

**Providing the Leadership in Education by Online Gamification-based Teaching Methods Utilization  
(COVID-19 Quarantine Brief Lessons Based on Phenomenological Analysis)**

**Abstract**

State of art tools of students' motivation enhancement being commonly used in higher education are treated in completely new way being considered as component of teacher's new role in contemporary educational environment governed by distributed knowledge networking. The core hypothesis presented in the paper is that online gamification-based teaching methods positive motivational impact on students can be rightfully explained by the fact that such an approach is charging the habitual contemporary students' communication environment with an educational value pushing them to the limits of intellectual competition. New exceptional role played by teacher in the HSE is identified as a facilitator using the potential of new educational trends for challenging students rather than guide and instruct them. Teachers' motivation to implement the online gamification-based teaching methods is also examined on the basis of Herzberg and Maslow theory with different factors put in form of motivational matrix. The effects of COVID-19 quarantine on teachers' motivation is explored. Corresponding phenomenological models presented based on Heaviside function and the Weber-Fechner psychophysical law. Deviators preventing teachers to use advanced educational approaches are also treated.

Distributed knowledge networking which dictate the contemporary educational environment development is represented by well-known logistical curve governing the process of new information propagation. Modeling the teaching process with respect to the new motivation incentives was done utilizing two most frequently used learning curve representations. Different modes of knowledge acquisition process were analyzed. On the basis of computational model, it was proved that gamification is unveiling the potential of contemporary educational environment. Main conclusion made that in case of gamification implementation the students not only exceptionally fast in knowledge acquisition but also demonstrate the ability of new knowledge creation. But at the same time, it was proven that the gamification alone could not provide students with enough level of motivation and should be accompanied with other incentives for the students.

Keywords: Gamification, Social networking type communication, Motivation in educational process, ICT impact on education efficiency, ICT-aided facilitation.

**Introduction.** Contemporary level of networking and communications technologies are shaping the educational environment in such a way that students are easily provided with huge volumes of information on all thinkable subjects. As a consequence, students belonging to Generation Z are totally disinterested in just getting new knowledge at schools or universities. Apparently, they need to be motivated to study, entertained during the teaching process, presented with challenge; they seek for being appraised by competitive rating. In this instance let's refer to British NSS (National Student Survey) questions. Being asked to assess the teaching process quality students should answer numerous questions some of which are formulated as follows:

- "The course has provided me with opportunities to explore ideas or concepts in depth
- I have had the right opportunities to work with other students as part of my course
- The course has stimulated my interest in the field of study.
- The course has stimulated my enthusiasm for further learning.
- The course is intellectually stimulating" (Office for Students, 2018, pp. 1-2).

It is obvious that one of the most advanced educational systems of the world is preoccupied with issues of students' motivation and enthusiasm at learning. Otherwise when they are not adequately involved one could not even think about quality of teaching process organization.

Gamification is believed to be one of the most powerful tools for increasing students' motivation in the new digital era. Most researchers agree on such a situation being most specific to the higher education. That could be explained by the fact that the social networking is habitual environment to the students who belong to the Generation Z and they are amused being provided with the opportunity to interact and compete in a virtual setting that gamification offers receiving virtual recognition and rewards for mastering new skills, that are supported not only by the authority of the teacher (instructor), but also by the opinion of comrades (other social network agents). Moreover, perceived utility of skills/knowledge they get as a result is also

dependent of reputation among “network agents” e.g. group members involved into gamification process. Respectively, the teacher, who traditionally has been an ultimate source of knowledge, turns into a recognized referee – e.g. source of opinions, values and judgments, which are adopted (or not) by the community participants. COVID-19 quarantine has obvious influence both on teachers and students due to sudden shift to online teaching which is altering motivation and needs to be explored in hot pursuit.

**Problem statement and hypothesis.** Quarantine or not but if the teacher can play the role mentioned above, then the teaching process gets a significant boost in terms of efficiency. Moreover, the teacher should become a facilitator in the virtual environment which is very important for Generation Z. According to (Wikipedia, 2018) “facilitation is the professional organization of the group work process, aimed at clarifying and achieving the group’s goals.” A specific of virtual facilitation is that theoretically it should lead to synergetic effect of social networking and psychological factors related to classical facilitation organized in the classroom. Coming weeks of quarantine give opportunity to check whether it is true.

