changes over time. In constructing the model, we utilized the existing theories in psychology and feedback perspective of systems thinking/system dynamics. As most psychologists still lack the language they need to accurately portray human behavior, this model serves the purpose of promoting the use of systems thinking/system dynamics within psychology. This is done by combining several theories concerning motivation and goal directed behavior into a conceptual model of performance dynamics. The model variables are explained and the feedback loops were discussed in detail. In future studies, we plan to use this conceptual model in explaining different modes of behavior observed in performance dynamics.

Keywords: ability; education; performance; psychology; satisfaction; self-efficacy; task difficulty; valence; goals.

1. Introduction

Human behavior is extremely complex and influenced by a large variety of factors. Especially fields such as developmental psychology that concern both short-term processes, as well as long-term processes, are given the challenge of generating models that can capture this complexity. In contrast, many models in psychology fail to do justice to this complexity. Consequently, researchers might overlook important long-term effects on behavior and interactions between variables. Only recently researchers have started to delve into developing models containing feedback links. Examples of these in Industrial and organizational psychology are goal-setting theory (Locke & Latham, 2002) and action theory (Frese & Zapf, 1994). However, most psychologists still lack the language they need to accurately portray human behavior. This model serves the purpose of promoting the use of systems thinking/system dynamics within psychology. This is done by combining several theories concerning motivation and goal directed behavior into a conceptual model of performance dynamics. Our model ignores cognitive dissonance and the specifics behind goal-setting. The aim of this model is to explain goal striving behavior using a feedback perspective.

2. The Conceptual Model and the Key Variables

In this part of the paper, we will define the variables that we used in the conceptual model and elaborate on their effects on other variables. The general model will be illustrated by an example concerning Grade Point Average (GPA).

2.1. Target GPA

Target GPA concerns the goal one is committed to, in this case a particular GPA one desires to obtain. Thus, Target GPA is the performance goal in this context. This target is assumed to have an objective difficulty level (as described through task difficulty) and higher targets (i.e., target GPA values closer to 4) are assumed to have a positive effect on this difficulty level. In this study, we take Target GPA as a given. Thus, the process of setting a target GPA will not be considered.

Aside from its objective difficulty level, target GPA is also assumed to have a subjective difficulty level (perceived difficulty level). Namely, the higher the target an

individual sets, the more likely it is that one regards the goal as difficult (Stamatogiannakis, 2013).

