Computer simulation of processes that influence adolescent learning motivation

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Abstract

In order for the learning process to always retain personal value for the learner, it is necessary that his or her motivation be maintained through an awareness of his or her purpose and goals. This article presents a local model (at the individual object level) of enhancing external motivation, which give to determine students' efforts to get rewards. The concept of this model based on describing the behavior of agents (in our case students). The characteristics of the phenomenon in the motivation of learning at different stages of adolescent development are analyzed. The problem of computer modeling of educational processes with the help of agent modeling on the example of studying student motivation is considered. Internal and external factors that may strengthen or weaken the adolescent's motivation to study have been studied. The expediency of using information technologies of agent modeling to study the dynamics of strengthening or weakening student motivation is substantiated. Using the AnyLogic Cloud computing environment the change of dynamics of strengthening of motivation of teenagers on an example of model of strengthening of external motivation is defined.

Keywords

computer simulation, behavior of agents, educational processes, adolescent learning motivation

1. Introduction

Adolescence is a phase of lifespan associated with greater independence, and thus greater demands to make self-guided decisions in the face of risks, uncertainty, and varying outcomes

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[1]. Evidence is mounting to suggest that multiple decision processes are tuned differently in adolescents and adults including reward reactivity, uncertainty-tolerance, delay discounting, and experiential assessments of value and risk [1]. The motivation of adolescents in learning contexts has emerged as an important issue of educational research over the last 20 years, because adolescence is a time of change and preparation for adulthood, and because academic achievement at this time can have significant implications on employment or career opportunities, understanding adolescents' motivation is vital to ensuring students achieve their potential [2].

Cloud technologies has great potential to address the problem solving process of adolescent learning motivation which is a complex activity [3, 4]. In the modern world, it is extremely important to study the complex processes in learning, the development of which can only be effectively predicted by computer simulation [5, 6, 7, 8, 9, 10, 11, 12, 13]. This paper discusses the peculiarities of cloud computing simulation of educational processes with the help of agent modeling based on the study of adolescent learning motivation. Learning motivation [14, 15], due to its multidimensionality, the presence of various (sometimes even opposite) factors that cause its emergence, development and disappearance, is one of the most difficult problems in psychology. A great deal of research is devoted to its solution, but there is still not a sufficiently convincing model of this phenomenon that would allow teachers to successfully control changes in pupils' learning motivation. The reason for this is not only the complexity of the phenomenon, but also its distinctive manifestations at different stages of the child's development.

The latest achievements of psychologists on learning motivation issues are presented in the 2018 annual edition of "How People Learn II" [16] by the American National Academies of Sciences, Engineering, and Medicine, which regularly provides thorough reviews of the latest views in various scientific and technical fields. According to it, learning motivation is defined as a condition that activates and sustains behavior toward a goal. It is critical to learning and achievement across the life span in both informal settings and formal learning environments. For example, children who are motivated tend to be engaged, persist longer, have better learning outcomes, and perform better than other children on standardized achievement tests [17]. Motivation is distinguishable from general cognitive functioning and helps to explain gains in achievement independent of scores on intelligence tests [18]. It is also distinguishable from states related to it, such as engagement, interest, goal orientation, grit, and tenacity, all of which have different antecedents and different implications for learning and achievement [19]. People are motivated to develop competence and solve problems by rewards and punishments but often have intrinsic reasons for learning that may be more powerful.

2. Results and discussion

Learners tend to persist in learning when they face a manageable challenge (neither too easy nor too frustrating) and when they see the value and utility of what they are learning. Children and adults who focus mainly on their own performance (such as on gaining recognition or avoiding negative judgments) are less likely to seek challenges and persist than those who focus on learning itself. Learners who focus on learning rather than performance or who have intrinsic motivation to learn tend to set goals for themselves and regard increasing their competence

to be a goal. Teachers can be effective in encouraging students to focus on learning instead of performance, helping them to develop a learning orientation. Given the above characteristic of the phenomenon, it is possible to distinguish several blocks in the learning motivation.

