ANALYSIS OF INTRINSIC AND EXTRINSIC MOTIVATION IMPACT ON ACHIEVEMENT OF FIRST-YEAR CIVIL ENGINEERING STUDENTS IN OSIJEK

ABSTRACT

The largest decrease in the number of students of the Civil Engineering Faculty in Osijek occurs during the first years of studying. This paper analyzes the influence of intrinsic and extrinsic motivation on students’ achievement in the selected course during the first semester of the full-time undergraduate study. Based on the survey among first-year students, which examined the motivational variables and subjective ratings of specific prior knowledge of subjects associated with the selected course, a database of 90 subjects has been obtained. This research has explored the possibility of using neural networks for the prediction of the learning outcomes expressed in measurable and observable terms, i.e., grades earned in the selected course. Several configurations of neural networks have been examined and the neural network that achieved the best correlation in the success prediction has been used to analyse the impact of each input variable on the students’ success achieved during the selected course. According to the Self-determination theory, increasing of intrinsic motivation would lead to higher student achievement, greater creativity and flexibility of thinking and better long-term memory. Variable intrinsic motivation can be encouraged by a certain social atmosphere, by strengthening individual sense of autonomy, by competence and connection. The results of this study have revealed a complex interaction of input variables, but generally the effect of extrinsic motivation on achievement of students included in this research is more significant. These results are indicative, but they should be taken with a grain of salt, because they include the assessment of the success of learning outcomes of the only one course. More realistic picture requires a longer period of observation of the students’ achievement, including more courses and the observation of the overall success of students during their undergraduate studies.
SAŽETAK

Najveće smanjenje broja studenata studija građevine događa se na prvim godinama. U okviru ovog rada napravljena je analiza utjecaja intrinzične i ekstrinzične motivacije na postignuti uspjeh studenata u odabranom kolegiju prvog semestra preddiplomskog studija. Temeljem provedene ankete medu studentima prve godine, u okviru koje su ispitane motivacijske varijable i subjektivna ocjena specifičnog predznanja ispitanika koje je povezano s odabranim kolegijem, dobivena je baza podataka od 90 ispitanika. Istražena je mogućnost primjene neuralne mreže za predikciju postignutih rezultata učenja izraženih kroz ostvarenu ocjenu na promatranom kolegiju. Ispitano je više konfiguracija neuralnih mreža i neuralna mreža koja je postigla najbolju korelaciju u predikciji uspješnosti, korištena je za analizu utjecaja svake pojedine ulazne varijable na postignuti uspjeh studenata u promatranom kolegiju. Sukladno Teoriji samodeterminacije jačanje intrinzične motivacije dovelo bi do veće uspješnosti studenata, veće kreativnosti i fleksibilnosti mišljenja i boljeg dugoročnog pamćenja. Varijabilnu intrinzičnu motivaciju moguće je poticati određenim socijalnim ozračjem i jačanjem osjećaja autonomije, kompetencije i povezanosti. Rezultati ovog istraživanja pokazali su složenu interakciju ulaznih varijabli, ali je ukupno gledano značajniji utjecaj ekstrinzične motivacije na postignuti uspjeh studenata obuhvaćenih ovim istraživanjem. Dobiveni rezultati su indikativni, ali treba ih uzeti s rezervom, jer obuhvaćaju ocjenu uspješnosti ishoda učenja jednog kolegija. Za realniju sliku potreban je duži vremenski period praćenja postignuća studenata, uključivanje više kolegija i praćenje ukupnog uspjeha studenata tijekom cijelog preddiplomskog studija.

Ključne riječi: intrinzična i ekstrinzična motivacija, studenti građevinskog studija, neuralne mreže

1. Introduction

Monitoring the scattering of students from the Faculty of Civil Engineering shows the largest decrease of the number of students during the first few years of the studies. Decrease percentage includes mostly students who failed the year or gave up the studies. Undergraduate studies of Civil Engineering finishes, without losing a year, approximately 25% of all the full-time students enrolled into these studies. This means that a significant number of students, that is ¾ of students, lose a year or leave their studies. Such a situation is not unexpected, but the question is whether an action, taken in order to strengthen the motivation of students for achieving greater success and continuation of studies at the desired Faculty, is possible and, if it is, in which domain it should be taken. In the analysis of motivation neural networks are chosen to be an optimization tool, since they have the possibility of giving the difficulty coefficient of every input variable for the prediction of a chosen research result. That feature can provide a basic insight into kinds of motivation relevant for the investigated population of students. Within this research a one course has been selected, and that was the Technical drawing and CAD, so that, for starters, neural networks responses in the analysis of this type of problem are examined.