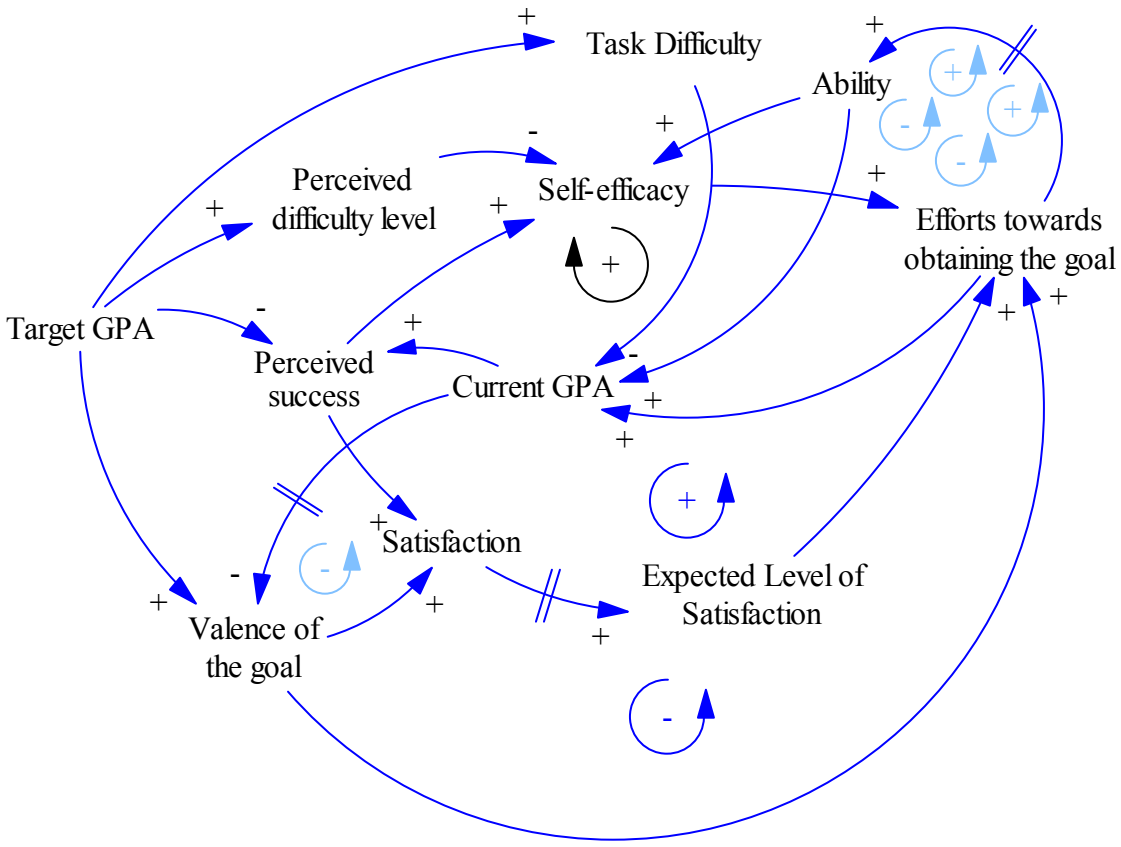

Fig. 1 A Conceptual Feedback Model of Performance Dynamics

Furthermore, target GPA is assumed to have a positive influence on the valence of the goal. Research on mastery and performance goals has indeed shown that students attach more value to goals that correspond to higher standards of achievement (Dompnier, Darnon, Meier, Brandner, Smeding, & Butera, 2015; Darnon, Dopmnier, Delmas, Pulfrey, & Butera, 2009). Lastly, target GPA could be a moderator of the relationship between Current GPA and Perceived success, which will be elaborated upon in a later section.

2.2. Task Difficulty

The objective difficulty level of a goal can be defined either as a function of the ratio of the individuals who accomplish the goal to the total number of people who attempted the goal or as a function of the ratio of the total successes of an individual to the

total number of trials of that individual. Accordingly, the difficulty level of a goal that is solely accomplished by 10% to 20% of individuals who attempted to obtain the goal, or that could only be accomplished by an individual 10% to 20% of the time is considered to be high (Landy & Conte, 2014). Task difficulty is, therefore, presumed to have a negative effect on Current GPA.

2.3. Current GPA, Target GPA, and Perceived Success

Current GPA is defined as the GPA an individual has attained following goal directed behavior to obtain the target GPA. Accordingly, current GPA is the main performance variable in our conceptual model. It is assumed that individuals engage in comparison processes in which they compare their current GPA to their target GPA, in order to determine whether they have obtained their goal or whether they have improved. Perceived success therefore relates to the evaluative component in action theory (Frese & Zapf, 1994). Together with valence of the goal, perceived success predicts satisfaction with the outcome (Locke, 1969).

2.4 Target GPA, Current GPA, and Valence

As previously stated, target GPA is presumed to have a positive effect on valence of the goal. Conversely, current GPA has a negative effect on the valence of the goal. Furthermore, this negative effect is only assumed to occur in a very gradual way. This works through a comparison process in which current GPA is compared to target GPA. When discrepancy is high (i.e., target GPA is higher than current GPA), the valence of the goal will increase over time. However, as Locke (1969) proposed, one will not indefinitely be satisfied with the same standard. Hence, the valence of the goal will start to decrease when one has obtained the goal several times.