Block 1. **The personal meaning of learning for the student (learning subject).** For a young child learning is a natural process, he or she learns constantly, exploring the world, knowing and realizing it. In the first stages, learning motivation is the innate need to understand the world in which you live. This understanding has always been and is a prerequisite for survival. Senior preschoolers and junior pupils are deepening their knowledge of the world in two ways: practically exploring it and purposefully studying it with the help of specially organized learning. For teens, learning is the main source of knowledge. Learning, according to the "Ukrainian Psychological Terminology dictionary" is "purposeful personal assignment of knowledge and skills of social experience, in the process of which their content is not only transformed to the individual experience of the student, but also directed at the formation of the subject's personalities through his or her needs and motivational sphere" [20]. APA dictionary, which is one of the most respected psychological dictionaries in the world today, views teaching as "the acquisition of novel information, behaviors, or abilities after practice, observation, or other experiences, as evidenced by change in behavior, knowledge, or brain function" [21, 16]. Despite some differences in understanding of the concept of learning in both dictionaries, it is noted that learning is a purely personal process, in contrast to teaching, which is based on the interaction between the teacher (someone, or something that teaches) and the student. A final point to make is that, in the context of the growing expansion of virtual learning systems, the important question is whether such learning systems provide interaction between the learner and the teacher (or program). In the absence of such interaction, even a motivated learning process can stop at the first stage of the assimilation of information, and not proceed to the second main stage of the internalization of information and its transformation into knowledge.

In order for the learning process to always retain personal value for the learner, it is necessary that his or her motivation be maintained through an awareness of his or her purpose and goals. At the same time, more stable motivation for learning is manifested when purposes and goals (the essence of the differences between these concepts will be discussed below) have a long-term character, directly related to future planning and conscious life tasks. Such motivation can be defined as "strategic". Tactical or short-term motivation defines purposes or goals that can be achieved in the near future (lesson, term, school year, etc.). Tactical motivation is often the result of specific external stimulation when a student tries to receive the promised reward or to avoid punishment. The least motivated to learn are those adolescents who do not associate their personal purposes and goals with learning at all. The purpose of the study answers the question "Why am I learning?"

The goal of the goal is to answer the question "What am I learning for?".

Learning motivation of adolescents increases significantly when combined with a well-understood goal and purpose.

Block 2. **Extrinsic and intrinsic learning motivation.** The effectiveness of learning motivation depends largely on the values that are important to a particular individual. What is most important for a adolescent is to achieve something (a life goal or a task); enjoy the process of cognition; raise your image in the eyes of the environment; deserve praise or reward; prove something to yourself or avoid anxiety and defeat. Personal values are directly related

to internal or external type of motivation. Intrinsic learning motivation is driven by cognitive curiosity, pleasure from solving intellectual problems, curiosity, desire to learn more. Intrinsic motivation does not need external stimulation (or reinforcement), because it is of value in itself, it is not tied to a specific result. In essence, it contains both motive and stimulus [22, 23, 24].

Extrinsic motivation depends on extrinsic factors, is driven by additional reinforcements, and is carried out using a reward incentive, which can be either tangible (money, valuation, privileges, etc.) or intangible (praise, enhancement of image or status in society, punishment, etc.). Important factors in influencing extrinsic motivation are the lack of real intrinsic motivation and the student's willingness to receive rewards for success in learning or preventing punishment for failure. At the same time, the learning itself is perceived as a burden and does not bring pleasure

Mixed motivation arises in the case of a combination of internal and external factors. This combination can be both positive and negative. In particular, intrinsic motivation can be reinforced by positive externalities when parents support and encourage the adolescent and weaken in case of indifference to the student's successes and failures. A special case of mixed motivation, in E.R. Lai's view, is learning motivation driven by internal pressures such as obligation or guilt [25]. Numerous studies [26, 27, 28, 29, 30] indicate that good intrinsic motivation correlates with both better learning outcomes and overall life success.

Block 3. **Objectives of motivated activity are indicators of what an individual is focused on when performing a particular task.** Broussard and Garrison separate goals of skill and performance. What's the difference? The goals of skill are focused on learning for the sake of learning, self-worth of learning, meeting one's own cognitive needs, while the goals of performance are to show others their achievements. Goals of skill are associated with a high capacity for information analysis and planning, and the belief that effort enhances a person's capabilities. On the other hand, goals of performance are accompanied by thoughts of achievements, evaluations, and external rewards. In the long run, goals of skill are better motivators of learning than goals of performance.

