Horizonti menadžmenta 2021,I(1), 93-108

UDK: 37.091.39:004
005.336:[37.018.43:004

Prethodno saopštenje
Rad je primljen/ Received: 17.09.2021;
Prihvaćen/ Accepted:: 19.11.2021.

PROGRESSION MODEL IN ADAPTIVE E-LEARNING SYSTEM BASED ON LEARNING OUTCOMES

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Abstract: *This paper presents one of possible progression models in adaptive e-learning system, based on learning outcomes.*

Key Words: *e-learning, adaptive, progress, learning outcomes.*

1. INTRODUCTION

In most cases of human learning, especially in cases of learning complex actions, there is rarely a level that could not be overcome. The results achieved in those cases are always more or less relative.

Above all they depend on numerous motivation factors and on the personal traits of the learner: needs and demands, set tasks, the size of the award, social acknowledgment, ambition and other personal motives, on the individual inertion, on his/her perseverance, on the level of aspiration, on his/her satisfaction with the achieved, or contrary, on the constant dissatisfaction with the results achieved. On the other hand, the level of the success achieved depends on the number of repetition or the amount of practice, as well as on the methods used.

According to Bloom's Taxonomy [1], the observed learning outcome is the main starting point in defining the measures which

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will be used to rank the acceptable success level using grades from 6 to 10 (educational standard).

The learning outcomes lead to the following:

- Shifting from teaching to learning and assessment.
- Internal evaluation and curriculum development.
- A necessary precondition for external evaluation.
- A framework for quality, standards and integrated higher education.

The advantages of applying the learning outcomes are the following:

- It helps candidates understand what is expected of them and makes the process of learning easier; it enables a candidate to see his /her own progress;
- It helps teachers define what candidates have to know (to perform) after a considerable period of time, and which they previously were not able to do; it redirects and shifts the teachers' attention from the content to the candidate;
- It informs candidates about the skills and competences gained during the learning process and makes it easier to identify and distinguish among different curricula.

The disadvantages are the following:

- The learning outcomes may limit the learning itself if they are too narrowly defined ;
- It is easier to measure the learning outcomes at lower levels; therefore, their application may lead to content reduction within the program.
- There is a risk of neglecting some of the learning aspects: the importance of affective components, portable skills, contextualization, etc.

2. EVALUATION OF THE LEARNING EFFECTS

The efects of practice during lerning can be evaluated in several ways. We can evaluate:

1) Actions or the material obtained,
2) Accuracy of actions and material obtained and
3) The time needed for the actions or the material to be obtained.

1) Evaluation of progress on different practice levels based on the actions and material obtained is carried out by evaluating how much material has been obtained or, for example, how many movements we can make for a certain time unit.

2) Progress in terms of accuracy is measured by the number of mistakes we make at different levels of learning, when we do an action or presents the material learnt. The fewer number of mistakes after a greater number of repetitions means a better learning progress.

3) Progress in learning can also be measured by time and speed. We can either measure in what time, at what speed, we can solve the complete task at different levels of practice, or determine the time needed to acquire a certain unit after a certain number of repeating. In that way, a constant reduction of time necessary to perform an action or a movement in the learning process is considered progress.

The efficiency of learning outcomes presents a key element, or evaluation instrument. It is necessary to define the equivalent of the learning outcome and convenient evaluation instruments, so that evaluation instruments can adequately determine knowledge or a skill.

Precisely defined learning outcomes present very important information for a candidate on the evaluation criteria, that is, on the level of acquiring knowledge, and are also one of the important motivators for gaining knowledge. During the knowledge evaluation process, we determine whether the candidates have achieved cognitive learning outcomes. In most cases, evaluation is done by testing, that is by systematic instruments used to determine the amount of acquired knowledge for a candidate.

3. EVALUATION TECHNIQUES

The ways of evaluating used to define, that is determine the knowledge of a candidate can be divided in two groups:

- objective evaluation techniques and
- subjective evaluation techniques.

In this way, we can define knowledge tests that are known as objective tests. A candidate's answer is compared with the offered answers (correct answers from the key). In this way, a teacher does not have to use his own estimation or personal opinion to determine if the answer of a candidate was correct or not, and to what extent it was correct.