2.5. Valence of the goal and Satisfaction

Valence of the goal is defined as the value individuals ascribe to their intended goal. Together with perceived success, valence of the goal is assumed to determine satisfaction. This is because when one does not attain a goal that is highly valued, one is likely to be dissatisfied, whereas when one does attain that goal, one is likely to be satisfied (Locke, 1969; Brown, Venkatesh, Kuruzovich, & Massey, 2008). Moreover, borrowing

from VIE (valence, instrumentality, expectancy) theory, it is assumed that valence of the goal has a positive effect on efforts towards obtaining the goal (Vroom, 1964).

2.6. Expected level of satisfaction

It is assumed that satisfaction with the previous outcome sets learning processes in motion, akin to those specified in reinforcement theory. This would mean that satisfaction will be associated with goal attainment. Therefore, expectancies are formed that future goal attainment will also lead to satisfaction (Landy & Conte, 2014). These learning and expectation formation processes cause a delay between satisfaction and its effect on expected level of satisfaction. Thus, the change in expected level of satisfaction is more gradual compared to changes in satisfaction itself.

It is assumed that higher expectancies will lead to the investment of more energy in obtaining the goal. Studies have indeed pointed to a positive influence of expectations on efforts (Levi, Einav, Ziv, Raskind, & Margalit, 2014; Domina, Conley, & Farkas, 2011; Sommerfeld, 2015).

2.7. Efforts towards obtaining the goal

Efforts towards obtaining the goal corresponds to a component in goal-setting theory. Goal-setting theory states that goals "direct attention and action (direction), mobilizing energy expenditure or efforts (efforts), prolonging efforts over time (persistence) and motivating the individual to develop relevant strategies for goal attainment (strategy)" (p. 145) (Locke, Shaw, Saari, & Latham, 1981). In this model, efforts is not solely understood as energy expenditure, but the other components (direction, persistence and strategy) are considered to be elements of efforts as well. These processes concern the actual behavior one engages in when trying to obtain the goal. It is therefore assumed to have a positive influence on current GPA. Furthermore, we propose an interaction effect between efforts, ability, and task difficulty on current GPA. Landy and Conte (2014) proposed a simple model portraying performance as a function in which motivation and ability are multiplied and its product is subtracted by situational constraints. Our conceptual feedback model (see Figure 1) considers performance to be a similar function in which motivation, which is embedded in efforts towards obtaining the goal, and ability have positive effects on the performance (i.e., current GPA). Meanwhile,

task difficulty, which is akin to situational constraints, has a negative influence on current GPA. It is important to note that a lack of ability could dominate the effect of the efforts on the level of current GPA. Similarly, the lack of efforts can dominate the effect of ability on the level of current GPA. Thus, a high GPA is a result of both high ability and high efforts. Without either ability, efforts, or both, performance level will be low. Over time, however, repeated practice and the accumulation of experience (efforts towards obtaining the goal) is also likely to increase the ability level (Kraige, Ford, & Salas, 1993).

2.8. Self-efficacy, Ability, and Perceived Difficulty

Self-efficacy regards the confidence one has that he or she can actually obtain the goal. Self-efficacy is assumed to increase by mastery experiences (situations in which the goal has been achieved), modeling (when someone similar to oneself attains the goal, this is likely to raise one's own confidence), social persuasion (others convincing an individual that he or she can obtain the goal) and physiological states (experiencing physiological stress reactions and therefore assuming the goal is too difficult) (Bandura, 1986).

As mentioned above, mastery experiences can positively increase self-efficacy. This role is portrayed by the link between perceived success and self-efficacy (see Figure 1). Furthermore, perceived difficulty level (subjective task difficulty) is likely to negatively influence self-efficacy as higher goals are more difficult to obtain and one would feel less confident in obtaining more difficult goals. However, when the goal has a high task difficulty, but one does not actually perceive it as difficult, this is assumed to have no effect on self-efficacy. Conversely, ability (which is defined as individuals' competence levels relative to others' capacities) can have a positive influence on self-efficacy as more competent individuals are more likely to have higher confidence levels about accomplishing the goal.

