Using Ordinal Regression Models to Predict the Difficulties of Blended Education and their Impact on the Teacher and Student. (As a Model for the Northern Technical University (NTU))

Lect. Dr. Ahmad Najim Sheet Al-Shallawi
Asst. Prof. Duha Khalid Abdul-Rahman Al-Malah
Northern Technical University

Abstract

The study aims to develop an ordinal logistic regression (OLR) model to identify the issues that face students, academic teachers, with blended learning with Coivd-19. Additionally, to explore the factors that influence the adoption of (BL) in Northern Technical University (NTU). Finally, to provide an analytical model to facilitate the task for university strategies and their decision-making for solving the problem and to deal with the present suggestions. An e-questioner study of the opinions of teachers and students were used to collect data. The data includes 214 that come from the e-questionnaire that was designed and distributed to the appropriate samples of educational groups. Then, ordinal logistic regression was used to develop 4 models of the effectiveness of each axis. It can be concluded that BL is a useful style of learning. However, it is still suffering from several impediments. One of the biggest obstacles students and staff are facing is the weakness of the internet network because of the inability to connect to fibreoptic Internet. Alongside it, the high prices of internet subscription and the lack of student's modern devices (computer and mobile) to connect to the platform. Another disadvantage is the drop of opportunities for excellence and creative students due to online assessments that allows other students to check the internet for solutions and answers. According to the data, poor connection was the main issue of BL that is facing students and staff. Additionally, the difficulty to get devices and facilities by students was another limitation of BL (cost effectiveness).

Key words: Ordinal logistic regression, blended learning, prediction models, Open lectures, Open collaboration, Open learning. Institutions of higher education.

الملخص

تهدف الدراسة إلى تطبيق نموذج الانحدار اللوجستي الترتيبي (OLR) لتحديد المشكلات التي تواجه التدريسي والطالب في التعلم المدمج باستخدام Coivd-19. لاستكشاف العوامل السلبية او الايجابية التي تؤثر على تبني التعليم المدمج في الجامعة التقنية الشمالية. ومن ثم تقديم توصيات لتسهيل مهمة اتخاذ القرار لموجهة الصعوبات. حيث تم استخدام الاستمارة الاستبيان الالكترونية لجمع بيانات لاراء عينة من أعضاء هيئة التدريس والطلاب في الجامعة. تضمنت البيانات ٢١٤ استجابة للاستبيان الإلكتروني الذي تم تصميمه وتوزيعه على مجتمع الدراسة .بعد ذلك تم استخدام الانحدار اللوجستي الترتيبي لتطوير اربعة نماذج انحدار خصص كل واحد منها لمحور من محاور المختارة. وبعد اجراء التحليل الاحصائي يمكن استنتاج أن التعليم المدمج هو أسلوب مفيد للتعلم. ولكن لا يزال مستخدمه (المعلم والطالب) يعانون من عدة عقبات. أحد أكبر العقبات التي يواجهها التدريسي والطالب هو ضعف شبكة الإنترنت بسبب عدم القدرة على الاتصال بالإنترنت عبر الألياف الضوئية. إلى جانب ذلك ، ارتفاع أسعار الاشتراك في الإنترنت وعدم توفر أجهزة حديثة للطلاب (كمبيوتر وجوال) للاتصال بالمنصة. فضلا عن ضياع فرص التميز والإبداع للطلاب بسبب التقييمات عبر الإنترنت التي تتيح للطلاب جميعا سهولة الحصول على حلول وإجابات الامتحان . وفقًا للبيانات وتحليل الاحصائي لها ، كان ضعف في الاتصال بكل انواعه هو المشكلة الرئيسية في التعليم المدمج التي تواجه التدريسي والطالب. بالإضافة إلى ذلك ، كانت صعوبة الحصول على الأجهزة مثل الحابة والموبايل من قبل الطلاب من القيود الأخرى على BL (الفعالية من حيث التكلفة).

