Received 3 January 2024
Revised 16 February 2024
Accepted 20 March 2024

Model of student engagement in the distance learning process

Anna Chwiłkowska-Kubala
Department of Organization and Management Theory, Poznan University of Economics and Business, Poznan, Poland
Małgorzata Spychała
Faculty of Engineering Management, Poznan University of Technology, Poznan, Poland, and
Tomasz Stachurski
Department of Statistics, Econometrics and Mathematics, University of Economics in Katowice, Katowice, Poland

Abstract

Purpose – We aimed to identify factors that influence student engagement in distance learning.
Design/methodology/approach – The research involved a group of 671 students from economic and technical higher education institutions in Poland. We collected the data with the CAWI technique and an original survey. Next, we processed the data using principal component analysis and then used the extracted components as predictors in the induced smoothing LASSO regression model.
Findings – The components of the students' attitude toward remote classes learning conditions are: satisfaction with teachers' approach, attitude to distance learning, the system of students' values and motivation, IT infrastructure of the university, building a network of contacts and communication skills. The final model consisted of seven statistically significant variables, encompassing the student's sex, level of studies and the first five extracted PCs. Student's system of values and motivation as well as attitude toward distance learning, were those variables that had the biggest influence on student engagement.
Practical implications – The research result suggests that in addition to students' system of values and motivation and their attitude toward distance learning, the satisfaction level of teachers' attitude is one of the three most important factors that influence student engagement during the distance learning process.
Originality/value – The main value of this article is the statistical model of student engagement during distance learning. The article fills the research gap in identifying and evaluating the impact of various factors determining student engagement in the distance learning process.

Keywords Student engagement, Model of student engagement, Distance learning, Teacher's attitude, Higher education
Paper type Research paper

1. Introduction

The issue of effective organization of distance learning environments has gained importance in the face of the COVID-19 pandemic, making distance learning a vital discussion topic in various scientific circles (Lassoued, Alhendawi, & Bashitialshaaer, 2020; Karasmanaki & Tsantopoulos, 2021; Qazi *et al.*, 2021; Zawacki-Richter, 2021; Fabian, Smith,

Edition of that article was financed under Agreement Nr RCN/SN/0330/2021/11 with funds from the Ministry of Education and Science, allocated to the "Rozwój czasopism naukowych" programme.

Central European Management Journal
Vol. 32 No. 4, 2024
pp. 534-548
Emerald Publishing Limited
e-ISSN: 2658-2430
p-ISSN: 2658-0845
DOI 10.1108/CEMJ-01-2024-0005

Taylor-Smith, & Meharg, 2022). Till now, we have perceived on-site teaching as the standard. Classes involved interaction between learners and the teacher or within the learners' group, which was limited in circumstances of physical separation (So & Brush, 2008). However, we saw information technology as an opportunity to support traditional learning: by increasing the effectiveness of traditional forms of training, with the help of games, simulation or projection of virtual reality (see Merchant, Goetz, Cifuentes, Keeney-kennicutt, & Davis, 2014) or else by deliberations on the proper projection of e-learning (Raaij & Schepers, 2008). The outbreak of the COVID-19 pandemic forced the education system to introduce changes in the form of training in a sudden and unplanned way. The optimal reorganization has been a particular challenge for those subjects that did not specialize in distance learning before the pandemic (Qazi *et al.*, 2021).

Another important issue that scientists raised was student engagement. It is a key predictor of academic achievement and student satisfaction (Kahu, 2013; Bowden, Tickle, & Naumann, 2021). Engaged students achieve better results and learn more willingly (Salanova, Schaufeli, Martínez, & Bresó, 2009). Stott (2016) indicates that a lack of student engagement affects poorer educational results. However, the study of the factors influencing student engagement in higher education requires more research (Wilson, Broughan, & Marselle, 2019). We need even more to understand the factors relating to student engagement in distance learning (Ma, Han, Yang, & Cheng, 2015; Bolliger & Halupa, 2018; Bagriacik Yilmaz & Banyard, 2020; Batdı, Doğan, & Talan, 2021). Zhang, Zhao, Zhou, and Nunamaker (2004) suggest that the effectiveness of distance learning may be shaped at least at the same level as classes in the traditional form. However, it will not be an adequate form of education for every student. According to Lassoued *et al.* (2020), in the context of remote classes, the nature of the obstacles that both professors and students faced was not only organizational but also technical, financial and pedagogical.

As university teachers, we have observed various levels of student engagement since March 2020. They defined the main research objective, which concerned the identification of factors that influence student engagement during distance learning. We posed the following research questions:

RQ1. What is the contribution of an academic teacher to shaping student engagement during distance learning?

RQ2. Does the remote form of education influence student engagement or is this engagement independent of the education form?

RQ3. What is the importance of student's attitudes in the perspective of their engagement in distance learning?

RQ4. Does efficient and modern IT infrastructure influence student engagement?

RQ5. Do students' need to shape the contacts network influence their engagement during distance learning?

RQ6. Are male students more engaged than female students?

RQ7. Are undergraduate students more engaged during distance learning than graduate students?

To answer these questions, we researched student engagement during distance learning. We developed a survey questionnaire and then validated it. Subsequently, students of economic and technical universities obtained remote access to the survey. The main result of the research conducted was the development of a model of student engagement in distance learning. The model describes components that influence this engagement.

2. Theoretical background

Regarding theoretical deliberations on distance learning, we should note terminological inconsistency (Moore, Dickson-Deane, & Galyen, 2011). Terms such as "distance learning," "e-learning" or "online learning" are not always synonymous. Originally, "distance learning" referred to remote learning with the use of various communication forms. However, it was not until information technology and digitalization were developed that distance learning started to be identified with the use of IT tools (Selim, 2007; Moore *et al.*, 2011; Almarashdeh, 2016). We adapted such an approach to the notion of "distance learning" in this article.