Self-efficacy is assumed to have a positive influence on efforts towards obtaining the goal. This is because individuals who are self-efficacious are more likely to attempt difficult tasks than individuals who perceive themselves as incompetent (Bandura, 1997; Colquitt, LePine, & Noe, 2000). In other words, individuals who have a low level of self-efficacy would be more inclined to give up. The relationship we captured in our model is in accordance with the literature. Namely, a study by Asseburg and Frey (2013) has shown

that a balance between individuals' abilities and task difficulty positively influences efforts.

3. Feedback-Loops in the Model

In this section, we will provide insight in the feedback loops of the conceptual model given in Figure 1. For this purpose, we will isolate the feedback loops and explain in what ways they could potentially influence the dynamics of the variables that are in the loop. In a causal-loop diagram (i.e., conceptual feedback model), the arrows define the direction of the causal effect of a variable on another one. A positive sign on the arrow implies a tendency in the linked variable to move in the same direction with variable causing the effect and a negative sign implies a tendency in the linked variable to move in the opposite direction of the variable causing the effect.

A feedback loop is a complete circle of casual effects. The polarity of the feedback loop is determined by the directions (i.e., positive or negative) of the effects. An odd number of negative effects result in a negative feedback loop and an even number of negative effects (or no negative effect) result in a positive feedback loop. Note that if everything else is kept constant, a positive feedback loop will reinforce an initial change in a variable, causing a similar change in the same direction and a negative feedback loop will counteract an initial change and either completely eliminate or eliminate only some part of the initial change. Sometimes, negative feedback loops counteract stronger than the initial change, causing over correction, which may eventually result in growing oscillations. In our diagrams, loop-polarity is shown in the middle of the diagram.

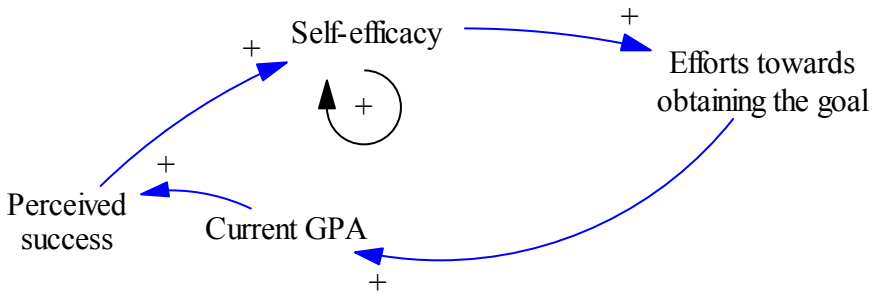

Fig. 2 Boost or collapse in confidence

In all our analysis, we will assume ceteris paribus. The first important positive feedback loop is depicted in Figure 2. If, for some reason, there is an initial increase in self-efficacy, this will increase the efforts towards obtaining the goal. This will either contribute to the ascent of current GPA or slow down its decline. In the following part, the effects on self-efficacy when current GPA is increasing, will be elaborated upon. Perceived success will then tend to increase, which in turn will result in a further increase in self-efficacy, causing all variables to continue to increase over time. Thus, we will end up with a boost in self-efficacy. Similarly, if, for some reason, there is an initial decrease in self-efficacy, this will decrease the efforts towards obtaining the goal. This will consequently either slow down the ascent of current GPA or cause it to decline. When focusing on the latter, perceived success will tend to decrease. This will lead to a further decrease in self-efficacy in turn, causing all variables to continue to decrease over time. Thus, we will end up with a collapse in self-efficacy.

In summary, the first important positive feedback loop depicted in Figure 2 explains how self-efficacy either increases or collapses over time. When this loop is in charge, success brings further success and failure brings further failure. This loop acts very quickly as it involves no delayed causal effects.