Block 4. **Locus of control is the tendency to attribute successes or failures to internal or external factors.** If an adolescent has an internal locus of control, then the student is aware of the importance of his or her activity to achieve a specific goal and purpose, and therefore his or her motivation for effective learning increases significantly. As research (Connell and Wellborn [23], Weiner [24], Eccles and Wigfield [30]) found in this case. he or she will be as motivated as he or she will feel that he or she is in control of his o her own successes and failures.

The influence of the various factors can enhance or weaken adolescent learning motivation is presented at figure 1 (included the number of conditional points that each factor can add to the motivation). When an exterior locus of control is present in an adolescent, in difficult situations his or her motivation for learning will decrease significantly. In particular, difficulties in completing a task will lead to a decrease in effort and a drop in motivation in students with extrinsic motivation, who believe that they lack skills, parents assist poorly, teachers explain poorly and, conversely, increase motivation in students with an internal locus of control that associates their success or failure with the effort spent, since failure for the first group means impossibility that is difficult to change, whereas failure for the second group means that one simply needs better try.

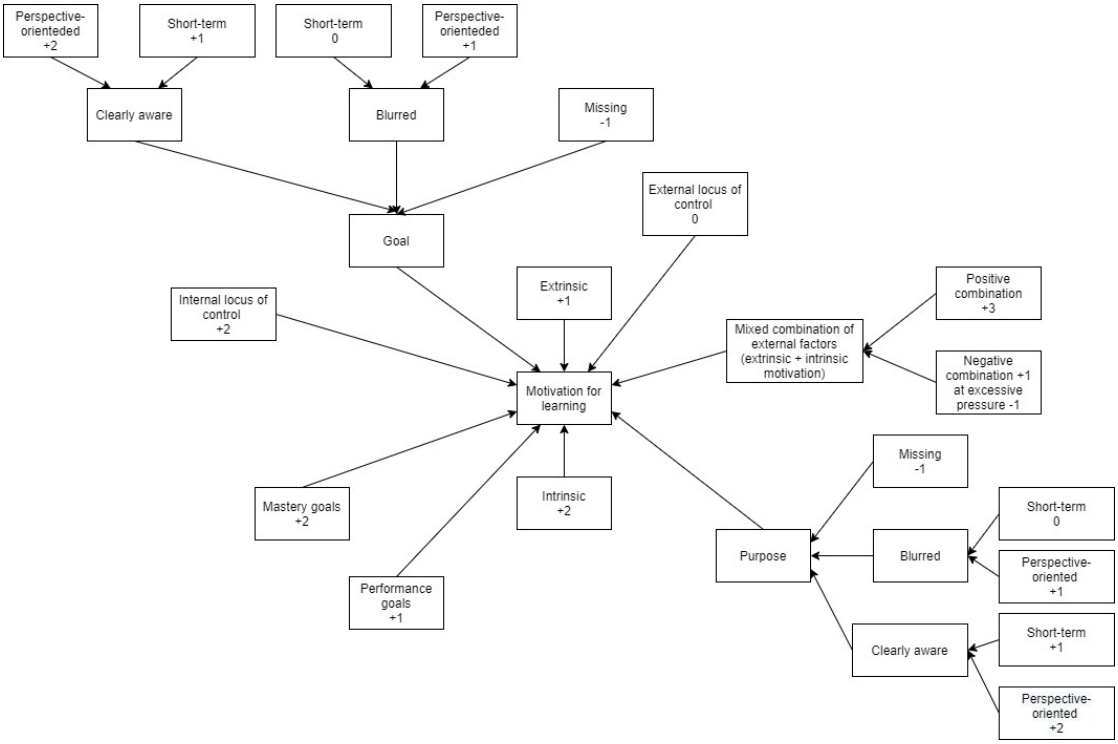

Figure 1: Graphical model of the influence of various factors that can enhance or weaken adolescent learning motivation.