1. Introduction

Has traditional education become a past to be replaced by virtual classes considering the Corona pandemic? Can distance education advance the educational reality of universities?[11] Co-education is a challenging task for many professors of higher education. In addition, junior college students face different types of difficulties that contribute to high dropout rates and repetition rates with less understanding of the course material [12-13]. As the traditional practical teaching curricula do not seem appropriate to help students overcome these difficulties at the present time, without academics being aware of their urgent need to develop and use new teaching and learning approaches that can improve students' learning experience better [14].

Over the current decade, BL has grown in popularity as it has proven to be an effective approach to overcome various difficulties related to traditional teaching methods. Therefore, several professors tried to take advantage of blended learning to improve the performance of their students in their attempts to advance the universities educational path, so they used the various components of BL and adopted different models for blended learning, (including face-to-face learning, open lectures, open group cooperation, and open self-learning) with its contents [15-20]. From imagination, perception, and simulation models when entering virtual laboratories, rather to setting partial attendance schedules for students in scientific laboratories and taking exams.

The most important feature of BL is that it is efficient learning using various educational methods and strategies, and it is considered a motivation and enhancer for the entire educational process. And make it more accessible, and it achieves successful results. Blended learning enables the students to develop their skills on their own by reducing student stress, increasing student self-satisfaction, in addition to increasing interaction and communication between teachers and students.

Blended learning is defined as learning that blends the characteristics of both traditional classroom teaching and online learning in an integrated model, while making the most of the technologies available to each [21]. Also, he [22] defined as learning that deals with one of the teaching or

learning styles in which e-learning merges with traditional learning in the classroom in one framework. Where e-learning tools, whether they are based on computers or on the network, are used in lessons such as laboratory, computers, smart classrooms and the teacher meets the student face to face most of the time. He also knew him [23] that is any educational system in which the student receives his partial education via the Internet, with some elements that allow the student to control the time, place, path and pace of learning. [24] Define it as mixing acts where the traditional teacher in the traditional classroom with the electronic teacher in the virtual classroom, which means that learning combines the advantages of traditional education and e-learning at the same time.

On the other side, applied statistical tools is an essential part of testing the theoretical hypothesises and building the prediction models. One of these tools is the ordinal logistic regression. It was first taken in account by Peter McCullagh [25]. It is an instrument that used to predict an ordinal dependent variable given one or more independent variables that represent a question on a survey is to be replied by a select among strongly agree, agree, neutral, disagree, strongly disagree. In this research, it was applied the ordinal logistic regression to develop four model for explaining the challenges of BL methods based on the students and teachers' opinion. SPSS software was implemented to undertake the statistical tests and developing models of this research.

Procedural definition: BL is a mixture of learning elements and tools such as face-to-face interaction within the traditional classroom and simultaneous and asynchronous learning in an integrated and effective manner as shown in Fig. 1.

Fig. 1: explain how to teach with blended learning in Northern Technical University (NTU)

There are different components of BL. These components are classified based on the type of reaction that each supports. Distance learning theory, the theory most influencing pedagogy and thus BL, which deals with concepts of knowledge that are inseparable from the learner independently; BL is created by interacting with content or individuals [24-27]. Therefore, the components of BL are: **Face-to-face**: A class attended by students where the teacher introduces the materials with few interactive opportunities, practical or training learning opportunities. This curriculum encourages students to work together in class, including discussion groups, and

problem-based learning. This type helps students build a deeper understanding of the content being learned in addition to engage students better while helping students diversify critical thinking and encouraging students to take charge of their own learning. **Open Lectures:** The curriculum is delivered online with a professor by setting speed and increasing interactivity, as an online broadcast, and virtual classroom. This component has the same benefits as a face-to-face professor with the bonus of being site-free. **Open Collaboration:** An educational approach that encourages students to work together via the Internet, for example, online learning communities, and online peer review. Compared to face-to-face collaborative work, this method has no location and time constraints. **Open self-learning**: an educational approach that allows students to study at their own pace, from their location and at their own times, such as reading online and watching videos. Which has four educational benefits of self-paced online learning: (1) Allowing students to choose the most appropriate time for their learning; (2) To allow them to learn at their desired speed; (3) Giving them flexibility to learn anywhere; And (4) allowing them to choose the most appropriate learning strategy.