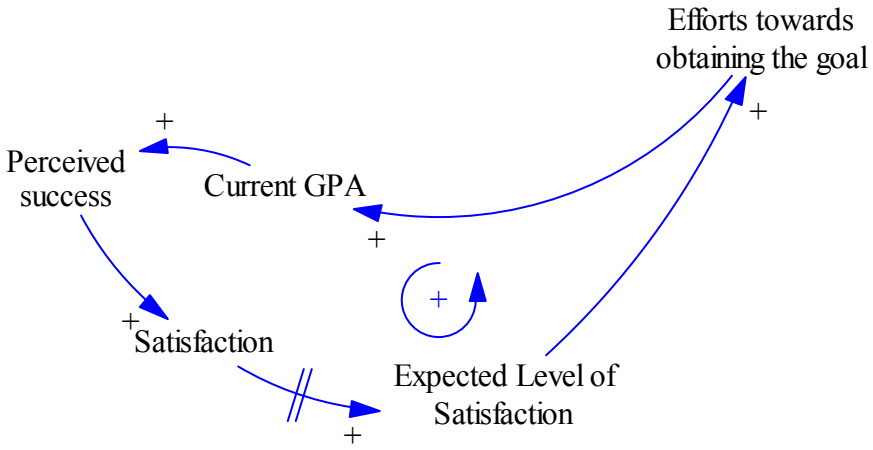

Fig. 3 Associative learning

The second important loop in our conceptual model is also a positive feedback loop (Figure 3). Thus, it will either produce a build-up or collapse behavior. If a person believes

that one's efforts are bringing success (e.g., an increase in GPA), this will increase the expectancy that one will experience satisfaction when the goal is attained again, which will result in an increase in the efforts towards obtaining the goal. In time, increased efforts bring further success. Thus, the person learns in time that one's efforts bring success. On the contrary, if a person believes that one's efforts are not bringing success (e.g., a decrease in GPA), this will decrease the efforts, which in time will result in a further decrease in success. Thus, the person learns in time that one's efforts do not bring success. Similar to the first loop (Figure 2), when this second loop (Figure 3) is in charge, success brings further success and failure brings further failure. However, its effect on the dynamics is slower compared to the first loop as it involves a delayed effect (i.e., the effect of satisfaction on the expected level of satisfaction; delayed effects are represented with two short parallel lines on the casual link between variables).

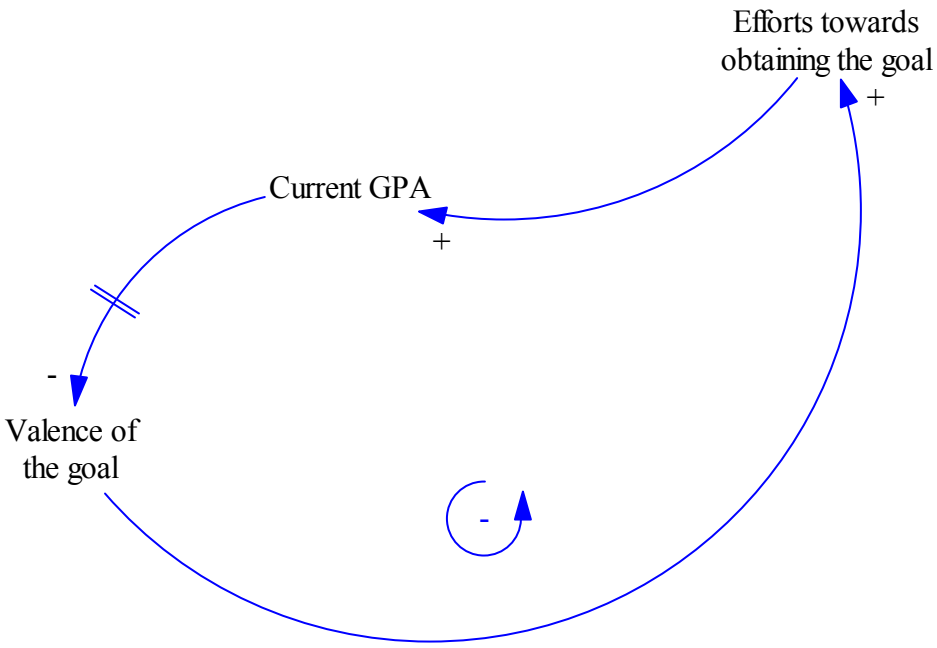

Fig. 4 Value of the goal (first loop)