In the discussion on distance learning, we highlighted its potential benefits for long-term learning (Aggeli & Vassala, 2013). They include diminishing cost and social barriers to participation in the learning process (Zhang *et al.*, 2004), diminishing temporal and geographical barriers (Pituch & Lee, 2006) and the use of distance learning tools as tools potentially increasing the effectiveness of the learning process (Selim, 2007). The variety of tools supporting distance learning makes it not only more flexible than the traditional form of education but also facilitates adaptation of the learning process to individual needs (Zhang *et al.*, 2004). Among the advantages of distance learning, scholars mention the following (Taguchi, 2020): shaping students' autonomy; adjusting the pace of realizing the syllabus to individual needs; shaping the ability to plan their own time and shaping the responsibility for actions undertaken in the learning process.

Villanueva, Ruiz-Madrid, and Luzon (2010) note that both students' autonomy and their responsibility for acquiring new knowledge depend on the context of the teaching–learning process and the culture of acquiring knowledge. For educational success, the importance of the context of the distance learning environment has been the subject of various deliberations for many years (Garrison & Cleveland-Innes, 2005).

2.1 Distance learning in the context of the outbreak of COVID-19 pandemic

In the context of the outbreak of the COVID-19 pandemic, literature analysis on distance learning differentiates four key perspectives. First, the student's perspective. Widely understood experience of the student regarding the university (or studying in general) is the product of many elements, concerning not only the perspective of the given individual, but also organization circumstances related to the structure of the learning process or models regarding engagement in paid studies. These aspects are part of a wider perspective of socio-economic priorities (Rosh White, 2006). Gopal, Singh, and Aggarwal (2021) found that expectations of students positively impact students' satisfaction and further student satisfaction impacts students' performance. During the pandemic, university teachers observed weak motivation of students for distance learning (Lassoued *et al.*, 2020). However, the issue of student motivation in the context of distance learning was the subject of discussion even before the outbreak of the pandemic (see: So & Brush, 2008; Sun & Rueda, 2012; Hartnett, 2016).

Second, the teacher's perspective. The literature (Facer, 2019) emphasizes the importance of the role of educators who practice in a challenging reality. As Silander and Stigmar (2019) highlight, the contemporary academic teacher is expected to adapt to the changing environment. Hargreaves (2000) observes that a teacher, as an emotional practitioner, influences whether their classes are engaging or dull. Moreover, Hargreaves pays attention to the issue that delivering engaging and dynamic lessons requires hard emotional work on the teacher's part. Prokopczuk (2012) notices that teachers' desire to do their job (intrinsic motivation) is related to the effectiveness of motivational systems that do not involve financial rewards. In the context of distance learning during the pandemic, Badrkhani (2021) highlights the lack of sufficient digital literacy. Gopal *et al.* (2021) underline that the teachers' perspective is critical, because their enthusiasm leads to a better quality of the online learning process.

Third, interactions. Considering the mutual university teacherstudent relationship, the relationship perspective is worth attention. The problem of interaction is one of the key elements requiring attention in the perspective of distance learning (Garrison & Cleveland-Innes, 2005). According to the results of research by Song, Kim, and Luo (2016), the effect of teacher upon teacher–student relationship satisfaction is stronger online than face-to-face classes. In view of research Karasmanaki and Tsantopoulos (2021), who show the influence of social distancing measures on the mental health of students during the pandemic, emotional support appears to be of the essence not only from the teacher but also from the university (including psychological help).

Fourth, projecting the educational environment. We may understand the notion of "educational environment" widely. It can take into account not only the optimal adjustment of IT functionalities to users, but also how the user (student) perceives the IT environment (system) and whether interaction with other students and the teacher is available (Pituch & Lee, 2006; Selim, 2007). Moreover, apart from the proper design of the education environment (the use of IT tools), evaluation strategies should also be considered, bearing in mind the specific character of individual and group work (Merchant *et al.*, 2014). Punjani and Mahadevan (2022) suggest the need to create educational content well-suited to the online teaching mode. As Zawacki-Richter (2021) notes, the COVID-19 pandemic contributed to increased expenditure to ensure not only technical infrastructure (both from the perspective of the teaching process and e-assessment) but also provide teachers with training in media technology knowledge.

2.2 Student engagement during distance learning

The quality of education and student engagement during distance learning is a common research subject (Chickering & Gamson, 1987; Herrington, Oliver, & Reeves, 2003). Kuh (2009) believes that student engagement starts when their input in learning facilitates their development and sustains their further engagement in classes. Scholars also understand engagement as the frequency of students' participation in classes (Smith, Sheppard, Johnson, & Johnson, 2005). Student engagement during distance learning is a difficult task because students are separated from other students and teachers (Moore *et al.*, 2011; Bolliger & Halupa, 2018).

Robinson and Hullinger (2008) examined online student engagement and found that the level of engagement differs depending on the subject, average grade and age. Chen, Lambert, and Guidry (2010) examined the influence of technology on student engagement. The authors found that there was a positive correlation between the use of technology and student engagement. Fisher (2010) highlighted another factor influencing student engagement in online learning: the type of classes, which can either promote or hinder students' participation.

Currently, due to the pandemic circumstances, a lot of research concerns the factors that influence student engagement during distance learning (Bagriacik Yilmaz & Banyard, 2020; Batdı *et al.*, 2021). One of them is the teachers' attitude toward the effects of physical distance and the increased use of social media. Some scholars claim that teachers around the world should adjust to online learning with the use of social media in difficult circumstances, such as the pandemic (Jogezai *et al.*, 2021). However, students must trust formal and informal sources of information connected with distance learning (Qazi *et al.*, 2021). On the other hand, Zawacki-Richter (2021) assumes that the current situation will positively impact digital innovation in university teaching. Technology management, increased awareness of students in the area of using distance-learning systems and the requirement of a high level of IT technology from students and universities are the most influential factors in distance learning during COVID-19 (Alqahtani & Rajkhan, 2020). However, independent of how

innovative technology is in a given university, students' attitudes and readiness to undertake remote learning played a big role in the acceleration of the education process during the pandemic.