2. Basic concepts in the research of motivation in the academic domain

Motivation is a state in which we are excited from ‘within’ by needs, motivations, aspirations, desires or motives for a particular behaviour directed toward achieving a goal, which acts as an external stimulus to the behaviour (Petz, 2005). Motivation directly or indirectly affects the process of learning and teaching, and is one of the important elements in the development and education. Settings of previous studies have analyzed the motivation as a unique phenomenon that varies only in its quantity, but the recent research settings distinguish variability of motivations according to the

Intrinsic (internal) motivation is a need arisen from internal impulses which are not caused by external influences, and the only reward inherent to intrinsic motivation is the pleasure of learning, cognition, development of knowledge and skills, encouraged by personal interests. The research (Deci, Ryan, Koestner, 2001) shows that the intrinsic motivation is significantly correlated with the positive outcomes of learning. Strengthening the intrinsic motivation leads to higher student achievement, greater creativity and flexibility of thinking and better long-term memory. Variable intrinsic motivation can be encouraged by certain social atmosphere. There are three basic psychological needs associated with intrinsic motivation: the need for autonomy, defined as the self-regulation of personal behaviour (Chirkov, Ryan, 2001, Ryan, Deci, 2006, Soenens, Vansteenkiste, 2007), the need for competence as a necessity of the success and the control of our own environment and the need for coherence, i.e. a sense of belonging to a particular social group (Deci, Ryan, 2000). On the other hand, the negative impact on the intrinsic motivation have all expected material rewards and all forms of external control, such as deadlines, surveillance, threats, which are invasive of the personal autonomy, the primary curiosity and desire for challenge (Deci, Ryan, 2000).

Extrinsic (external) motivation is influenced by external factors, various forms of incentives, such as awards, praises, reviews, progress in work and others for example, which impact the development of motivation (Rheinberg, 2004). The social responsibility context encourages not only intrinsically motivated activities, and the question of the degree of personal satisfaction in completing these activities is explained by the concept of internalization. Internalization is an active natural process within socialization through which an individual transforms social rules and expectations of self-worth. There are four basic stages to extrinsic motivations: external regulation (avoidance of sanctions), introjected regulation (discomfort with the environment), identified regulation (acceptance of environmental rules as one’s own) and integrated regulation (activity for a particular purpose). The division implies a certain degree of internalization: pure extrinsic motivation is the external regulation, and the integrated regulation implies that a certain external goal is recognized as important for personal growth and adopted as an internal goal. The integrated regulation is the closest to the intrinsic motivation, but it is considered to be a form of extrinsic motivation, because the actions are aimed at achieving a particular goal, and not arising from the inner satisfaction.

3. Analysis of motivation influence on success of students of the first semester of civil engineering studies in Osijek

3.1. Database

Database of 90 subjects has been obtained by survey the among the first-year students of the undergraduate studies. The translated and revised questionnaire (Self-Regulation Questionaire—Study Abroad, Ryan, Connell, 1989, Chirkov, Vansteenkiste, Tao, Lynch, 2007) has been used. Each student has responded to questions about the motivation for performing the obligations under the first semester, by rating the answers. Offered responses were rated in the range from 1 to 7, where 1 meant – “I completely disagree”, and 7 meant – “I completely agree”. The questions were focused on examining intrinsic and extrinsic motivation and subjective assessments of prior AutoCAD knowledge, as it is evident from Table 1.
Table 1 Examined input parameters (adopted from Self-Regulation Questionnaire, Ryan, Connell, 1989)

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>LEVEL I</th>
<th>LEVEL II</th>
<th>LEVEL III</th>
<th>VALUE RANGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRINSIC MOTIVATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1 Personal interest</td>
<td>I1</td>
<td>I11</td>
<td>1-7</td>
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<tr>
<td>E1 External regulation</td>
<td>E11</td>
<td>E12</td>
<td>1-7</td>
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<tr>
<td><strong>EXTRINSIC MOTIVATION</strong></td>
<td>E21</td>
<td>E22</td>
<td>1-7</td>
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<tr>
<td>E2 Introjected regulation</td>
<td>E2</td>
<td>E21</td>
<td>1-7</td>
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<tr>
<td>E3 Identified regulation</td>
<td>E31</td>
<td>E32</td>
<td>1-7</td>
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<tr>
<td>PPREVIOUS KNOWLEDGE</td>
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<td>1-5</td>
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The number of male and female respondents is shown in the Figure 1a, and the breakdown of respondents according to prior high school education is shown in the Figure 1b.