The following ways of evaluating belong to objective ways, or techniques of evaluation:

- multiple choice tests,
- matching tests,
- completion tests,
- double choice tests.

Other ways of evaluating belong to subjective ways of evaluation, since the teachers use their own estimation or personal opinion for evaluation.

The development of modular teaching programmes in education has to answer a large number of questions:

- Is the candidate's answer a correct one?
- Is the answer partly correct?
- If a correct answer is 20 points, how many points should we give for a partly correct answer?

Techniques that belong to subjective ways of estimation are:

- an essay,
- speaking presentation.

Providing answers based on the candidate's memory provides another important difference between these evaluation methods.

In subjective evaluation ways, a candidate is asked to provide the answer based on his/her memory. In objective evaluation ways, only one kind of tests uses memory for providing answers-completion tests. In these tests, a candidate is asked to provide the answer based on his/her memory by completing a gap or giving a short answer (a number, a word, a symbol or a phrase).

Matching, double choice and multiple choice tests are techniques where candidates choose the correct answer based on many offered answers.

These evaluation techniques test the competence of a candidate to recognize the correct information, to test the competence of a candidate to remember the correct information in completion techniques, and, in some cases, to interpret, apply, analyze, unify or estimate the given information.

Contrary to the teachers in classical education, teachers in e-leaning system have different challenges ad tasks in order to manage to evaluate their candidates. First, teachers no longer have a traditional classroom, relatively homogenous user group, "face to face" contact during a class, etc.

On the other hand, it is necessary to acknowledge individual characteristics of candidates and adapt courses and examination methods so that each candidate can achieve a desired outcome that he/she is aspiring to.

This approach demands that the existing systems for electronic learning be enriched with a mechanism that would make it possible for the candidates to achieve the desired outcomes as fast as possible, according to their individual abilities, in correlation to their ambitions and projected time.

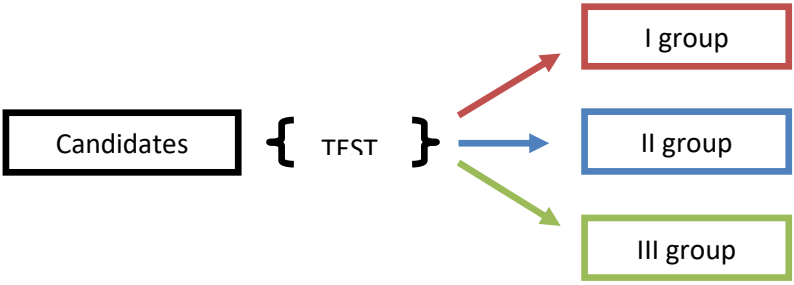
Certainly, this system and its "decisions" are not obligatory for a candidate, that is, a candidate can choose his/her own progression way.

A system projected in this manner can be improved, based on the evaluation results, in terms of greater personalization of users' modules.

In my opinion, the adaptive system that I have been developing presents a good base for further research and its improvement.

This system will be a learning model directed on the candidate, where a candidate is not a passive receiver of information, but will actively participate in searching for information and contribute to further system development. (Pic. 1).

Picture 1. *From traditional to directed*



4. THE AIM OF THE SYSTEM DEVELOPMENT

The development of the adaptive system for electronic learning should make it possible for teachers to estimate the candidate's acquired knowledge in an easier way, and make it possible for the candidate to achieve the desired result depending on their individual characteristics, that is to adopt the knowledge required by the course in an easier and faster manner, directing him to the model of advancement that best suits his previously estimated knowledge.

The adaptive system should, depending on the "desired level" and real knowledge of the candidate (estimated by testing), recommend further way of advancement (learning).

General presumptions:

- "The system" wants the candidate to acquire the greatest level possible of knowledge, taking into account the time necessary for the preparation of an exam.
- If the candidate has a sufficient number of points (on the test), the system recommends further course of studying. The candidate chooses on his own, the system only recommends.
- "The system" reacts only when the candidate has a low number of points (cumulatively) and directs the candidate to more complex material for the field to be tested (time planned for acquiring the field should be included here).