3. Material and methods

3.1 Data collection and sample characteristics

We conducted the study among students of technical and economic universities in Poznan, Poland. We preceded the main study, conducted from August 2020 to May 2021, with a pilot study conducted in June on a group of 41 students. The pilot study aimed to verify the intelligibility of the questions included in the survey. As a consequence of the pilot study, we removed four items and reformulated another six. Finally, we obtained 34 items for the main study and eight items for the survey metrics.

We divided the survey into five sections. The first section consisted of questions on students' attitudes. Variables in the first section were of qualitative, ordinal character (1 – strongly disagree, 2 – disagree, 3 – undecided, 4 – agree and 5 – strongly agree). The second section consisted of questions regarding the comparison of online classes and traditional classes. The variables studied in the third section were of ordinal character. Respondents evaluated (minimum mark – 1 and maximum – 5): teachers and lecturers; and university – whether IT base was provided. The fourth section was self-assessment (minimum mark – 1 and maximum – 5) in the following areas: preparation for classes, engagement in realizing projects/tasks, diligence in realizing projects/tasks, honesty in realizing projects/tasks and diligence in acquiring knowledge. The fifth section was the survey metrics.

Participation in the survey was voluntary. We conducted the survey using a computer-assisted web-interview (CAWI). In total, we obtained 671 completed questionnaires. Table 1 presents the distribution of respondents according to their sociodemographics. We verified the validity of the survey using the percentage of total explained variance, whereas we verified the reliability using Cronbach's alpha (1951) with threshold levels for social studies of 0.5 and 0.45, respectively (Merenda, 1997; Taber, 2018).

3.2 Statistical approach

We analyzed statistical material gathered within the research using SPSS 27.0 software and R environment (R Core Team, 2021).

3.2.1 Principal component analysis (PCA). We conducted a principal component analysis to reduce the dimensionality of the dataset with little loss of information by extracting a smaller number of components. Each of the extracted components was a linear combination

Variable name	Category	*n*	%
Sex	Female	331	49.33
	Male	340	50.67
Level and year of studies	Undergraduate studies (total)	417	62.15
	Graduate studies (total)	254	37.85
Form of study	Full-time studies/day studies	573	85.39
	Part-time studies/extra-mural studies	98	14.61
Place of residence	Village	214	31.90
	Town up to 50,000 inhabitants	171	25.48
	Town from 50,000 to 100,000 inhabitants	68	10.13
	Town above 150,000 inhabitants	218	32.49

Source(s): Own elaboration

Table 1. Sample sociodemographic characteristics

of the standardized original variables. To facilitate the interpretation of the factor structure, we performed an equamax rotation. We decided on the number of components to be extracted based on the eigenvalues-greater-than-one rule proposed in the paper (Kaiser, 1960) and the scree plot criterion (Cattell, 1966).

Before using PCA, we also verified whether it was justified to use that particular method. Therefore, we investigated using the Kaiser–Meyer–Olkin (KMO) criterion (Kaiser, 1960) and Bartlett's test of sphericity (1951) whether statistical relationships exist between the variables analyzed that would allow for extracting interpretable factors.

3.2.2 IS LASSO regression analysis. We used induced smoothing least absolute shrinkage and selection operator (IS LASSO) regression (Cilluffo, Sottile, La Grutta, & Muggeo, 2020) to estimate the parameters of the model describing student engagement in distance learning. Noteworthy, IS LASSO is a modified LASSO method (Tibshirani, 1996). The latter belongs to regularization techniques, which are used to avoid the multicollinearity effect. The LASSO regression consists of minimizing the mean square errors of estimators through the reduction of their variance at the expense of an increase in bias. You achieve the vector-valued estimators of the regression model as a result of the following equation:

$$\widehat{\beta}^{\mathrm{LASSO}} = \sum_{i=1}^{n} \left(y_i - \sum_{k=1}^{p} x_{k,i} \widehat{\beta}_k \right)^2 + \lambda \sum_{k=1}^{p} |\beta_k| \rightarrow \min . \tag{1}$$

in which λ is the penalty parameter, whose optimal value is defined by the cross-validation method. The original version of the LASSO method proposed by Tibshirani (1996) prevents obtaining a standard error of parameters for zero-point estimates (for variables left out of the model). Meanwhile, the IS LASSO method (Cilluffo *et al.*, 2020) is free from this drawback. It enables obtaining estimation errors for each data estimator with the following formula:

$$Z = \frac{\widehat{\beta}_j}{SE\left(\widehat{\beta}_j\right)}, \tag{2}$$

in which $SE(\widehat{\beta}_j)$ is the standard error computed as the square root of the jth diagonal element of the variance-covariance matrix defined in the paper (Cilluffo *et al.*, 2020).

We chose explanatory variables for the estimated model with the use of IS LASSO regression using a backward selection procedure (Maddala, 1992).

4. Results

4.1 The results of principal component analysis (PCA)

In the principal component analysis, we considered 26 variables measuring students' opinions on the conditions for distance learning classes. The value of the KMO criterion was 0.856, thus it was greater than 0.8, the suggested threshold of the original variable correlation level, justifying the use of principal component analysis (Kaiser, 1960). Moreover, we confirmed the correlation between the original variables with the statistically significant value of $\chi^2 = 5848.741, p < 0.001$. That justifies the claim that the variable correlation matrix was not an identity matrix.

As a result of the principal component analysis, we extracted 26 components. However, only six components were characterized by eigenvalues greater than 1, which explains in total about 56% of the variability of students' opinions regarding the conditions for distance learning classes (Table 2).