The research aimed to apply the ordinal logistic regression to find solutions to overcome the most important difficulties and problems facing the student when practicing blended learning, including the scientific model with its various variables to reduce these difficulties. Through the data obtained from the community sample to achieve the desired goal.

2. Ordinal Logistic regression

Ordinal regression is an extension of binary logistic regression. It is used when the data of the dependent variable is composed of more than two ordinal levels for the values of a particular phenomenon [17]. In other words, it is used to facilitate the interaction of response variables (having multiple ordered levels) with one or more independent variables. For example, the data that represents the opinions of a group of people collected using the Likert scale (Strongly Disagree, Disagree, Agree, Strongly Agree.

Suppose we have a random variable$y$ that has a discontinuous distribution of more than two levels: 1,2, 3,…..,k; and let $xi1, xi2, xi3, \ldots\ldots, xim$ be a set of independent variables. Let that a explanatory variable X is linearly associated to the log odds of some appropriate event, a easy approach to check for ordinality is to plot the mean of X stratified by levels of y then the appropriate form for this type of data takes the form [18]:

$$\Pr(y \geq j|X) = \frac{1 + e^{B_{0j} - (B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5)}}{1 + e^{e^{\beta_{0j} + (B1X1 + B2X2 + B3X3 + B4X4 + B5X5)}}}$$

Where: j=1, 2,..,k. And B is parameter coefficients.

If the value of j is fixed, the model will be a binary logistic regression. There is an essential point to mention, if the close categories of y and many of the X(s) cannot differentiate the means, that is a good reason that those levels should be pooled. Additionally, ordinal logistic regression has assumption of proportional odds which means the effect of an independent variable is constant for each raise in the level of response. Thus, the outcome of the model will include different intercepts which means each level of the dependent variable has a different intercept except one, and a unique slope for each independent variable [17,18].

The process of estimating or developing an ordinal logistic model is called parameterisations/ Cumulative logit parameterisations. In order to parametrised, different methods have been suggested, however great care should be considered to explain or interpret the model. The most common methods of parameterisations as follows:

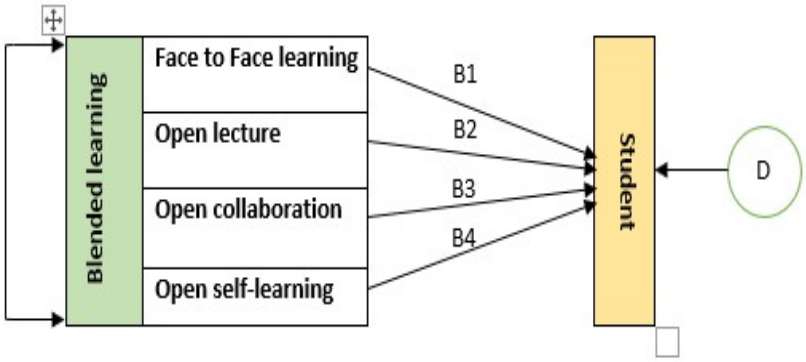
$$\log\left(\frac{p(y \le j)}{1 - p(y \le j)}\right) = B_{0j} - (B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5); \qquad j = 1,2,3,4,5$$

B_{0j} represents the different values of intercept.