It should be noted that the academic group has at least two features distinguishing it from the «classical» social network – non-anonymity and limited size. These features are quite interesting from the mathematical modeling point of view and related assumptions will be formulated in the corresponding section. But of course, distant mode of learning is influencing specifics mentioned and is adding more similarity to «classical» social network due to physical isolation of the students.

Core hypothesis being dealt in the paper is that motivational impact of gamification can be explained by the fact that gamification of the teaching process charges the habitual social networking environment of the contemporary students with educational workload resulting in the involvement increase.

It should be also noted that the right now after several weeks of the widespread adoption efficiency of distant learning is considerably smaller compared to the theoretical maximum. This could be explained by the fact that the teachers’ motivation to use modern ICT tools in the educational process being lower than the students’ motivation to benefit from the outcome of such work. Similar situation applies to the gamification.

**The scope of research formulation.** Therefore, the following tasks will be resolved:

- building a mathematical model of teachers’ motivation based on most recognized motivation theories;
- building a mathematical model of students’ “gamified community” based on ideas adopted from theory of information and the representation of rivalry in the social networks;
- choosing the proper learning model without regards to the gamification effect;
- estimation of teachers’ motivation limiting impact on gamification efficiency;
- identification of further research directions.

**Modeling the teachers’ motivation in the context of the gamification usage and the shift to distant learning.** It should be noted that not gamification solely but the attractiveness of the global Internet environment which the teacher is using both in the professional activities and in the everyday life is motivating him to implement two main features of Internet teaching:

- asynchrony (the teaching processes’ growing independence from fixed time, scheduling etc.);
- non-locality (independence from position in space).

By the way these two features were heavily explored right now during the shift to distant learning due to the COVID-19 quarantine.

Asynchrony and non-locality may improve the comfort of the teacher’s working conditions and expand performance in time and space, which in turn can lead to an increase of:

- productivity
- and flexibility in providing the educational services.

In the long run that leads to the possibilities increase for self-realization of the teacher’s individuality and ensures his autonomy level and satisfaction rate.

So why the first experience of the nation-wide shift to the distant learning system could be characterized as being controversial? The experience of authors is indicating that the biggest “bottleneck” in implementing of both gamification and distant learning system being an insufficient motivation. The availability of motivated academic teachers is a tremendous question mark for the whole HES. If such teachers do not exist, nothing will come of it right now and in the future.

Let’s examine the teachers’ motivation based on the well-known Maslow (Maslow & Frager, 1987) and Herzberg (Herzberg, Mausner, & Snyderman, 2017) theories.

Being applied to the academic teacher and his attitude regarding gamification, the motivating factors are expected to be the consequences of asynchrony and non-locality of teaching process which result in increasing comfort and labor mobility. At the same time the following aspects could substantially limit teachers' motivation to implement gamification and distant learning:

- *the technical readiness of the teacher*, e.g. availability of Internet-based teaching tools at the teacher disposal (computer, Internet access) – this aspect makes basic influence on the very fact of easy switch to the distant learning mode;
- *the technological readiness of the teacher*, e.g. ability to use the computer and the Internet (general ICT competence) – the same influence on the online added teaching success;
- *the availability of the gamification tools* (specialized platforms in the relevant professional domain, e.g. gamification databases, remote access facilities, etc.) – makes a principal impact on the utilization of gamification;
- *the availability of learning environments* and the corresponding competence of the teacher in the field of electronic pedagogy (e-learning, distant learning).

It should be noted that the last aspect will lose its braking effect on teachers' motivation very shortly with saltatory intensification of distant learning in Ukraine during the COVID-19 quarantine.

The motivational model of the teacher regarding the utilization of distant learning and gamification according to Herzberg theory is given in the Table 1. Each "hygiene" factor should be reinforced by the corresponding teacher's competence. All these competencies are completely new compared with ones needed for the traditional model of teaching process being organized in the classroom.