Component	Initial eigenvalues Eigenvalue	% of explained variance	Cumulative % of explained variance	Rotation sums of squared loadings Eigenvalue	% of explained variance	Cumulative % of explained variance
1	6.109	23.495	23.495	4.308	16.570	16.570
2	2.753	10.587	34.082	2.533	9.744	26.314
3	1.866	7.175	41.257	2.152	8.276	34.590
4	1.389	5.340	46.598	2.006	7.715	42.305
5	1.274	4.899	51.496	1.794	6.901	49.205
6	1.041	4.004	55.500	1.637	6.294	55.500
7	0.963	3.705	59.205			
8	0.924	3.552	62.757			
9	0.878	3.379	66.136			
10	0.854	3.285	69.421			
11	0.805	3.095	72.516			
12	0.738	2.839	75.355			
13	0.720	2.768	78.123			
14	0.656	2.523	80.645			
15	0.641	2.465	83.110			
16	0.584	2.246	85.356			
17	0.562	2.163	87.519			
18	0.555	2.136	89.655			
19	0.475	1.827	91.482			
20	0.442	1.699	93.181			
21	0.397	1.525	94.706			
22	0.375	1.442	96.148			
23	0.309	1.187	97.335			
24	0.290	1.115	98.450			
25	0.212	0.816	99.266			
26	0.191	0.734	100.000			

Source(s): Own elaboration

Table 2. Eigenvalues and percentage of total explained variance

Table 3 shows the values of factor loadings for the first six extracted components, explaining the largest part of the variance of the examined phenomenon. To facilitate components' interpretation, we performed equamax orthogonal rotation. We should interpret the factor loadings as the correlation coefficient between the original variable and the extracted component.

Principal component analysis allowed us to reduce the dimensionality and extract six principal components while retaining most of the information included in the original variables. The extracted components were orthogonal, which facilitated their easy use for the construction of regression models, limiting the question of the potential collinearity of regressors. For the first five components, we confirmed scale reliability (Cronbach's alpha >0.45, which can be deemed satisfactory in the case of education research (Taber, 2018). For the sixth extracted component, Cronbach's alpha (0.388) was below the accepted criterion; therefore, we excluded it from further analyses.

4.2 Student engagement model in distance learning

We used the extracted principal components that represent students' opinions on conditions for online classes to build a model explaining student engagement in distance learning. We included the chosen sociodemographic variables, such as the student's sex, level of studies (undergraduate/graduate) and type of studies (full-time and part-time), in the model

	Principal components					
	PC1	PC2	PC3	PC4	PC5	PC6
Atmosphere during lecture	*0.794*	0.101	0.164	0.154	−0.031	−0.034
Method of giving a lecture	*0.763*	0.039	0.237	0.225	0.005	0.068
Contact with teachers giving lectures	*0.763*	0.137	0.121	0.118	−0.008	−0.051
Teaching materials provided during the lecture	*0.739*	−0.020	0.249	0.260	0.013	0.044
Atmosphere during classes	*0.694*	0.136	0.130	0.267	0.089	−0.032
Contact with teachers running classes	*0.683*	0.182	−0.005	0.273	0.187	−0.062
Method of running classes	*0.632*	0.072	0.154	0.453	0.160	0.015
Teaching materials provided during classes	*0.622*	0.031	0.144	0.419	0.166	−0.009
Scope of knowledge acquired during distance learning classes compared to traditional classes	0.063	*0.697*	0.104	0.301	−0.080	0.093
Amount of time devoted to learning/projects during distance learning classes compared to traditional classes	0.072	*0.685*	0.043	−0.073	0.083	−0.018
Online classes are more interesting than traditional classes	0.026	*0.667*	0.014	0.336	−0.261	0.201
Online classes are more motivating than traditional classes	−0.069	*0.613*	0.211	0.292	−0.251	0.230
Frequency of contact with teachers during online classes compared to traditional classes	0.249	*0.612*	−0.049	−0.329	0.166	−0.083
Revising materials from previous classes	0.083	0.054	*0.651*	0.059	−0.181	0.059
Strong internal motivation to study	0.052	0.195	*0.646*	−0.047	0.288	−0.129
Participation in optional classes	0.155	0.000	*0.645*	0.052	0.189	0.013
Studying for self-development	0.152	−0.011	*0.586*	0.151	0.353	0.025
Adequate IT tools provided by the university during the pandemic	0.211	0.028	0.021	*0.688*	−0.013	−0.048
Platforms used during online classes	0.155	0.128	0.060	*0.571*	0.228	−0.145
Studying for professional development	0.045	0.038	0.213	0.056	*0.716*	0.165
Teacher's personality and learning effectiveness	−0.097	0.031	0.013	0.107	*0.649*	−0.047
Making friends at university	0.091	−0.261	0.069	−0.011	*0.500*	−0.143
Preference for online classes due to the Lack of necessity to join public discussions	0.053	0.380	−0.125	0.171	0.021	*0.657*
Unwillingness to join online discussions for fear of being recorded	−0.081	−0.127	0.101	−0.205	−0.100	*0.589*
Preference for individual work	0.020	0.050	0.075	−0.021	0.009	*0.573*
Willingness to join discussion (traditional classes)	−0.024	−0.055	0.429	0.059	−0.053	*−0.558*
Scale reliability analysis						
Cronbach's alpha	0.911	0.720	0.634	0.464	0.478	0.388

Source(s): Own elaboration

Table 3. Factor loadings based on principal component analysis with equamax rotation

specification. The mean arithmetic (Cronbach's alpha = 0.832) of students' replies in Section 4 of the survey played the role of the endogenous variable in the regression model. It concerned students' self-assessment of their diligence and engagement in fulfilling tasks and acquiring knowledge.

We selected the variables for the regression model using the method of backward selection, and model parameters were estimated using IS LASSO. Table 4 shows parameter estimates for the specified model. The final version of the model included the first five components extracted using PCA: the student's sex and the study level.