$(B_1, B_2, B_3, B_4, B_5)$ indicate that as the value of the independent variable changes (increases / decreases), the value of likelihood of higher-ranking changes (increases / decreases). The interpretation models' coefficients are undertaken based on the proportional odds ratio $exp^{(-B)}$. The developing phase was done using Polytomous Universal Model (PLUM) based on SPSS software. This was done by selecting the Analyse, regression, ordinal and select the goodness of fits statistics, test of parallel lines and parameters estimates. The odd ratio was account to interpret the four models estimated parameters [18,34]. To determine the model's ability to explain changes in the response variable, model fit information and goodness-of-fit was calculated. Additionally, pseudo-squared R were calculated based on the Nagelkerke criterion, which is similar to the coefficient of determination (R square) in multiple linear regression. Then the parameters were estimated for each model in the four models, and here it should be noted forever that it is not possible to rely on the estimated values as found in the third and fourth tables in interpreting the results further to find the value. If the value is greater than one, this indicates that the relationship is positive and strong, but if the value is negative, then this indicates a weak relationship.

3.Methodology:

3.1. The default design of the study:



3.2. Study hypotheses:

Assumptions are considered that require validation and are formulated based on the hypothetical study mode. **The first main hypothesis:** Which is a significant correlation between and the student in the field of study. The blended learning variables are (Face-to-Face, Open lecture, Open collaboration, Open self-learning). **The second main hypothesis:** There is a significant impact

between BL and the student in the field of study. The BL variables are (Face-to-Face, Open lecture, Open collaboration, and Open self-learning).

3.3. Study methodology:

The present study relied on the descriptive and analytical methodology in order to:

1. Achieve the objective of the study and answer the questions and choose the hypotheses through the two axes of theoretical and practical study to enable the compatibility between these parts of the study and analysis.
2. Develop four ordinal logistic models using SPSS software.

3.4. Instrument:

After reviewing the relevant literature, a questionnaire with (26) statements were used in this study to collect primary data. It consists of two parts, the first of which is covered by demographic characteristics, the second section is dedicated to the independent and dependent variables.

3.5. Approved sample:

The targets within the study are an educational community (lecturers and students) of the Northern Technical University (NTU). The method of taking this convenient sample to use in this study is very fast, easy and cost-effective, which made it our preferred choice. Thus, two hundred and fourteen (214) e-questionnaires were collected.

4. Data Analysis

Our survey includes 26 questions. Six of them represent the demographic information of our sample. And 20 of questions represent the Likert scale of four dimensions: Face to Face learning, Open lectures, open Collaboration and open self-learning. Both student and teachers answered the same question, and it was developed four models for students and teachers, respectively.

The dependent variable includes five level based on the Likert scale and the independents variable too. Each model has 5 Independent variables that are represented the five questions. First selected variables were done for each model separately. After the process of selecting the variables, they were entered into the process of developing or building the four models, according to their significance or importance in explaining the changes in the adopted variable.

4.1. Descriptive demographic data analysis:

As shown in the table (1) below, The descriptive analysis of the data indicates that 68.1% are for the youth age group, 51.4% of the respondents are males, 72.2% are students, and that the percentage of the number of years of service for educational personnel is the least-served group and reached 39.5% , 52.5% of respondents hold a master's degree. And 41.1% with a scientific title of teacher in the target sample [24].

Table (1) Descriptive Analysis –Profile of respondents

Demographic and functional variables	Frequency	Percentage%
Age: less 25\25-35\35-45\45-55\more 55	148\27\25\11\5	68.1\12.7\11.7\5.2\2.3%
Gender: Male\Female	110\104	51.4\48.6%
Type: student\teacher	163\51	76.2\23.8%

Years of service: less10\10-20\20-30\more30	**34/30/15/7**	**39.5\34.9\17.4\8.1%**
Educational level: BA\high diploma\Master & PHD	**3\7\31\18**	**5.1\11.9\52.5\30.5%**
The scientific title: assistant teacher\teacher\assistant prof.\prof.	**20\23\9\4**	**35.7\41.1\16.1\7.1%**
No. of student	**163**	**72.17**
No. of teacher	**51**	**27.83**

4.2. Examining Reliability of Scale Items

Cronbach's alpha was used in this study based on the applied tool (Spiliotopoulou, 2009) and with respect to the Cronbach's alpha values that were (0.784, 0.831) as presented in the table (2). Additionally, the total values for each of the Lecturer and students reflect a good degree of internal consistency considering that both exceed the valid value limit (0.60) [28-30].