The aim is to achieve the best results for the time planned. The candidates that make progress in keeping with this aim, the system

tries to direct to a higher level (compromised course) with the rationalisation of time. On the other hand, less ambitious candidates are directed by the system to reaching the desired level of knowledge in planned time. With the knowledge thus limited, between the ambitious (those who want the highest grade) and non-ambitious (who are satisfied with the passing mark), it is necessary to define levels of progress for other candidates, according to the already defined desired learning outcomes.

5. PROGRESS MODELS

According to the defined desired learning outcomes:

- Level 1 - meets the minimum criteria
- Level 2 - generally good, but with significant drawbacks
- Level 3 - average with noticeable mistakes
- Level 4 - above the average, with some mistakes
- Level 5 - excellent success with minor mistakes

It is, therefore, logically to conclude that it is necessary to design five levels/models of progress. However, there is a question if there should be exactly the same number of progress models or is it possible to sublime thus defined learning outcomes to a fewer number of progress models.

Here we should take into account the time spent on achieving the desired level of knowledge, which allows us to define the system with fewer number of progress models, for example 3, since it is not the same to achieve something in "shorter" time, "longer" time or in "real" (estimated) time. Having in mind this time dimension for the reaching of a knowledge level, makes it possible for us to create a system with fewer number of progress levels, but in correlation with the time component.

To rang the candidates into adequate modules (progress levels), it is necessary to carry out their testing. Testing can be done in two different ways:

- Knowledge test on the field of the course to be attended with additional questions concerning the candidate's ambitions and their perception of the desired learning outcomes

- Intelligence test

Taking into account these two possibilities, we have concluded that it would be more practical to carry out the knowledge testing on the field covered by the course which allows us to correlate and estimate the present knowledge of the candidate and his ambitiousness, success in dealing with the problems and the possibility to really notice individual differences among candidates.

Namely, if a candidate has "great" (or "solid") previous knowledge, he will get compromised materials for studying, and it is also possible to shorten the time needed for a certain unit, since such a candidate will be able to achieve greater level of knowledge in shorter time.

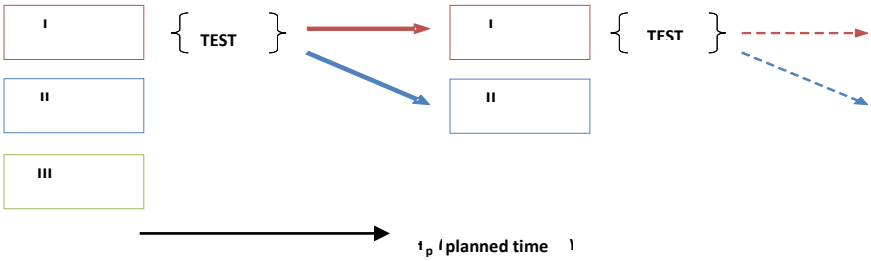
On the other hand, the candidates with less previous knowledge should be given more material, with the help of which they could catch up for their lack of knowledge in relation to their projected outcomes.

Testing was done by writing testing, by To test (knowledge test) and TA test (ambitiousness test) which are presented as well as their results in attachment 2.

According to the testing results, it is noticed that we can divide the candidates into three groups (Picture 2.):

- First – the candidates that aim to higher average grade (9 and 10)
- Second – the candidates that acquire average knowledge and are difficult to be graded by marks. Those are the candidates whose average testing marks were between 6 and 9. (7 and 8)
- Third – the candidates whose sole aim is to achieve a passing mark. (6)

Picture 2. *Placing candidates into progress levels (I group)*



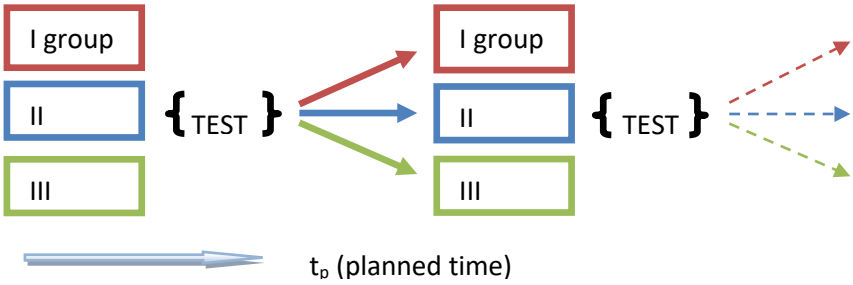
Tested candidates, placed according to projected progress levels, are enrolled at the prepared course from the subject Information technologies, on the platform for electronic studying of the Management Faculty in Zajecar, where their progress was observed.