Table 4.
LASSO regression model coefficients between student engagement in distance learning and chosen factors

Variable	Unstandardized coefficients: Beta	Unstandardized coefficients: Standard error	Standardized coefficients beta	Z	P-value
Intercept	3.7578	0.0332		113.1735	<0.001
PC1 – satisfaction level with teachers' attitude	0.1558	0.0186	0.2315	8.3549	<0.001
PC2 – attitude to distance learning	0.2227	0.0190	0.3309	11.7429	<0.001
PC3 – student's system of values and motivation	0.3189	0.0187	0.4738	17.0194	<0.001
PC4 – university IT infrastructure	0.1455	0.0185	0.2162	7.8462	<0.001
PC5 – building a network of contacts	0.1290	0.0188	0.1917	6.8493	<0.001
Sex	−0.1243	0.0387	−0.0924	−3.2136	0.0013
Level of studies	0.0857	0.0411	0.0618	2.0863	0.0370

Source(s): Own elaboration

Based on the results included in Table 3, the model of student engagement in distance learning (Y) may be presented with the following equation as well as in the graphic form (Figure 1).

$$\widehat{Y} = 3.7578 + 0.1558 \cdot PC_1 + 0.2227 \cdot PC_2 + 0.3189 \cdot PC_3 + 0.1455 \cdot PC_4 + 0.1290 \cdot PC_5 - 0.1243 \cdot gender + 0.0857 \cdot study\,level$$

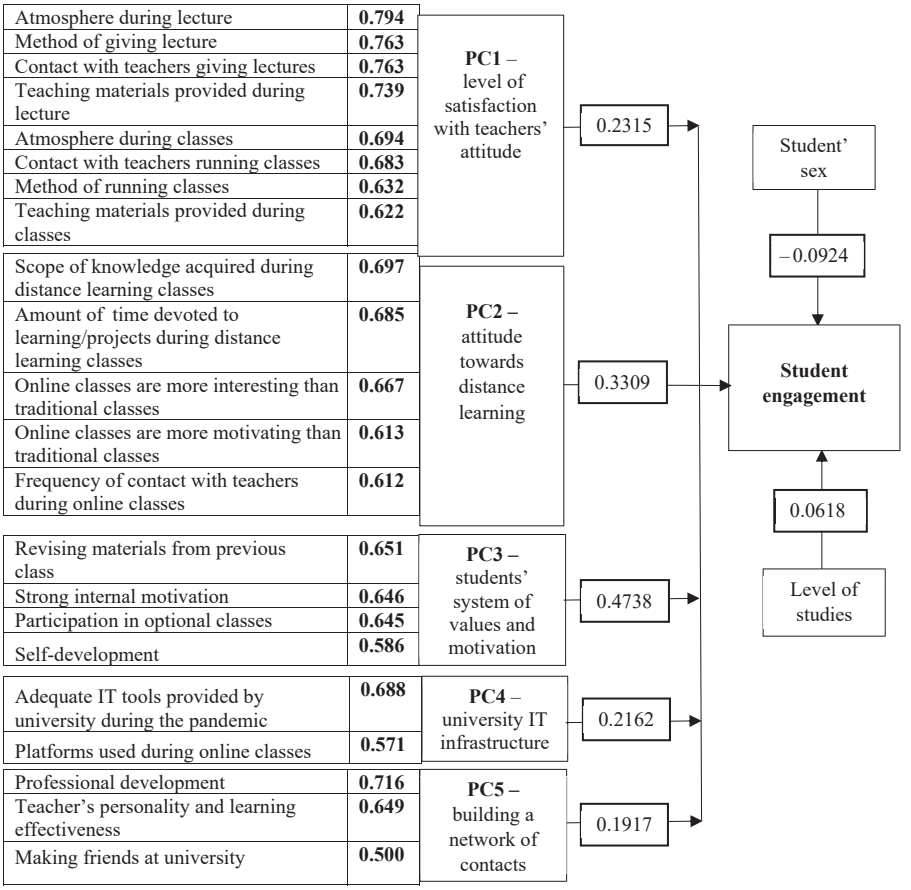
The standardized beta coefficient in Table 3 enabled us to confront the impact of individual regressors on the level of the dependent variable, i.e. student engagement.

The estimated model explained almost 50% of the variability of the variable examined (adjusted coefficient of determination $\overline{R}^2 = 49.5\%$), which confirmed a satisfactory goodness-of-fit. To verify whether the specified model was adequate, i.e. it adequately reflects relationships between the variables, we conducted a formal diagnosis of the model. Moreover, Shapiro–Wilk test allowed us to conclude that error terms are normally distributed ($p = 0.0639$). Goldfeld–Quandt test demonstrated that the error term was homoscedastic ($p = 0.4944$). Failing to reject the null hypothesis of the residual randomness ($p = 0.0817$) confirmed that the chosen mathematical model was appropriate (Motulsky & Ransnas, 1987). The results obtained in the model diagnostics process justified the claim that the model fulfills the assumptions of the used estimation method and that the model was correctly specified.

5. Discussion

The objectives set initially concerned two areas: factors that impacted student engagement during distance learning and proposing a model of student engagement in the process of distance learning. As a result of the PCA, we extracted 26 components; however, only six components had eigenvalues greater than 1.

The first of the components explained about 23.5% of the variability. It was strongly correlated with variables expressing the satisfaction level with teachers running both lectures and classes concerning the quality of teaching materials, the way they run classes and the atmosphere in class as well as the possibility to contact the teachers. Previous



Source(s): Own elaboration

Figure 1.
Research model of student engagement in distance learning

research by Fisher (2010) emphasizes that the form of education influences engagement, but our research suggests it is not the form of education but the teachers' attitude and students' motivation.