It is advisable to use agent modeling information technology to quickly track and respond to changes in learning, as well as to depict the dynamics of enhancing or weakening learning motivation. The basis for describing the behavior of agents (in our case students) is based on a life cycle model: each agent develops according to his or her own behavior model, which can change within his or her individual life cycle. The life cycle of a particular agent is presented as a system that changes its internal states, and can be specified as a graph of transitions between stages (modes) of its existence. The dynamic model of the transition of the agent from one mode of operation to another is presented in the form of a production model, which consists of agent functioning modes array; transformation rules array (knowledge base); and interpreter (inference machines) [31]. There are two types of agent model definition levels:

- global models (multiple objects grouped on the basis of a particular attribute),
- local models (at the individual object level).

According to the principles of agents building models, there are several approaches (figure 2):

- the use of regression dependencies to determine logic at the level of agents arrays,
- the formation of a knowledge base of agents based on Data Mining to determine the logic of individual agents behavior,
- the use of target functions to determine the logic of agents' behavior.

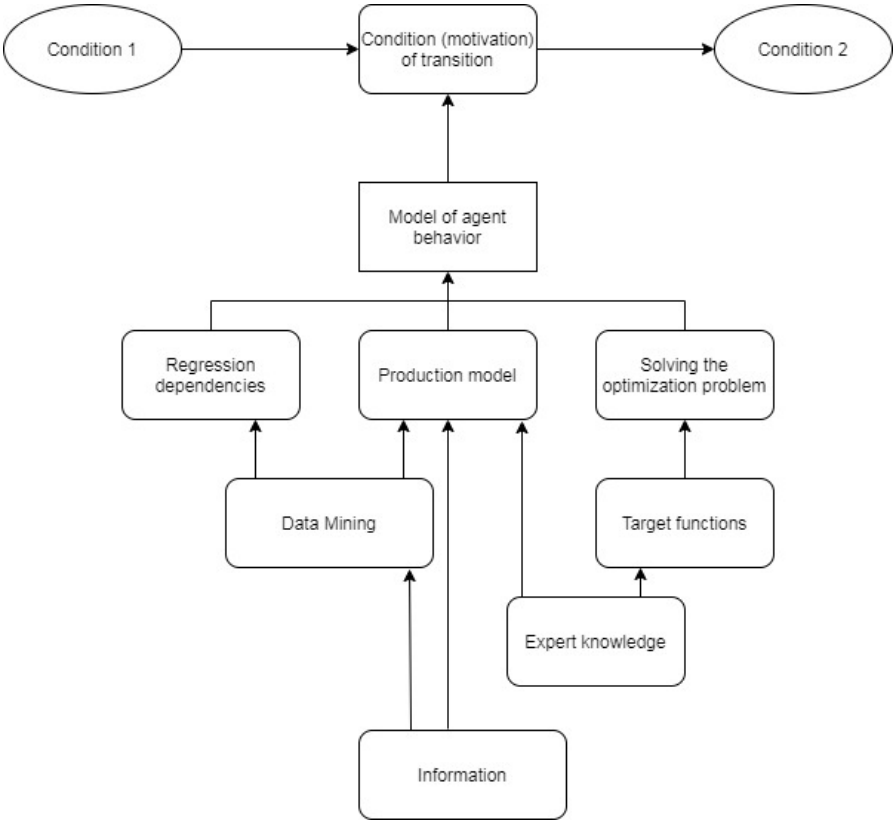

Figure 2: Model of agent behavior.

Investigating the change in the dynamics of enhancing the motivation of agents can be exemplified by the model of enhancing external motivation (figure 3). The first step in building the model will be to determine the criteria and conditions under which the experiment will be started. We will consider a comparatively small educational institution of 5000 people. To implement the model, each student will be an agent. Because it is determined that contingent rewards are new, no one will ever be interested in and will not use them from the very beginning, interest in students may be influenced by advertising. After that, the number of interested people will also be affected by the natural increase that will occur due to the fact that students who have already received awards will share information about them with their acquaintances. The latter will be added to the model indicators that can adversely affect the performance of the system, since they will change the conditions of external motivation in the model under consideration. Using the model implemented in the AnyLogic Cloud software environment [31] (web service for applying simulation operationally) it is possible to determine students' efforts to get rewards (the transition of agents from state 1 to state 2) (figure 3).