**Table 1.** The teacher's motivational matrix in the context of gamification, built based on the Herzberg theory

Hygienic	Appropriate competence of the teacher	Motivational
Technical readiness	General ICT competence	Demand for improving the comfort of work
Technological readiness	General ICT competence	Demand for increasing mobility
Subject-object readiness	Professional ICT competence	Demand for increasing labor productivity
Methodical and didactic readiness	Pedagogical ICT competence	Demand for increasing labor flexibility

Thus, the task of ensuring the teaching process modernization by implementing the distant learning and gamification is unconditionally depending on "hygiene" factors. These factors should form teacher's attitude towards the distant learning and gamification being at least neutral. Only after that one can expect the higher motivational factors come into the play.

According to (Timkin, 2007), the following groups of the teacher's competence in the field of ICT can be distinguished:

- *General technical and technological competence* (mastering the modern information and telecommunication technologies defined by the technical requirements of the teaching process organization);
- *Technological communicative competence* (mastering the modern software developed to organize interaction between the teacher and the students);
- *Competence in the field of teaching aids creation* (mastering the software developed to create online teaching materials);
- *Organizational competence* (mastering the basics of the online educational process management, managing the flows of students and streams of teaching materials, creating individual learning trajectories).

The experience already accumulated during COVID-19 quarantine is indicating that two last groups of mentioned teacher's competences are most difficult to possess. Even more, majority of teachers found it being kind of cultural shock being put in front of computer screen to teach remotely.

Considering the main hypothesis of this research it should be noted that reason exists to progress from investigating the technical specifics of the ICT application in the teaching process to the exploration of humanitarian aspects, which according to (Parshukova & Bovtenko, 2005) include:

- Creation and maintaining the virtual communities,
- Psychology of network users' communication,
- Collective activity in the network,
- Critical thinking in processing the information and,
- Synchronous and asynchronous training.

But obviously right now we do not yet possess enough empirical information to analyze these aspects in context of transition to distant learning in March-April 2020. Besides corresponding mathematical models are not well developed so such a study was left out of our focus being definitely very important direction for further research.

Returning to the mathematical modelling of the Herzberg theory it is logical to assume (although it is not explicitly indicated in the Herzberg model definition) that any teacher has a certain intrinsic level of motivation, essentially due to the fact that the teacher needs a job as a basic source of income. Especially now during quarantine and having the economic crisis expected in the nearest future it is quite improbable that a teacher could find another working place and/or other occupation. Thus, the teacher has some basic motivation in doing a job and carrying out the responsibilities assigned to it. Let denote this level of motivation as  $M_b$ . The total level of teacher motivation in this case will be determined by the impact of hygiene factors and incentives (see Table 1).

Let's also introduce the following notation:

- $S_i$  – motivational factors (incentives) of the  $i$ -th group;
- $SL_i$  – the maximum level of incentives of the  $i$ -th group (if the actual value of the incentives of this group exceeds this limit level, then the motivation of the teacher will increase);
- $n$  – is the number of incentives' groups ( $n=3$  in our case);
- $H_j$  – hygienic factors of the  $j$ -th group;
- $HL_j$  – the limiting level of hygiene factors of the  $j$ -th group (if the actual value of the hygienic factors of this group is below this limit, the motivation of teacher will decrease);
- $m$  – is the number of groups of hygiene factors ( $m=3$  in our case).

Then the total level of motivation of the teacher  $M$  could be defined using the following formula:

$$M = M_b + \sum_{i=1}^n F_i(S_i - SL_i)\text{Heav}(S_i - SL_i) - \sum_{j=1}^m K_j(H_j - HL_j)\text{Heav}(H_j - HL_j) \quad (1)$$

where the functions  $F_i(S_i - SL_i)$  and  $K_j(HL_j - H_j)$  describe impact of the incentives and hygiene factors deviation from the specified limits on the cumulative teacher motivation, and Heav is a Heaviside function. Of course, the expression (1) is quite formal and the exact form of these functions is unknown. But the most reasonable assumption is that they could obey the Weber-Fechner psychophysical law, see (Mackay, 1963), according to which the sensitivity towards the external impact increases in proportion to the logarithm of this impact magnitude.

In that case, formula (1) takes the following form:

$$M = M_b + \sum_{i=1}^n Z_i \lg\left(\frac{S_i}{SL_i}\right)\text{Heav}(S_i - SL_i) - \sum_{j=1}^m Y_j \lg\left(\frac{H_j}{HL_j}\right)\text{Heav}(H_j - HL_j) \quad (2)$$

where  $Z_i$  and  $Y_j$  are the proportionality coefficients determined on the basis of the empirical data.