Wang, Stein, and Shen (2021) indicate the significance of how the student perceives distance learning. The second component, which explains 10.6% of the variance of the examined phenomenon, shows the strongest correlation with the variables expressing students' attitudes toward distance learning, considering both the attractiveness of this form and its effectiveness. In our research, student attitudes included various factors like gaining knowledge and participating in activities related to distance learning. Similarly, the results of Fabian *et al.* (2022) show the importance of study skills for student engagement. Research on the importance of student motivation yields various insights. For instance, Tani, Gheith, and Papaluca (2021) suggest that the desire for personal growth and the expectation of securing a desired job are key factors influencing the decision to pursue studies. The perspective of employability and career advancement is an important aspect of student engagement, as highlighted by Chhetri and Baniya (2022). Although Eom, Wen, Ashill, Vional, and Susilo (2006) did not show a correlation of self-motivation with perceived learning outcomes, aspects

related to student motivation and engagement turned out to be significant in our research. Yun and Park (2020) showed that a student's academic level significantly influences the connection between motivation and engagement. The third extracted component was strongly correlated with variables such as revision of materials from previous classes, participation in voluntary classes and a high level of internal motivation.

The fourth component is influenced mainly by satisfaction with IT tools provided by the university and platforms used for distance learning classes. Chen *et al.* (2010) also observed a positive correlation between student engagement and information technology. However, Bravo-Adasme and Cataldo (2022) noticed a negative phenomenon related to technology: the effect of forced use of technology for distance learning. Bravo-Adasme and Cataldo showed that the effect of technodystress on performance is significant for students and teachers through technological overload.

Garrison and Cleveland-Innes (2005) and So and Brush (2008) raised the issue of the importance of interaction in distance learning. The fifth component encompasses the perception of studying as an opportunity to make acquaintances and shows a big role of the teacher's personality in the effectiveness of the learning process. Moreover, this component correlates strongly with studying to achieve professional development. The literature highlights the role of a teacher in improving student engagement. For instance, Heilporn and Lakhal (2021) study teaching strategies from the viewpoint of improving blended courses as a tool for future higher education.

The last component was "low verbal activity." We obtained the biggest positive factor loading for variables related to the unwillingness to take the floor during online classes as well as to the preference for individual work over group work. This component correlates negatively with the willingness to participate in discussion in the traditional form. However, due to the insufficient Cronbach's alpha value (0.388), we excluded it from further analyses.

The factor representing a student's system of values and motivation had the biggest impact on student engagement in distance learning. Thus, we may conclude that students' participation in education is significant. The second most important variable was the attitude toward distance learning as the variable representing aspects concerning not only the student's perspective (e.g. time devoted to studying during distance learning) but also those referring to organization aspects of the university/teachers (e.g. the form of online classes). From the perspective of impact on student engagement, the third place belongs to the level of satisfaction with the teacher's attitude. Therefore, it is not only necessary to take care of such aspects as the atmosphere in class, the quality of teaching materials and the form and method of organizing classes but also to improve programs and methods in the area of ethical education (Gasparski, Lewicka-Strzałecka, Bąk, & Rok, 2012).

Noteworthy, a student's sex also influences student engagement. The negative beta coefficient indicates slightly greater engagement among female students, and the positive value of the beta coefficient for the variable "level of studies" implies greater engagement among graduate students. We used the extracted components to create a model of student engagement, which may serve as a diagnostic tool for those involved in shaping the teaching process.

Conclusions on student engagement during the pandemic refer uniquely to a fragment of the examined reality. The teaching process consists of various elements. Identifying them is a difficult task that carries cognitive limitations. We should mention the subjectivity of self-assessment as one of such research limitations because we did not consider the objective final/average grades of students obtained to pass subjects during the pandemic. Another cognitive limitation was that we did not conduct the research before the pandemic. Therefore, we were unable to answer the question of to what extent engagement during distance learning/pandemic differs from engagement during traditional learning.

References

Aggeli, A., & Vassala, P. (2013). Women in distance learning: Second chance or third shift?. In *Distance and E-Learning in Transition: Learning Innovation, Technology and Social Challenges* (pp. 325–334). doi: 10.1002/9781118557686.ch22.

Almarashdeh, I. (2016). Sharing instructors experience of learning management system: A technology perspective of user satisfaction in distance learning course. *Computers in Human Behavior*, *63*, 249–255. doi: 10.1016/j.chb.2016.05.013.

Alqahtani, A. Y., & Rajkhan, A. A. (2020). E-Learning critical success factors during the COVID-19 pandemic: A comprehensive analysis of e-learning managerial perspectives. *Education Sciences*, *10*(9), 1–16. doi:10.3390/educsci10090216.

Badrkhani, P. (2021). How a catastrophic situation turns into an exceptional opportunity: Covid-19 pandemic in Iran and challenges of online education for new English language educators. *Interactive Learning Environments*, *31*(7), 1–19. doi: 10.1080/10494820.2021.1956545.

Bagriacik Yilmaz, A., & Banyard, P. (2020). Engagement in distance education settings: A trend analysis. *Turkish Online Journal of Distance Education*, *21*(1), 101–120. doi: 10.17718/tojde.690362.

Bartlett, M. S. (1951). The effect of standardization on a $\chi 2$ approximation in factor analysis. *Biometrika*, *38*(3-4), 337–344. doi: 10.1093/BIOMET/38.3-4.337.

Batdı, V., Doğan, Y., & Talan, T. (2021). Effectiveness of online learning: A multi-complementary approach research with responses from the COVID-19 pandemic period. *Interactive Learning Environments*, *31*(7), 1–34. doi: 10.1080/10494820.2021.1954035.

Bolliger, D. U., & Halupa, C. (2018). Online student perceptions of engagement, transactional distance, and outcomes. *Distance Education*, *39*(3), 299–316. doi: 10.1080/01587919.2018.1476845.

Bowden, J. L. H., Tickle, L., & Naumann, K. (2021). The four pillars of tertiary student engagement and success: A holistic measurement approach. *Studies in Higher Education*, *46*(6), 1207–1224. doi: 10.1080/03075079.2019.1672647.

Bravo-Adasme, N., & Cataldo, A. (2022). Understanding techno-distress and its influence on educational communities: A two-wave study with multiple data samples. *Technology in Society*, *70*, 102045. doi: 10.1016/j.techsoc.2022.102045.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research*, *1*(2), 245–276. doi: 10.1207/S15327906MBR0102_10.