Leaning material that was presented to the candidates meets all the modern requirements in terms of scope, structure and the way of presenting.

The first group of candidates was presented the reduced learning materials, with the recommendation of additional literature for individual research that they successfully mastered and achieved desired results in the planned time interval.

Checking their knowledge (by testing) we concluded that a certain number of the candidates from this group does not achieve the desired level of knowledge for the time planned. These candidates were recommended to "correct" their ambitiousness and to join the second group ("getting down" for a level) and to continue in the pace of the new group (Picture 3.).

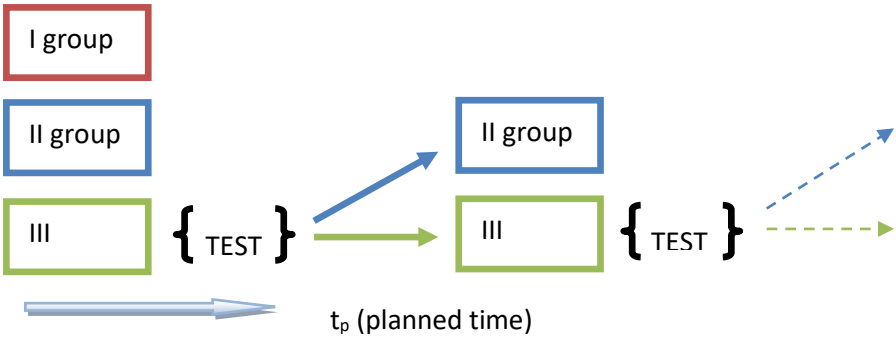
Picture 3. *Testing the candidates after each logical sublevel (II group)*



The second group of candidates was presented by the extended learning material that the candidates mastered in the set time interval. After knowledge check, it was noticed that some candidates master the material in a shorter time than planned. These candidates were directed to the first group ("rising" higher for a level) and continued with their further work. However, there were candidates of this group

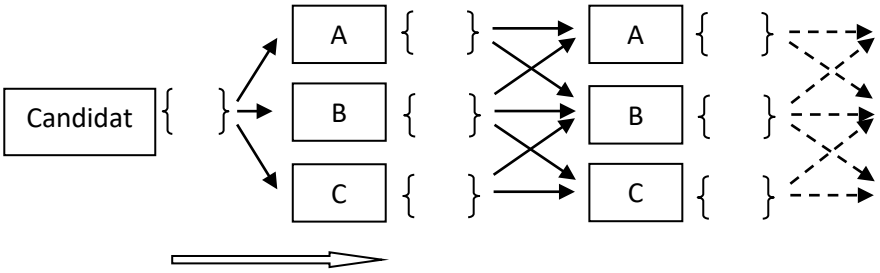
that did not reach the desired level in the time set. These candidates were recommended to join the third group ("getting down" for a level) and to continue at the pace of the new group (Picture 4.).

Picture 4. *Testing the candidates after every logical sublevel (III group)*



The third group of candidates was presented by the extended learning material with additional clarification of certain terms since they had shown slower acquisition of learning material in the significantly longer period. After their check of knowledge, it was seen that some candidates master the material in the period shorter than planned. These candidates were joined to the second group ("rising" higher for a level) and continued with their further work (Picture 5.).

Picture 5. *Scheme of the adaptive model*



6. PROGRESS MODEL

This is the reason why I have suggested three progress levels that will allow me to mark the candidates objectively according to the adopted learning outcomes in correlation with the time set for mastering the material.

It should be mentioned that, during the candidates testing, we have combined the tests with multiple answers, essay tests and seminars. The candidates were also allowed to participate in different discussion groups that were, apart from the course creator, created by the candidates themselves.

This is why we suggest the progress levels be defined as:

A: comprised level

B: standard level

C: extended level

Comprised level (A) is the progress direction of the candidates who aim towards highest grade (the ambitious ones). This level includes achieving the desired learning outcomes in shortest time.