The third important loop in our conceptual model is a negative feedback loop (Figure 4). An increase in GPA will decrease the value of the goal (i.e., valence) in time. A decrease in the valence of the goal will decrease the efforts toward obtaining the goal, which in turn have a negative effect on the GPA. However, a decrease in GPA will

increase the valence of the goal in time. An increase in the valence of the goal will increase the efforts toward obtaining the goal, which in turn has a positive effect on the GPA. Therefore, if this third loop (Figure 4) is in charge, both an improvement or a deterioration in GPA will be counteracted. If the person is adjusting one's behavior relatively fast, this loop may possibly produce growing oscillations and if the person is adjusting one's behavior relatively slowly, this loop may possibly cause damping oscillations.

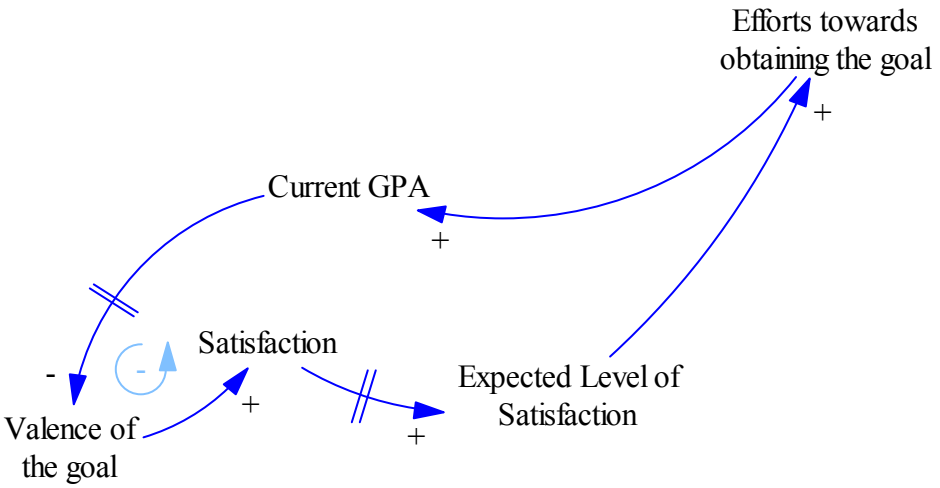

Fig. 5 Value of the goal (second loop)

The fourth important loop in our conceptual model also concerns a negative feedback loop (Figure 5). Similar to the negative feedback loop depicted in Figure 4, it will produce a counteracting behavior. This feedback loop (Figure 5) shares four variables with the previous negative feedback loop (Figure 4). Therefore, it generates a similar kind of behavior when it is in charge. However, its effect on the dynamics is slower as it involves two delayed effects instead of just one.

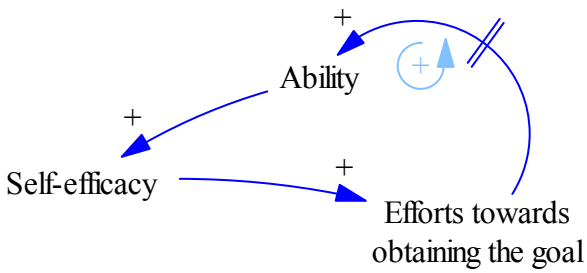

Fig. 6 Knowledge and skills acquisition (main loop)

The fifth important feedback loop in our model (Figure 6) is a positive feedback loop. The efforts that one spends towards obtaining the goal will improve one's ability in time, which in turn improves self-efficacy and consequently increases efforts towards obtaining the goal. On the other hand, a decrease in efforts results in less practice and will produce a decline in ability over time, which in turn deteriorates self-efficacy and consequently decreases efforts towards obtaining the goal. Similar to the first and second loops (Figure 2 and Figure 3), when this loop (Figure 6) is in charge, success brings further success and failure brings further failure.