Thus, the detected regression dependencies can be used to build models of system dynamics (used in cases where it is impossible to take into account all external factors that affect the behavior of a group of people in modeling the behavior of each person separately). Using the

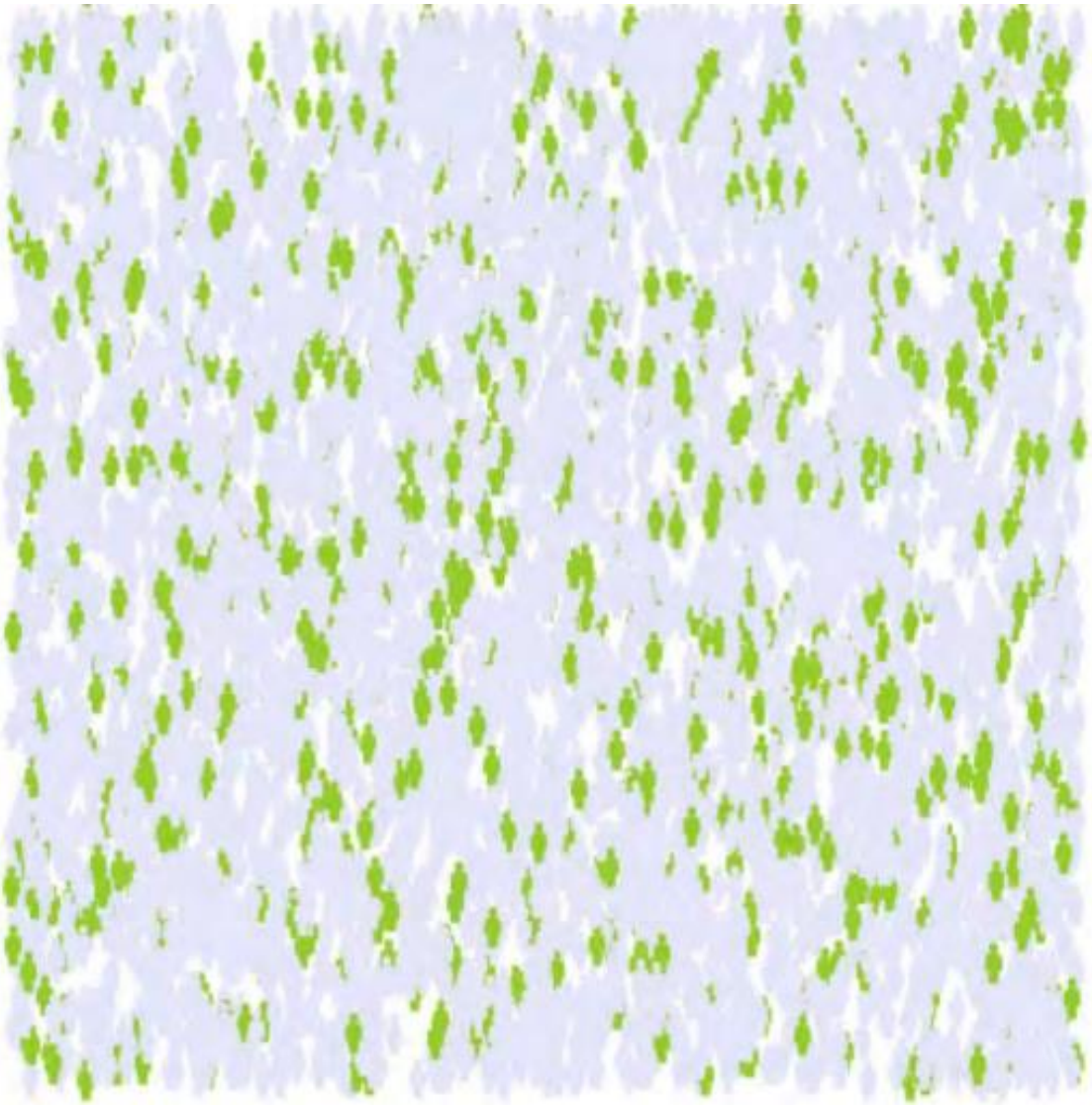

Figure 3: Transition of agents.

knowledge base of agents enables the construction of local models that determine the logic of behavior at the individual agent level.