Maslow theory which obviously has better "resolution" than Herzberg's can be represented in quite similar way. Let's introduce the following notation:

- $M$  – teacher's motivation;
- $D$  – material income;
- $A_i$  – degree of satisfaction of the  $i^{\text{th}}$  level needs. This indicator characterizes the income of a person which guarantees such a degree of satisfaction of the  $i^{\text{th}}$  level needs, that for  $D > A_i$  the needs of  $(i+1)^{\text{th}}$  level begin to influence the motivation of the person. At the same time, the  $i^{\text{th}}$  level needs continue to influence the person's motivation;
- $B_i$  – level of saturation of the  $i^{\text{th}}$  level needs. This value is equal to the income at which a person has reached full satisfaction of the  $i^{\text{th}}$  level needs and therefore these needs cease to affect motivation;

- $M_i$  – the contribution of the  $i^{\text{th}}$  level needs to the aggregate motivation. It indicates how the aggregate motivation depends on the  $i^{\text{th}}$  level needs (or, being more precious, how the aggregate motivation depends on the degree of satisfaction of these needs).

It is logical to assume that the  $M_i$  is maximal, when the teacher just begins to satisfy the needs of  $i^{\text{th}}$  level (in accordance with our notation, when  $D$  is equal to or slightly higher than  $A_{i-1}$ ). According to the law of diminished marginal utility the marginal utility of each successive unit of the good  $M_i$  decreases with the income increase. Consequently, the dissatisfaction level of these needs decreases and therefore these needs influence on aggregate motivation will be lesser.

In accordance with the abovementioned qualitative considerations, it seems reasonable to represent  $M_i$  as an exponential function of  $D$ ,  $A_i$  and  $B_i$ :

$$M_i = C_i e^{\frac{D-A_{i-1}}{B_i-D}}, \quad (3)$$

where  $C_i$  is a constant for the  $i^{\text{th}}$  level needs.

To be exact, formula (3) by no means is either rigorous or based by the results of direct empirical studies, vice versa it is built from qualitative considerations and therefore needs an additional verification. It could be, for example, that  $C_i$  is not a constant, but a function.

It is easy to see that formula (3) is lacking any economic meaning for  $D < A_{i-1}$  (in such a case  $M_i=C_i$ ) and  $D > B_i$  (in such a case  $M_i \rightarrow \infty$ ). However, it should be converted to a form in which:

1. it should have economic meaning for any values of  $D$ ;
2. it should consider the stair-step-like nature of the Maslow model – i.e. spontaneous “inclusion” of the needs of the higher level in the aggregate motivation in case when the corresponding amount of income  $D$  is reached.

Thus, the contribution of the  $i^{\text{th}}$  level needs to the aggregate motivation can be described by the following formula:

$$M_i = C_i e^{\frac{D-A_{i-1}}{B_i-D}} \text{Heav}(D - A_{i-1})\text{Heav}(B_i - D) \quad (4)$$

$$M_i = \sum_{i=1}^5 C_i e^{\frac{D-A_{i-1}}{B_i-D}} \text{Heav}(D - A_{i-1})\text{Heav}(B_i - D) \quad (6)$$

For all their cumbersomeness, both expressions (4) and (5) do correspond to the both requirements formulated above.

**Modeling of the Distant Learning in the (Social) Networking Environment.** When modeling the crucial features of the social networks such as the mutual influence of their members, the dynamics of their opinions, etc., from the point of view of the current research it becomes necessary to take into account the effects these factors unveil with respect to the distant learning. In general, see (Gubanov, Novikov & Chxartishvili, 2010) social networks can have the following effects, conditioned both by the specifics of the network agents, the very nature of their interaction, and the properties of the social network itself:

1. the differentiation of agents’ own individual opinions/attitudes/values;
2. fast and frequent opinion changes under the influence of other members of the social network;
3. different significance of the opinions (influence, trust) between different network agents;
4. different degree of susceptibility of agents to the influence (conformism, stability of opinions);
5. indirect influence in the chain of social contacts; decrease of the indirect influence with the increase of chain “distance”;
6. the existence of “opinion leaders” (the agents with maximal influence), a stratification of the impact indices;
7. the sensitivity threshold to the opinions change of the others;
8. the localization of groups with similar opinions;
9. specific social norms of behavior, communication etc.;
10. “social correlation” or “social alignment” (forming the groups of agents who have common roots/attitudes/values/etc.);
11. less significant influence of the factors (and agents) that are external relative to the network;
12. the existence of characteristic stages of the opinions’ dynamics of the social network members (for example, the process of diffusion of innovations);

13. the avalanche effects (cascades of information dissemination or opinions change);
14. the impact of the structural properties of social networks on the opinions dynamics:
  - the more the agent is communicating, the more he has the ability to influence the whole network through his environment, and on the other hand, the greater is his vulnerability to the influence of other people;
  - clustering effect: the higher is the density of ties between the active agents-neighbors, the greater is the probability of a change in the associated agent state);
  - “local interim” – the more intermediate the network agent is, the more is his value in disseminating the opinion/information from one part of the network to another (the role of the information broker), but, at the same time, the smaller is his influence on the neighbor agent;
  - smaller size of the social network causes a shorter chain of the opinion dissemination in the network;
15. purposeful behavior of agents in information/opinion/values dissemination;
16. the possibility of forming a different groups, coalitions;
17. incomplete and/or asymmetric information at the network agents’ side, pushing them to make decisions under conditions of uncertainty;
18. non-trivial mutual awareness (reflexion) of agents;
19. gamified interaction of agents;
20. optimization of information impacts;
21. controlling the information by purposeful management.

As a result, the social networks compared to the set of noninteracting agents, demonstrate qualitatively new property of agents’ behavior related to the opinions dissemination. There are numerous approaches modelling different scenarios of such a dissemination. For sake to meet the goals of current research the model of controlling the information by purposeful management should be utilized. The agent of the social network (in our case – the student in the distant learning system) is receiving some knowledge from the teacher. According the social network concept such knowledge could be defined as the opinions of external agents with whom students are not directly connected. If the students who communicate in the closed network already have their own knowledge/opinion on the subject studied each of them will share the “defect of trust”  $(1 - \alpha - \beta)$  equally between network agents with whom they are directly connected, where  $\alpha$  is probability that the student will preserve his own opinion/attitude and  $\beta$  is probability he will switch to the teacher’s opinion. Distant learning and gamification in such a case are treated as powerful tools to apply control to bring the system from opinion  $x^0$  (initial opinion of students unaffected by the teacher) to the opinion  $x^*$ .

Let’s stress the point that in this case we are speaking just about dissemination of the knowledge/opinion/attitude/values and alike in the social network type environment. Students’ motivation to get this knowledge is similar to the teachers’ and also can be described by Maslow and Herzberg theory (see the corresponding section above). Thus, using gamification, or any other technique to increase students’ motivation we create motivational impulse which is facilitating the teaching process as was described in the introductory section.

According to (Gubanov, Novikov & Chxartishvili, 2010) such model has the following form:

$$x^k = u(1 - (1 - \beta)^k) + x^0(1 - \beta)^k, \quad (7)$$

where  $k=1,2,\dots$  – discrete moments of time and  $u$  – the control applied to the system.

Again, according to (Gubanov, Novikov & Chxartishvili, 2010) the control which should be applied to bring the system from opinion  $x^0$  to the opinion  $x^*$  during the specified time  $t$  can be represented as follows:

$$u(x^*, x^0, t) = \frac{x^* - x^0(1 - \beta)^t}{1 - (1 - \beta)^t}. \quad (8)$$

**Modeling the teaching process with/(out) respect to the motivation.** According to survey (Troiczka, 2015) one can get a whole set of the mathematical models of the teaching process.

There are at least two classical models which do not consider the motivation – logistics curve that describe the iterative teaching process and the statistical approach that is treating the complicated psycho-physiological processes which stand behind the learning.

So according to (Троицкая, 2015) we can pick up two representations of learning curve:

$$x(t) = \frac{x^0 x^*}{x^0 + (x^* - x^0)e^{-\gamma t}} \quad (9)$$

$$x(t) = [x^0 + (x^* - x^0)(1 - e^{-\mu t})]e^{-\gamma t}, \quad (10)$$

where  $x(t)$  is current level of knowledge,  $\gamma$  knowledge forgetting coefficient and  $\mu$  is knowledge perceiving coefficient (we assume  $\mu > 0.7$  to recognize teaching results as being satisfactory).