The delayed effect of efforts towards obtaining the goal and ability introduces three more feedback loops; one positive and two negative loops. Thus, there are four feedback loops passing through this single causal link (Figure 6, Figure 7, Figure 8, and Figure 9), where two of these feedback loops are negative and two are positive. If there were no causal effects between efforts towards obtaining the goal and ability, all of these feedback loops would vanish. Accordingly, these feedback loops are weak because (1) when positive and negative loops pass through the same causal link, they cancel out each other's effects; (2) they share almost all of their variables with the aforementioned feedback loops.

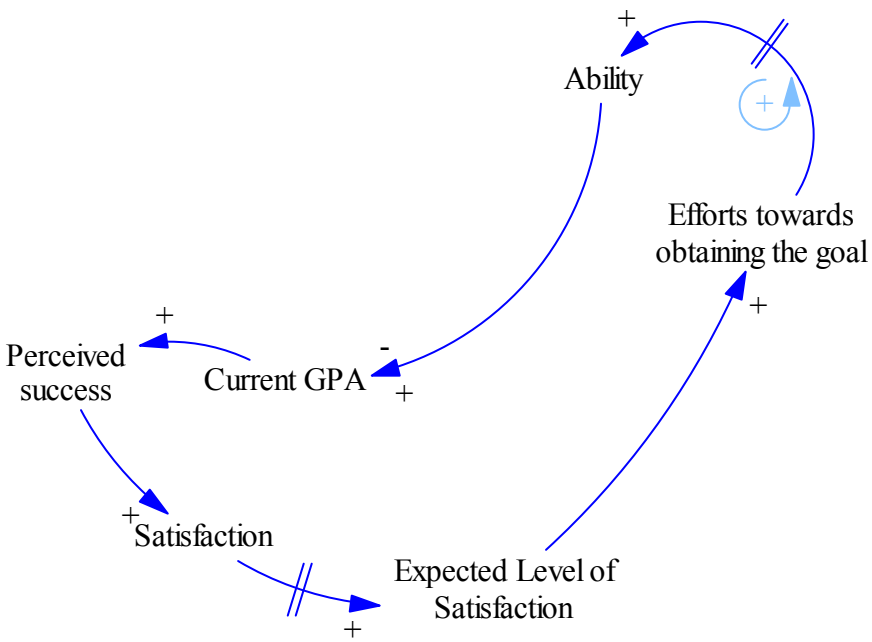

Figure 7. Knowledge and skills acquisition (secondary positive feedback loop)

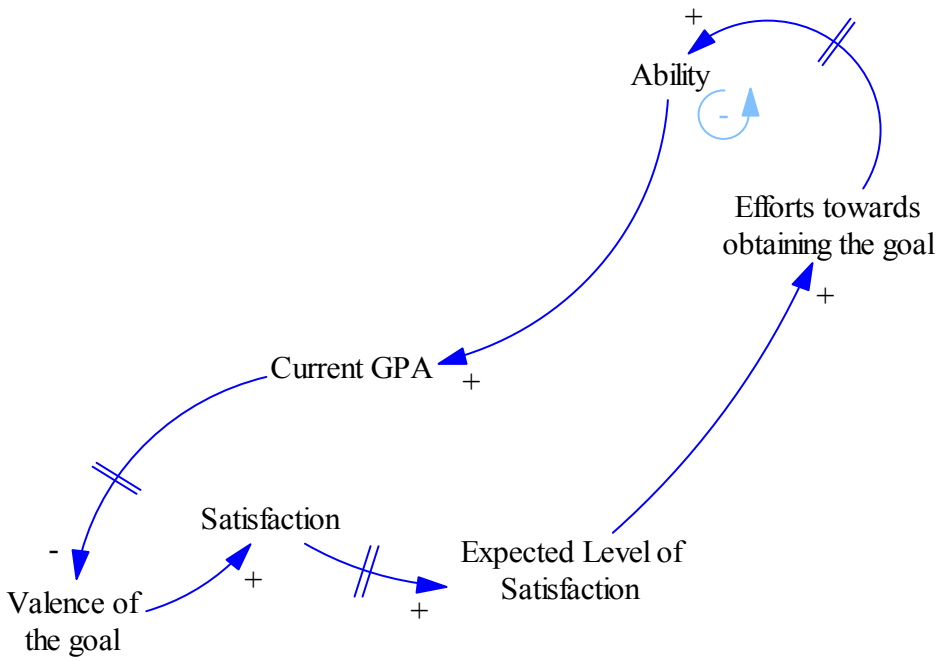

Figure 8. Knowledge and skills acquisition (first of the secondary negative feedback loops)