The extended level(C) is the progress direction of a candidate towards reaching the minimum knowledge (passing mark) in the set time. (the non-ambitious ones).

Standard level (B) includes all the other candidates.For every level we have defined a number of possible points at knowledge checks (tests) that are same for every module, but achieved in different time.

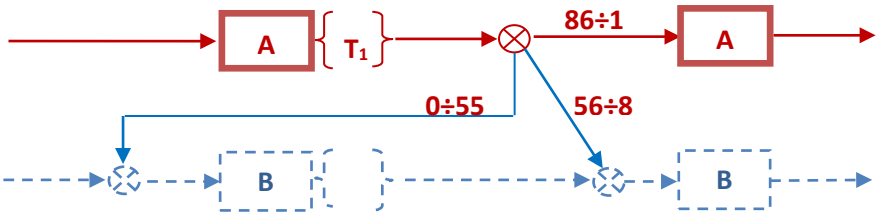
Of course, the candidates who meet neither of the criteria of progress level (reaching the desired level of knowledge in set time) are the candidates whose level of achieved knowledge does not go for the passing mark. These candidates have to make additional efforts to acquire the planned material and acquire knowledge satisfactory for the passing mark.

After each teaching unit of the course (logical sublevels that are yet to be defined) candidates do tests to estimate their knowledge and based on the results, the "system" places them in one of the categories defined (A,B or C) and "suggests" further progress level to the candidate. Marking the tests is numerical, according to Bologna:

5 – nonsatisfactory (0 – 55 points)
6 – satisfactory (56 – 65 points)
7 – good (66 – 75 points)
8 – verygood(76 – 85 points)
9 – excellent (86 – 95 points)
10 – excellent-extraordinary (96 – 100 points)
According to the following criteria:
A – 86 to 100 points (marks 9 and 10)
B – 66 to 85 points (marks 7 and 8)
C – 56 to 65 points (mark 6)

It should be noted that a greater number of progress models provides greater personalization of learning, and thus greater involvement of the course creators on defining the scope and kinds of teaching content for every level (Picture 6.).

Picture 6. *Monitoring the progress of the group A candidates*



However, there is a question what happens if the candidate does not meet the minimum knowledge after the first testing (T1), that is, does not reach the satisfactory knowledge level (0 to 55 points).

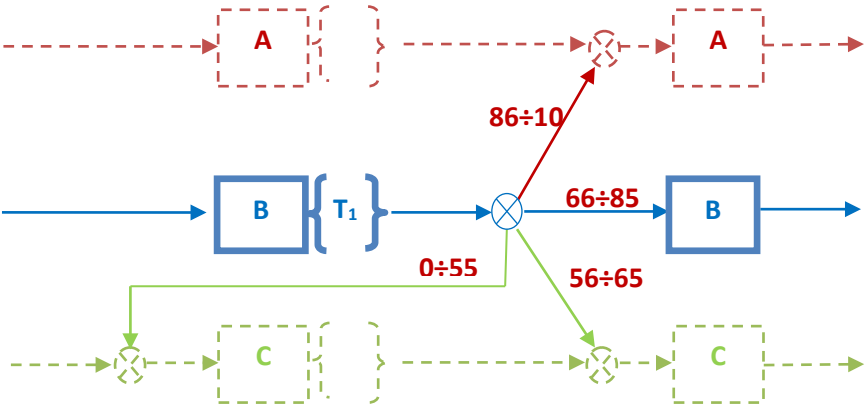
In that case it is necessary to redesign previous progress level.

According to the progress levels we would get the following models:

For the A progress level, the candidates do determining test T1 and after summing the results we can notice three possibilities:

1. The candidate had 86 to 100 points, and based on that the system suggests further progress way according to A level of progress.
2. The candidate had 56 to 85 points, and based on that the system suggests to go for a level down (B level), but to continue with the overcoming of the next unit since he showed satisfactory knowledge.
3. The candidate had 0 to 55 points, and based on that the system suggests to get for a level down (B level), but to revise the unit for which he did not show satisfactory knowledge (Picture 7.).