The knowledge forgetting coefficient is function of time according to Ebbinghaus's forgetting curve (Ebbinghaus, 2013):

$$\gamma(t) = \frac{1.84}{(\lg t)^{1.25} + 1.84}$$

Involvement of motivational processes into analysis will lead us to more complicated models based on ordinary differential equations. The pace of the students' knowledge change in the network-like environments with regards to the effect of motivation, is proposed to describe by a logistic equation of the form:

$$\frac{dx}{dt} = \mu M \vartheta - \frac{\gamma}{k} x, \quad (11)$$

where  $M = \text{const}$  is motivation coefficient of the student,  $\vartheta$  – pace of information dissemination and  $k$  is indicator of motivation process direction ( $k > 0$  indicating positive motivation and  $k < 0$  indicating negative motivation – naturally we assume, that motivation is positive). This is a phenomenological model which is describing qualitative features of the process analyzed and could have a practical meaning when the coefficients are determined on the empirical data basis.

Supposed  $\gamma = \text{const}$  this equation has an exact solution having the form:

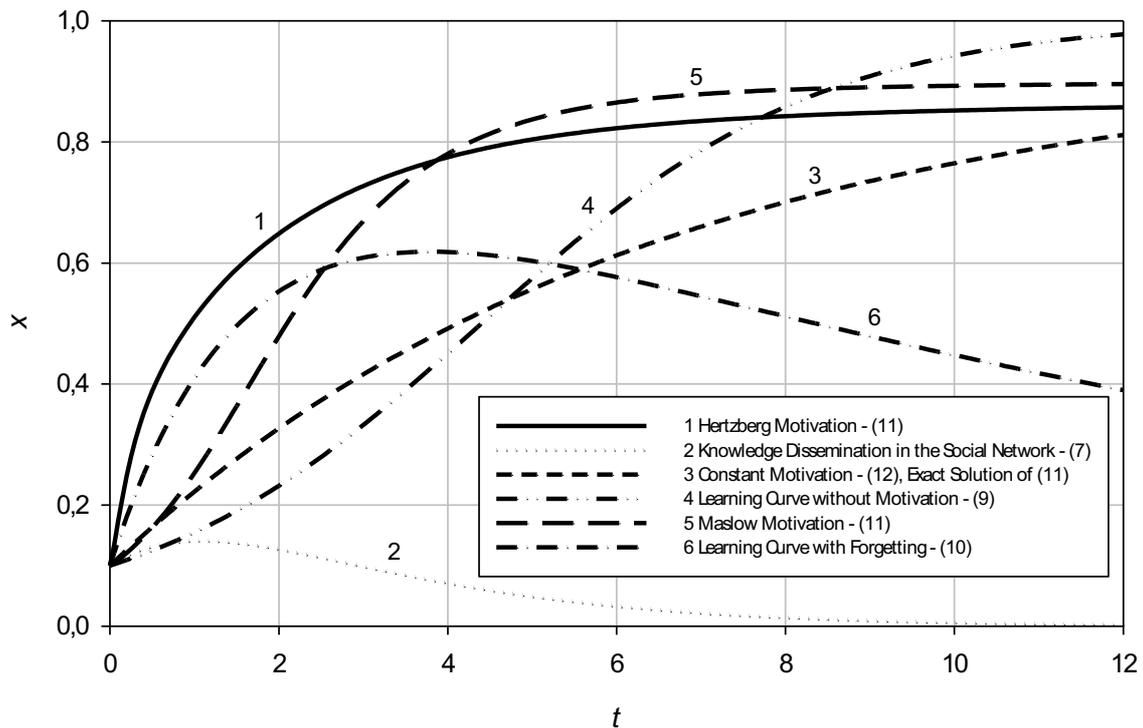
$$x(t) = \frac{\mu M \vartheta}{\gamma} \left( 1 - e^{-\frac{\gamma}{k} t} \right) + x^0 e^{-\frac{\gamma}{k} t}. \quad (12)$$