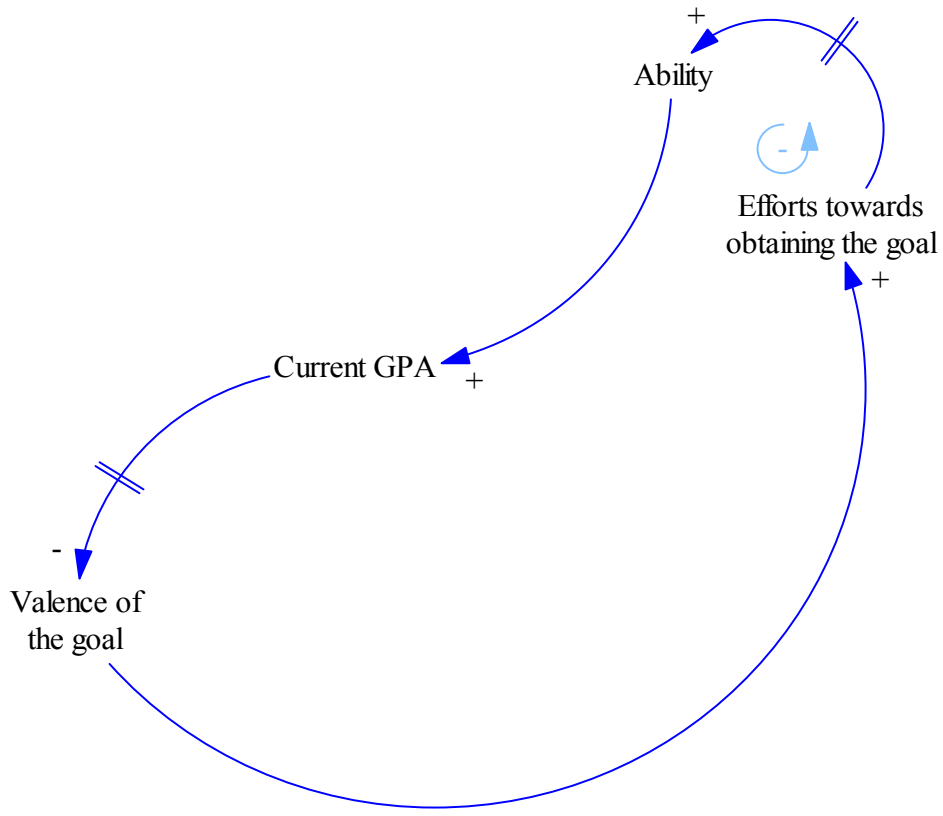

Figure 9. Knowledge and skills acquisition (second of the secondary negative feedback loops)

4. Conclusions

In this study, we constructed a conceptual model of performance dynamics. We specifically focused on how GPA of a student changes over time. In constructing the model, we utilized the existing theories in psychology and feedback perspective of systems thinking/system dynamics. The model focuses on the variables in the presence of a set goal, thus excluding the goal setting processes. The model variables are explained and the feedback loops were discussed in detail. As this paper is not solely directed to an SD audience, explanations about the meaning of positive and negative causal effects and positive and negative feedback loops are included as well. In future studies, we plan to use this conceptual model in explaining different modes of behavior observed in performance dynamics, such as: "an initial increase followed by a collapse", "a sustained high level performance", "an initial decrease in performance followed by a success", "an oscillating performance around an average performance level", "an unavoidable, sustained weak performance", etcetera.

This model can also support future studies that aim to construct stock-flow model of performance dynamics. There is a possibility of widening the focus of the paper by incorporating "goal setting processes" within the model. We also hope that our paper will set another example of utilizing systems thinking/system dynamics tools in psychology.

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