Table (2) Reliability and collinearity Test

variables	Reliability test
Student	.831
teacher	.784

4.3. Results and discussions:

The results reveal that the problems and difficulties associated with BL and the extent of management satisfaction with the availability of ease of use is a correct idea to move towards BL. The results reveal that the effect of BL on ineffectiveness of learners to be negatively predicted on achievement, participation, and retention of cognitive outcomes. Additionally, the results also indicate that the effect of BL on faculty effectiveness is significantly influenced by delivery, performance, evaluation, and motivation. In addition to the lack of its contribution to the theoretical enrichment of the educational process and the lack of quality of teaching through the lack of interaction of students and the lack of eagerness to receive e-learning, with the inability to manage the course time for its dependence on the Internet, which suffers from weakness and general weakness

Main hypothesis H0: There is a significant effect of BL difficulties on students. The researchers divided the answers into two parts:

There is a moral effect among BL difficulties on students. The statistical analysis was divided into two parts:

First - the statistical analysis of students: As shown in Table (3), the axes (**face to face, open lecture, open cooperation and open self-learning**), the values of the distribution tests for the categorical variables of the chi-square were significant and their values were as follows (**51.326, 82.084, 78,576, 117.782**), and that the values of the non-significant deviation tests are

(**243.694,197.653, 140.456, 178.143**) at the level (**0.05**), and the sentences with significant significance are [**(I find it difficult to prepare the lecture, I need time to prepare it), (dissatisfaction with the transformation to the integrated learning), (network disturbances as a reason for the failure of the team collaboration), (the student did not get all the educational elements)**], and the answer tended towards [**(agree), (strongly agree), (strongly agree) and (strongly agree)**], These values in the models reflected the quality of the statistical analysis. Therefore, the task of the research team became to find ways to solve the problems facing both students and teachers. Therefore, Google added to the G-suite platform benefiting from what Google added to the G-suite platform. Usage and administration with the ability to log in. Recording of lectures and practical workshops makes the process of preparing the lecture interesting, comfortable and easy. The teacher can design and prepare educational portfolios with ease and harmony.

Table (3) Model fitting information for students

Axis	Chi-square	Deviance	Statement	Estimate (B)	St. Error	Sig.
Model1 Face to face learning	51.326	243.694	I am having difficulties preparing the lecture, as I need time to prepare it.	-24.046	.000	-
				-1.856	.710	.009
				-.936	.538	.082
				-1.346	.469	.044
Model2 Open lecture	82.084	197.653	Not feeling satisfied with switching to blended learning.	-4.538	1.399	.001
				-3.022	.707	.000
				-1.121	.526	.033
				-1.331	.529	.12
Model3 Open collaboration	78.576	140.456	Network disruptions are a reason team collaboration has not worked well	.633	2.339	.787
				-6.016	1.610	.000
				-3.460	.859	.000
				-1.584	.515	.002
Model4 Open-self learning	117.782	178.143	The student did not obtain all the educational elements	19.534	2.026	.000
				-4.646	.932	.000
				-1.397	.611	.022
				-1.6161	.508	.001

Second: the statistical analysis of teacher. As shown in Table (4), the axes (**face to face, open lecture, open cooperation and open self-learning**), the values of the distribution tests for the categorical variables of the chi-square were significant and their values were as follows (**32.653, 106.513, 43,149, 103.957**), and that the values of the non-significant deviation tests are (**68.518, 33.246, 35,941, 34.844**) at the level (**0.05**), and the sentences with significant significance are [**(I am facing difficulties in preparing the large number of questions), (The low quality of using designs in electronic platforms contributed to the lack of qualitative scientific outputs), (Network disruptions are a reason team collaboration has not worked well), (The lack of**

equal equipment available to the professor and the learners in their homes)], and the answer tended towards [**(agree), (strongly agree), (strongly agree), (strongly agree)**], These values in the models reflected the quality of the statistical analysis.
Significant effect of the BL dimensions on academic teachers, this result obliged us **to reject the null hypothesis and accept the null hypothesis.**