Figure 1 Breakdown of respondents by sex (a) and the type of high school (b)

Database served for learning of neural network. Based on the numerical values of the input parameters (within the range - Table 1), the neural network was given the task of predicting grades achieved in the courses. Prediction of grades is not the main aim of the research, but the good correlation achieved will give more realistic values of difficulty coefficients of the analyzed input parameters of intrinsic and extrinsic motivation, which in this research makes it particularly interesting. The analysis was made in three levels, as seen in Table 1. At the first level the three input parameters were analyzed – intrinsic and extrinsic motivation and prior knowledge, at the second level the extrinsic motivation was divided according to the internalization level (Ryan, Connell, 1989), and at the third level 12 input variables were analyzed.

3.2. Neural Networks

Neural network learning and prediction results analysis is done with the NeuroShell2 software package. The following basic neural networks were tested: Ward nets, Standard nets and General

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regression net (Figure 2). In total around 30 neural networks, which differed in basic architecture, the number of hidden layers, number of neurons in the hidden layers and activation function, were analyzed. Neural networks were compared according to two basic criteria – their training and generalization ability. Training ability is a success of the prediction on a data set (used by network for learning), and the generalization is a success of the prediction on an unknown set of data (test data set). For the estimate of the generalization (test set), 20% of the data from an existing database was allocated.

Figure 2 Examined types of neural networks

At the first level three input variables are analyzed (Table 1). The best correlation of 73.58% is given by Ward net network and, according to the importance of input variables, extrinsic motivation and prior knowledge were equally important, and the intrinsic motivation had a smaller impact. Response of the neural network was not as good as expected, so the decision was made to do the detailed analysis. At the second level, the extrinsic motivation is divided according to the degree of internalization (Table 1). A slightly better response has been obtained from neural networks. The most successful was Ward net network and 83.34% correlation with the mean absolute prediction error of 0.27 has been achieved. Ranking of the examined input variables according to the influence coefficient is: (E1) external regulation 0.23, (I1) intrinsic motivation 0.22, (E3) identified regulation 0.20, (E2) introjected regulation 0.17 and (P) prior knowledge 0.16.

The best response has been obtained from neural networks at the third level of the analysis (Table 1). Correlation between the actual success achieved by students in the examined course (subject grades) and the prediction of the neural network achieved by the most successful neural network at the third level, according to the generalization criterion, is 97%. The neural network that has achieved the highest correlation is the General regression neural network of genetic, adaptive type, with one hidden layer containing 800 neurons and a linear activation function, hereinafter General regression 1. Prediction of the neural network in comparison with actually achieved grades in the existing database is shown in the Figure 3.
Besides the achieved correlation, the performance indicators of General regression neural network 1 can also be evaluated through the mean absolute error of prediction which equals to 0.08, and the percentage (92.22%) of the results with the prediction error less than 5% shows the performance success. Good response of the neural network provides us a real insight into the difficulty coefficients and the amount of influence of particular input variables on prediction results.

3.3. Analysis of difficulty coefficients

Table 4 show difficulty coefficients given by General regression 1. On the abscissa the input parameters of the third level of analysis (Table 1) are shown and on the ordinate the coefficients of influence of each parameter on the prediction outcome.

The greatest impact on learning outcomes, according to Figure 4, have the parameters of the extrinsic motivation (introjected regulation) – the desire for praise and exemplary behaviour (E21)
and personal pride (E23). According to the importance of the impact, prior knowledge is the next, and then the network estimated the element of intrinsic motivation ‘I love to (learn, know, understand)’ (I12) and two parameters of external regulation – other people's opinion (E12) and a reward (E14) – as equally important. Highly ranked parameters – the desire for praise, exemplarity, awards and positive social atmosphere – are consistent with the results of studies that show a significant effect of the parents on the motivation of students of lower years (Gonzalez-DeHass, Willems, Doan Holbein, 2005, Soenens, Vansteenkiste, 2005).

4. Conclusion

This piece evaluates the impact of motivation on students' achievements in the selected course of the first semester of undergraduate Civil Engineering studies. Neural networks were selected as a tool of analysis. The results have revealed a complex interaction of input variables, but generally the effect of extrinsic motivation on achievement of students is more significant. According to the neural network, with the best correlation achieved, the elements of the introjected regulation of the extrinsic motivation (the desire for praise and exemplary behaviour and personal pride) have the greatest impact. The aim of this part of the study was to examine the response of neural networks in the analysis of students' motivation and get the insight into the dominant motivation for learning outcomes for the surveyed group of students and that goal is reached. The obtained results are indicative, but they should be taken with a grain of salt, because they include the assessment of the success of learning outcomes of the only one course. More realistic picture requires a longer period of observation of the students' achievement, including more courses and the observation of the overall success of students during their undergraduate studies. Good response of neural networks opens the possibility of further research with this tool and testing of certain hypotheses, such as - whether students who have greater intrinsic motivation achieve better performance, which is the main (or missing) type of motivation among students who are leaving the selected Faculty, etc.

REFERENCES