But we still need a representation which will enable to study the functional dependence of the motivation from several factors which were discussed in the section devoted to the motivation models. To get such a representation we simply substitute  $M = \text{const}$  in (8) by proper model of motivation (2) or (6). In such a case we could not obtain an exact solution of equation (11) and need to solve it numerically. In order to put all the calculations on the proposed models to the same conditions, the same value of  $\mu$ , the knowledge perceiving coefficient was used everywhere in the formulas (7), (9), (10), (11), (12). Similarly, in the model (12) with constant motivation, the value  $M = \text{const}$  was chosen to be equal to the average defined by calculations according to the formula (2) and (6). In the case when the learning process model (10) was used with a constant forgetting coefficient  $\gamma$ , it was taken as being the average value determined over a time period of 12 weeks using Ebbinghaus's formula. Similarly, in the model (12) with constant motivation, the value of  $M$  was chosen to be the average determined as a result of calculations by formulas (7) and (9). The pace of information dissemination  $\vartheta$  in the equation (11) was taken equal to 1, since it was assumed that the teacher affects the group of students simultaneously and without obstacles.

Results of calculations using formulas (9)-(10) and numerical solution of equation (11) with motivation described by (2), (7) and (9) are accumulated in the Fig. 1. All the curves are denoted by respectful equation number and line style to avoid misunderstanding. Numerical solution of ODE (11) was rendered by standard Runge-Kuut scheme of 4<sup>th</sup> order of accuracy with adaptive step which is more than satisfactory for the non-stiff equations. The realistic time period of 12 weeks for numerical integration on the basis of equations (9)-(10) and (11) was selected to reflect actual length of semester in the Ukrainian HES and at the same time to represent trimester system utilized in some of European countries. To obtain initial condition for the ODE integration the initial level of knowledge  $x^0$  was assumed to be 10% of target level  $x^*$  of 100%.

It is obvious that models without motivation are giving quite low sloped process of knowledge acquisition in comparison to ones which consider it. Certainly, such a result was expected. But the most interesting is that the models including motivation are not only demonstrating fast process of knowledge acquisition but also testify that this process is beginning earlier (see curves 1, 3 and 5 at Fig. 1). At the same time, it should be noted that in case when the distant learning is unveiling the potential of social networking

(see curve 5 at Fig. 1) the students in spite of being very fast in knowledge acquisition though they did not reach the target level of full 100% knowledge.



**Fig. 1.** A comparison between different models of learning and different motivation scenarios (all curves are denoted by corresponding line style and number of equation).

Source: author calculations

It is obvious effect of change a role of teacher using utilizing distant learning in the social network influenced environment. The ultimate goal of teacher in such a situation is to provide direction and milestones for students to create their own path individually. Respectively the knowledge generated by the group can differ from formal expectation. Implementing such an approach could facilitate even the creation of the new knowledge especially in humanities.

Let's try to answer the questions formulated in the section devoted to the teachers' motivation based on the analysis of the theoretical curves on Fig. 1. It is obvious that the most inefficient way to teach is just to rely on the "unattended" learning curve – see *4 Learning Curve without Motivation*. Moreover, when the forgetting effect was taken into account the students' group not only had not succeed to reach required level of knowledge, but even began to lose it starting from the very beginning of the teaching period. The 4<sup>th</sup> week proved to be the turning point when students losing interest in teaching process have begun to drop out the knowledge even though they did not reach even the half of the required level. And vice versa – when motivation came into play the teaching process becomes visibly more stable and efficient. Motivated students are ready to master up to 80% of theoretical knowledge during first 4 week of teaching. The rest of the time could be utilized to instill the practical skills which are of great value for contemporary labor market. But at the same time the motivated group would reach 100% level of required knowledge slower than for example directly controlled social network created for knowledge dissemination. Even if motivation of the group is represented by Hertzberg theory or constant motivation is assumed, the group is reaching the highest level of knowledge more rapidly. So, it could be concluded that this effect is defined by the ladder-like character of Maslow motivation.