Picture 7. *Monitoring the progress of the group B candidates*



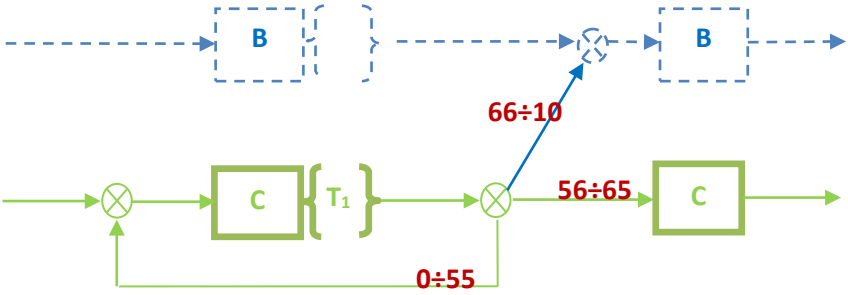
For B progress level, the candidates do the determining test T1 and after summing the test results we can see four possibilities:

1. The candidate had 86 to 100 points, and based on that the system suggests him to go up for a level (A level) and to continue with mastering the next unit, since he showed knowledge that satisfies higher progress level.
2. The candidate had 66 to 85 points, and based on that the system suggests him further progress course on B progress level.
3. The candidate had 56 to 5 points, and based on that the system suggests him to go down for a level (C level), but to

continue with mastering the next unit, since he showed satisfactory knowledge.

4. The candidate had 0 to 55 points, and based on that the system suggests him to go down for a level (C level), but to revise the unit that he did not show satisfactory knowledge at. (Picture 8.).

Picture 8. *Monitoring the progress of the group C candidates*



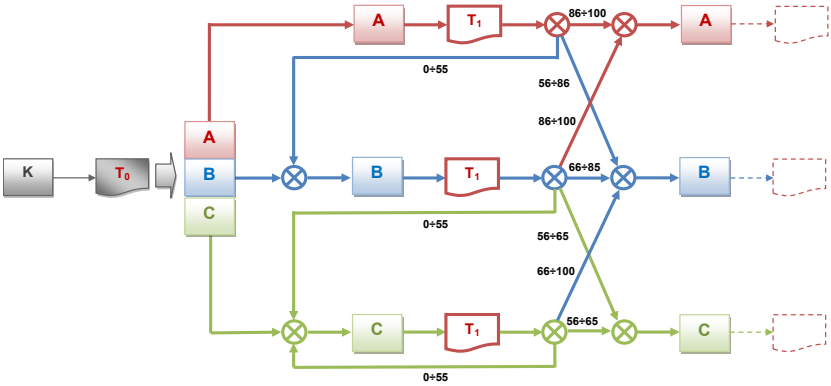
For C progress level, the candidates do determining test T1 and after summing the test results we can notice three possibilities:

1. The candidate had 66 to 100 points, and based on that the system suggests him to go up for a level (B level) and to continue with mastering the next unit, since he showed satisfactory knowledge for the higher progress level.

2. The candidate had 56 to 65 points, and based on that the system suggests further course of progress according to C progress level.

3. The had 0 to 55 points, and based on that the system suggests him to stay at the same level (C level), since that is the lowest level, but also to revise the unit for which he failed the test. (Picture 9.).

Picture 9. *Synthesis of analysed progress levels*



K – Candidates; t_i – time for studying; A - 86 to 100 points (marks 9 and 10) ; B - 66 to 85 points (marks 7 and 8); C - 56 to 65 points (mark 6); T_0 – determining test; T_i – knowledge tests (i = 1...n)

7. CONCLUSION

Progression models in adaptive e-learning system, based on learning outcomes is possible.

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MODEL NAPREDOVANJA U SISTEMU ADAPTIVNOG E-UČENJA ZASNOVANO NA ISHODI UČENJA

Apstrakt: Ovaj rad predstavlja jedan od mogućih modela napredovanja u adaptivnom sistemu e-učenja, zasnovan na ishodima učenja.

Ključne reči: e-učenje, adaptivno, napredak, ishodi učenja.

Kako citirati ovaj članak/how to cite this article:

Ivanov, S. (2021) Progression model in adaptive e-learning system based on learning outcomes. *Horizonti menadžmenta*. I (1), 93-108