Chen, P. S. D., Lambert, A. D., & Guidry, K. R. (2010). Engaging online learners: The impact of web-based learning technology on college student engagement. *Computers and Education*, *54*(4), 1222–1232. doi: 10.1016/j.compedu.2009.11.008.

Chhetri, S. B., & Baniya, R. (2022). Influence of student-faculty interaction on graduate outcomes of undergraduate management students: The mediating role of behavioral, emotional and cognitive engagement. *International Journal of Management Education*, *20*(2), 100640. doi: 10.1016/j.ijme.2022.100640.

Chickering, A. W. & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*. *2*, 7.

Cilluffo, G., Sottile, G., La Grutta, S., & Muggeo, V. M. (2020). The induced smoothed lasso: A practical framework for hypothesis testing in high dimensional regression. *Statistical Methods in Medical Research*, *29*(3), 765–777. doi: 10.1177/0962280219842890.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. doi: 10.1007/BF02310555.

Eom, S. B., Wen, H. J., Ashill, N., Vional, & Susilo, A. (2006). The determinants of students' perceived learning outcomes and satisfaction in BINUS online learning. *Decision Sciences Journal of Innovative Education*, *4*, 215–235. doi: 10.1109/CONMEDIA46929.2019.8981813.

Fabian, K., Smith, S., Taylor-Smith, E., & Meharg, D. (2022). Identifying factors influencing study skills engagement and participation for online learners in higher education during COVID-19. *British Journal of Educational Technology*, *53*(6), 1915–1936. doi: 10.1111/bjet.13221.

Facer, K. (2019). Storytelling in Troubled Times: What is the role for educators in the deep crises of the 21st century?. *Literacy*, *53*(1), 3–13. doi: 10.1111/lit.12176.

Fisher, K. A. (2010). *Student engagement in community college online education programs: An exploration of six constructs with implications for practice*. The University of Texas at Austin. Available from: https://repositories.lib.utexas.edu/handle/2152/ETD-UT-2010-05-952

Garrison, D. R., & Cleveland-Innes, M. (2005). In online learning: Interaction is not enough. *The American Journal of Distance Education*, *19*(3), 133–148. doi: 10.1207/s15389286ajde1903.

Gasparski, W., Lewicka-Strzałecka, A., Bąk, D., & Rok, B. (2012). Business ethics. Teaching and learning. *Management and Business Administration. Central Europe*, *3*(116), 5–25. doi: 10.7206/mba.ce.2084-3356.12.

Gopal, R., Singh, V., & Aggarwal, A. (2021). Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID 19. *Education and Information Technologies*, *26*(6), 6923–6947. doi: 10.1007/s10639-021-10523-1.

Hargreaves, A. (2000). Mixed emotions: Teachers' perceptions of their interactions with students. *Teaching and Teacher Education*, *16*(8), 811–826. doi: 10.1016/s0742-051x(00)00028-7.

Hartnett, M. (2016). The importance of motivation in online learning. In *Motivation in Online Education* (pp. 5–32). doi: 10.1007/978-981-10-0700-2_2.

Heilporn, G., & Lakhal, S. (2021). Fostering student engagement in blended courses: A qualitative study at the graduate level in a business faculty. *The International Journal of Management Education*, *19*(3), 1472–8117. doi: 10.1016/j.ijme.2021.100569.

Herrington, J., Oliver, R., & Reeves, T. C. (2003). Patterns of engagement in authentic online learning environments. *Australasian Journal of Educational Technology*, *19*(1), 59–71. doi: 10.14742/AJET.1701.

Jogezai, N. A., Baloch, F. A., Jaffar, M., Shah, T., Khilji, G. K., & Bashir, S. (2021). Teachers' attitudes towards social media (SM) use in online learning amid the COVID-19 pandemic: The effects of SM use by teachers and religious scholars during physical distancing. *Heliyon*, *7*(4), e06781. doi: 10.1016/j.heliyon.2021.e06781.

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, *38*(5), 758–773. doi: 10.1080/03075079.2011.598505.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*(1), 141–151. doi: 10.1177/001316446002000116.

Karasmanaki, E., & Tsantopoulos, G. (2021). Impacts of social distancing during COVID-19 pandemic on the daily life of forestry students. *Children and Youth Services Review*, *120*, 105781. doi: 10.1016/j.childyouth.2020.105781.

Kuh, G. D. (2009). The national survey of student engagement: Conceptual and empirical foundations. *New Directions for Institutional Research*, *2009*(141), 5–20. doi: 10.1002/ir.283.

Lassoued, Z., Alhendawi, M., & Bashitialshaaer, R. (2020). An exploratory study of the obstacles for achieving quality in distance learning during the COVID-19 pandemic. *Education Sciences*, *10*(9), 1–13. doi:10.3390/educsci10090232.

Ma, J., Han, X., Yang, J., & Cheng, J. (2015). Examining the necessary condition for engagement in an online learning environment based on learning analytics approach: The role of the instructor. *Internet and Higher Education*, *24*, 26–34. doi: 10.1016/j.iheduc.2014.09.005.

Maddala, G. S. (1992). Introduction to econometrics. *631*. Available from: https://books.google.com/books/about/Introduction_to_Econometrics.html?hl=pl&id=nBS3AAAAIAAJ

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-kennicutt, W., & Davis, J. (2014). Computers & education effectiveness of virtual reality-based instruction on students ' learning outcomes in

K-12 and higher education: A meta-analysis. *Computers and Education*, *70*, 29–40. doi: 10.1016/j.compedu.2013.07.033.

Merenda, P. F. (1997). A guide to the proper use of factor analysis in the conduct and reporting of research: Pitfalls to avoid. *Measurement and Evaluation in Counseling and Development*, *30*(3), 156–164. doi: 10.1080/07481756.1997.12068936.

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). E-Learning, online learning, and distance learning environments: Are they the same?. *Internet and Higher Education*, *14*(2), 129–135. doi: 10.1016/j.iheduc.2010.10.001.