This approach is based on the assumption that agents who have the same sets of characteristics under the same conditions behave similarly (the likelihood of a positive decision on an issue changes with the change in the characteristics of the agent). These approaches can be used in the presence of a sufficient amount of statistics and the ability to distinguish stable relationships between impact factors and outcomes. When modeling conditions that have not previously been encountered (such as crises), it is appropriate to use target functions to determine the behavior of agents that determine the behavior of model objects in different situations.

Changing the parameters will reflect the growth of agents of one or another category as a graph. As a result, the diagram (figure 4) will show the approximate result that can be expected after the model is started.

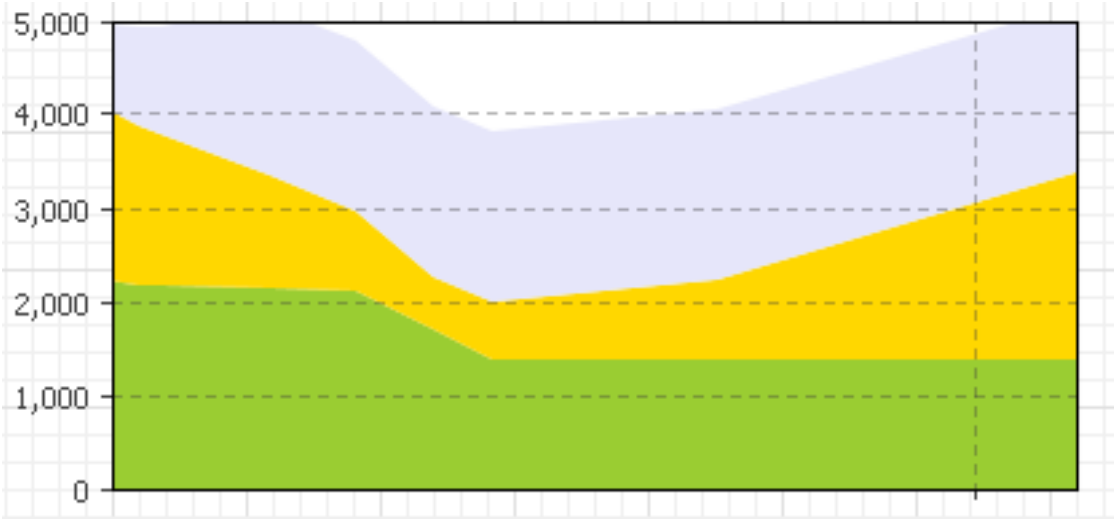

Figure 4: Changing the number of interested agents.

There is a significant group of agents who receive rewards from extrinsic motivation, further some of them are interested and even fewer are completely uninterested. To test the work, you must run the model and follow its execution. The number of interested agents is constantly growing and does not exceed the number of agents who have already received rewards (on most of the schedule). In a certain area (figure 5), agents also successfully switch from one state to another, which is also accompanied by a change in color.

This indicates that the model successfully reflects the processes that occur when students are externally motivated.

3. Conclusion

Motivation plays a key role in the learning process [25]. The effectiveness of learning motivation depends largely on the values that are important to a particular individual [32]. Personal values are directly related to internal or external type of motivation. It is advisable to use agent modeling information technology to quickly track and respond to changes in learning. The detected regression dependencies can be used to build models of system dynamics (used in cases where it is impossible to take into account all external factors that affect the behavior of a group of people in modeling the behavior of each person separately). This approach is based on the assumption that agents who have the same sets of characteristics under the same conditions behave similarly (the likelihood of a positive decision on an issue changes with the change in the characteristics of the agent). These approaches can be used in the presence of a sufficient amount of statistics and the ability to distinguish stable relationships between impact