An interesting common feature of models with motivation is that it takes longer to reach a higher level of knowledge than even in case of simple learning curve 4 that does not consider the influence of different motivation mechanisms. Moreover, the constant motivation mode (curve 3) allows to reach a higher level of knowledge than in case when the motivation is described by the Maslow Law (curve 5). Possibly this could be

explained by the fact that the Maslow motivation has a ladder-like nature and therefore decreases as the level of the teaching stuff assimilation increases. This conclusion is indirectly confirmed by the results of the calculation, when the motivation was presented by Herzberg's theory (curve 1), where Weber-Fechner's law of the stimulus incidence is not used. The curve 1, corresponding to this model demonstrates a more intensive growth of the level of assimilation. But ultimately, over a longer period, it reaches a lower level of knowledge. Indeed, Herzberg's motivation model lacks saturation and ladder-like property, but still motivation is treated as a decreasing function of time. That is a clear reflection of the empirical property of intangible motivation to lose its influence on the individual over time. Indeed, in the model of Herzberg's motivation there are neither stepwise increments nor saturation, but still motivation is a diminishing function of time, which again reflects the empirical property of intangible motivation to lose its attractiveness to the individual over time.

In addition, all the simulation results of learning process with regards to motivation clearly show that just gamification alone cannot serve as the only incentive for students. The very nature of the Weber-Fechner's law is such that the influence of the stimulus decreases significantly as it is utilized. Consequently, the students need to be offered with more and more incentives either in the form of advanced teaching methods or in the form of new opportunities to gain skills and knowledge. Given that according to Maslow's theory motivation has ladder-like nature, these incentives must be proposed to the students with a certain hierarchy in mind based on an increase of the impact on the individual and being changed in nature. Such a hierarchy establishing can be considered as an important direction for further research.

The constant motivation regime somewhat "overtakes" the classical learning curve, but in the long run it gives a lower level of the teaching stuff assimilation. This also could be explained by the fact that students' motivation needs to be amplified as they approach the desired level of knowledge, which in turn is requiring the additional efforts for the teacher.

The classical learning curve corresponds to a situation where students are driven by internal motives, and when neglecting the forgetting process, it characterizes the scenario of "slow but granted" obtaining the required level of a knowledge assimilation. And, as it was indicated, forgetting leads to the situation when the students not only do not reach the desired level of assimilation, but ultimately, they lose knowledge that had been already acquired. Such a situation, in some sense being even more critical, corresponds to the "free" dissemination of information in a social-network-type community when students are perceiving information in accordance with a certain probability and may or may not accept it. This effect causes additional difficulties in a situation when the teacher interacts remotely with a group "cemented" by internal connections such as a social network (see the relevant section of this study). Gamification in this case can serve as a tool to reduce the "probability of disagreement" of network community agents with the information/opinions/knowledge that the teacher brings in while working remotely.

Summing up the comparative analysis of the various modes of learning process when using gamification and distance learning, it should be noted that the motivation of students is a prerequisite for the successful teaching process. However, creating a system of motives for the students should be structured in such a way as to maintain their interest increase for at least the first 6-7 weeks of the semester.

**Conclusions.** Thus, summarizing findings obtained in the analysis of possible teaching process improvements by the utilization of the online gamification-based teaching methods in the context of social networks type communication and subsequent effects one can draw the following conclusions:

- It is shown that theoretical concepts using the phenomenological models allow better understanding of the influence of various factors on the learning process, despite the fact that they cannot be used to predict the progress of the real educational process accurately.
- At the same time, the use of the forgetting curve based on the real psychophysiological features of most individuals, the utilization of the realistic constants magnitudes corresponding to national standards of the quality of education make it possible to assess some important time parameters of the learning process, knowing which helps to refine the teacher's behavior strategy in the area of students' motivation.
- The modeling of the effects associated with the influence of the "factor of being connected" carried out in the work makes it possible to study the process of disseminating knowledge in a community (environment) of a social network type, which is also fundamentally important for designing modern approaches to improve the efficiency and quality of the educational process.

- The main difficulty in the process of applying motives has been identified, which related to the situation when the students need to be offered with incentives of a changing nature – alternating incentives based on the approach to the teaching and the content of the teaching stuff.
- It was shown that the gamification which is facilitating the utilization of potential of social network could substantially alter the role of (remote) teacher.
- The teaching process enriched by gamification proved to be more efficient especially regarding time factor, but at the same time potentially is limited in sense of reaching the required level of knowledge, unless new incentives will be proposed to the students.
- Theoretically new knowledge can be created in gamification-charged educational environment.

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