Motulsky, H. J., & Ransnas, L. A. (1987). Fitting curves to data using nonlinear regression: A practical and nonmathematical review. *The FASEB Journal*, *1*(5), 365–374. doi: 10.1096/FASEBJ.1.5.3315805.

Pituch, K. A., & Lee, Y. (2006). The influence of system characteristics on e-learning use. *Computers and Education*, *47*(2), 222–244. doi: 10.1016/j.compedu.2004.10.007.

Prokopczuk, A. (2012). Motives for choosing a career vs work motivation. *Management and Business Administration. Central Europe*, *5*(118), 29–49. doi: 10.7206/mba.ce.2084-3356.28.

Punjani, K. K., & Mahadevan, K. (2022). Transitioning to online learning in higher education: Influence of awareness of COVID-19 and self-efficacy on perceived net benefits and intention. *Education and Information Technologies*, *27*(1), 291–320. doi: 10.1007/s10639-021-10665-2.

Qazi, A., Qazi, J., Naseer, K., Zeeshan, M., Qazi, S., Abayomi-Alli, O., . . . Haruna, K. (2021). Adaption of distance learning to continue the academic year amid COVID-19 lockdown. *Children and Youth Services Review*, *126*, 106038. doi: 10.1016/j.childyouth.2021.106038.

R Core Team (2021). A language and environment for statistical computing. Available from: https://www.r-project.org/

Raaij, E. M. V., & Schepers, J. J. L. (2008). The acceptance and use of a virtual learning environment in China. *Computers and Education*, *50*(3), 838–852. doi: 10.1016/j.compedu.2006.09.001.

Robinson, C. C., & Hullinger, H. (2008). New benchmarks in higher education: Student engagement in online learning. *Journal of Education for Business*, *84*(2), 101–109. doi: 10.3200/JOEB.84.2.101-109.

Rosh White, N. (2006). Tertiary education in the noughties: The student perspective. *Higher Education Research and Development*, *25*(3), 231–246. doi: 10.1080/07294360600792947.

Salanova, M., Schaufeli, W., Martínez, I., & Bresó, E. (2009). How obstacles and facilitators predict academic performance: The mediating role of study burnout and engagement. *Anxiety, Stress and Coping*, *23*(1), 53–70. doi: 10.1080/10615800802609965.

Selim, H. M. (2007). Critical success factors for e-learning acceptance: Confirmatory factor models ☆. *Computers and Education*, *49*(2), 396–413. doi:10.1016/j.compedu.2005.09.004.

Silander, C., & Stigmar, M. (2019). Individual growth or institutional development? Ideological perspectives on motives behind Swedish higher education teacher training. *Higher Education*, *77*(2), 265–281. doi: 10.1007/s10734-018-0272-z.

Smith, K. A., Sheppard, S. D., Johnson, D. W., & Johnson, R. T. (2005). Pedagogies of engagement: Classroom-based practices. *Journal of Engineering Education*, *94*(1), 87–101. doi: 10.1002/J.2168-9830.2005.TB00831.X.

So, H. J., & Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors. *Computers and Education*, *51*(1), 318–336. doi: 10.1016/j.compedu.2007.05.009.

Song, H., Kim, J., & Luo, W. (2016). Teacher-student relationship in online classes: A role of teacher self-disclosure. *Computers in Human Behavior*, *54*, 436–443. doi: 10.1016/j.chb.2015.07.037.

Stott, P. (2016). The perils of a lack of student engagement: Reflections of a lonely, brave, and rather exposed online instructor. *British Journal of Educational Technology*, *47*(1), 51–64. doi: 10.1111/bjet.12215.

Sun, J. C.-Y., & Rueda, R. (2012). Situational interest, computer self-efficacy and self-regulation: Their impact on student engagement in distance education. *British Journal of Educational Technology*, *43*(2), 191–204. doi: 10.1111/j.1467-8535.2010.01157.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. doi: 10.1007/s11165-016-9602-2.

Taguchi, N. (2020). Digitally mediated remote learning of pragmatics. *Foreign Language Annals*, *53*(2), 353–358. doi: 10.1111/flan.12455.

Tani, M., Gheith, M. H., & Papaluca, O. (2021). Drivers of student engagement in higher education: A behavioral reasoning theory perspective. *Higher Education*, *82*(3), 499–518. doi: 10.1007/s10734-020-00647-7.

Tibshirani, R. (1996). Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society: Series B (Methodological)*, *58*(1), 267–288. doi: 10.1111/J.2517-6161.1996.TB02080.X.

Villanueva, M. L., Ruiz-Madrid, M. N., & Luzon, M. J. (2010). Learner autonomy in digital environments: Conceptual framework. In *Digital Genres, New Literacies and Autonomy in Language Learning* (pp. 1–22). Cambridge Scholars.

Wang, Y., Stein, D., & Shen, S. (2021). Students' and teachers' perceived teaching presence in online courses. *Distance Education*, *42*(3), 373–390. doi: 10.1080/01587919.2021.1956304.

Wilson, C., Broughan, C., & Marselle, M. (2019). A new framework for the design and evaluation of a learning institution's student engagement activities. *Studies in Higher Education*, *44*(11), 1931–1944. doi: 10.1080/03075079.2018.1469123.

Yun, H., & Park, S. (2020). Building a structural model of motivational regulation and learning engagement for undergraduate and graduate students in higher education. *Studies in Higher Education*, *45*(2), 271–285. doi: 10.1080/03075079.2018.1510910.

Zawacki-Richter, O. (2021). The current state and impact of Covid-19 on digital higher education in Germany. *Human Behavior and Emerging Technologies*, *3*(1), 218–226. doi: 10.1002/hbe2.238.

Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker, J. F. (2004). Can e-learning replace classroom learning?. *Communications of the ACM*, *47*(5), 75–79. doi: 10.1145/986213.986216.

Corresponding author
Anna Chwiłkowska-Kubala can be contacted at: anna.chwilkowska-kubala@ue.poznan.pl