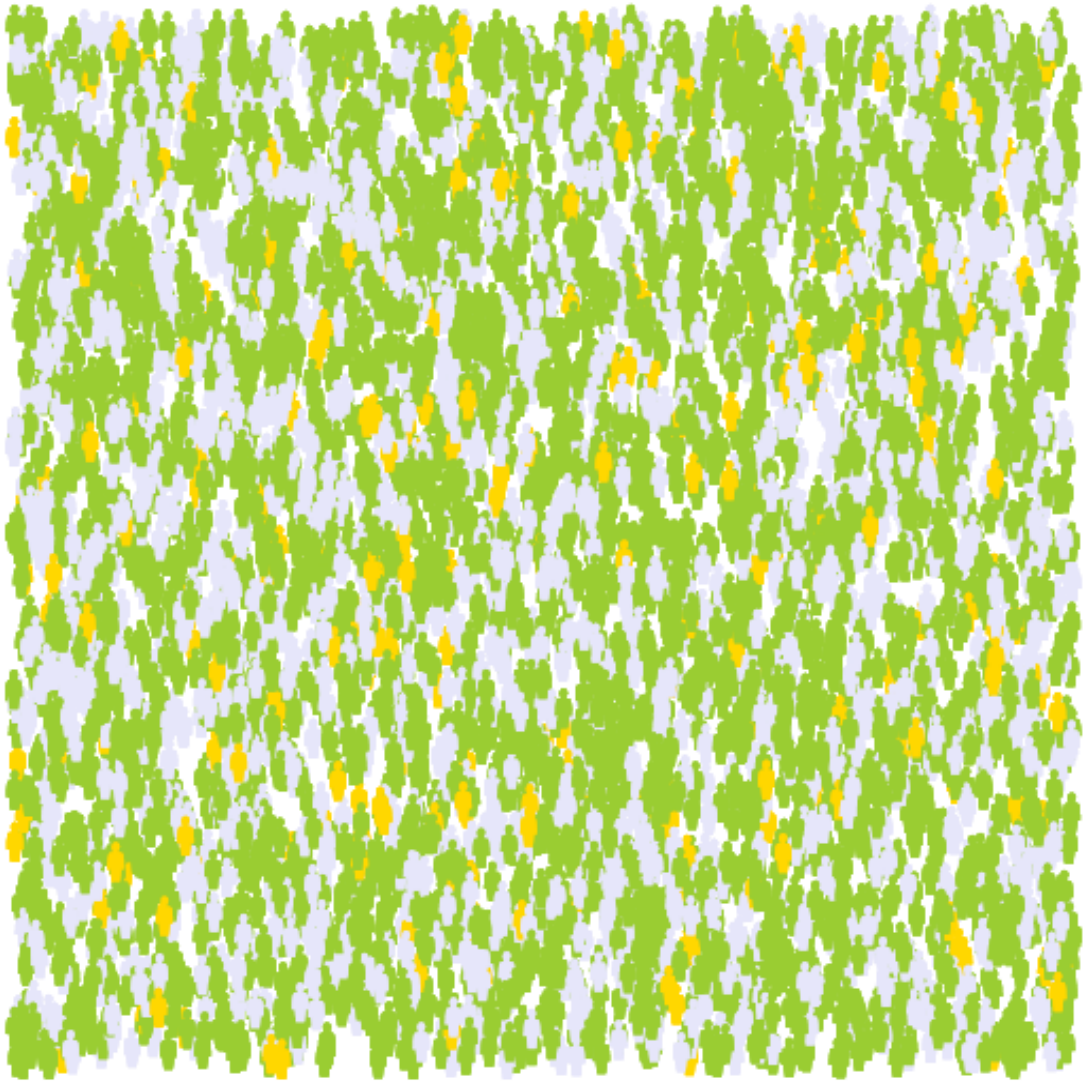

Figure 5: Visualization of agent state transition.

factors and outcomes. When modeling conditions that have not previously been encountered (such as crises), it is appropriate to use target functions to determine the behavior of agents that determine the behavior of model objects in different situations.

Using the knowledge base of agents enables the construction of local models that determine the logic of behavior at the individual agent level. Investigating the change in the dynamics of enhancing the motivation of agents can be exemplified by the model of enhancing external motivation. Using the model implemented in the AnyLogic Cloud software environment it is possible to determine the stransition of agents from completely uninterested to receive rewards from extrinsic motivation. The implementation of an agent model of enhancing external

motivation as an element of learning about student motivation provides a significant level of growth for the group of students who receive rewards from external motivation. Involving information technology to agent modeling provides an opportunity to track the conditions when the motivation will be strengthened or weakened.

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