Table (4) Model fitting information for teachers

Axis	Chi-square	Deviance	Statement	Estimate (B)	St. Error	Sig.
Model1 Face to face learning	32.563	68.518	I am facing difficulties in preparing the large number of questions	-4.711	2.021	.020
				-.551	1.519	.717
				-1.771	1.195	.138
				0	-	-
Model2 Open lecture	106.513	33.246	The low quality of using designs in electronic platforms contributed to the lack of qualitative scientific outputs	10.899	68.591	.874
				-4.411	1.889	.020
				-2.081	1.765	.238
				-3.039	1.416	.032
Model3 Open collaboration	43.149	35.941	Network disruptions cause group collaboration to fail	-2.763	1.969	.161
				-25.255	.000	-
				-5.168	1.560	.001
				0	-	-
Model4 Open-self learning	103.957	34.844	The lack of equal equipment available to the professor and the learners in their homes.	0	-	-
				-3.166	1.221	0.10
				-2.437	1.133	0.32
				0	-	-

5.Conclusion and recommended

Conclusion

All in all, the advantages of the BL system are that the teachers and the students are satisfied. However, there are still some barriers related to BL e.x. exams, lack of users' experience, poor connections and cost-effectiveness.
Therefore, the study concluded that there are several obstacles and problems facing each of the professor and the student that contribute to rejecting e-learning and returning to traditional education, including the percentage of control and controlling the electronic class less than the traditional class, in addition to the full commitment to the lecture timing included in the schedules and the student not arguing that the internet is weak or interrupted. E-learning added a burden to

the teaching with the necessity to prepare systematic and programmed electronic lectures and bags in an attractive and interesting way, so the need for learning and entering into training courses became urgent, which was reflected in the time spent and prolonged by producing various lectures that the student wanted to continue and present the lecture without boredom or monotony. Teaching research production as well as administrative production.

The study also emerged from the loss of satisfaction and acceptance of e-learning because the diligent students were not able to obtain the first ranks they aspire to, because most of the students obtained high grades, which lost the quality of education and graduated generations with little understanding and awareness.

Recommended

After analysing the data of the studies, the extracted data were analysed using a narrative format according to predetermined topics and the incidence of the research questions. Topics included: Face- to -Face, open lecture, open collaborate and open self-learning. The aim of this study was to investigate the different BL models that have been applied in BL disabilities and the outcomes associated with them. Four separate models were identified for each of the students and professors to be classified according to speculative values that showed a significant effect between the independent variable and the adopted variable. As it appears there are difficulties and obstacles that limit reliance on BL and return to traditional education, to adopt the first, which is BL on the unreliable internet network for many Its cuts and weaknesses in general. In addition, face-to-face model has the ability to activate the student and increase their ability to focus and pay attention during the lecture delivery, and the four models must be applied cautiously with the renewal of the necessary methods and strategies to ensure monitoring of the student's performance and the continuity of his work via the Internet. For this reason, the teacher needs skill and a full and comprehensive knowledge of all the platforms, programs and applications contained in blended learning with all its capabilities, tools and components to harness and link them to the events of the virtual classroom.

The study made recommendations in this area to avoid the negative effects of BL, namely:

1- The necessity to adopt the BL as a means to improve the educational performance of students and to diversify the teaching activities at the university.

2- It is necessary to change the annual curricula and decisions and make them quarterly.

3- Financial support for the student to be able to acquire a personal computer to help them in their studies.

4- Providing halls and laboratories of large sizes when attending so that social distancing is applied to students.

5- Encouraging teamwork via the Internet to design projects, reports or research.

6- Adopting intellectual and mental questions and formulating them in a way that increases the student's attention and allocating grades on daily and monthly activities and duties to enable first students to achieve their academic goals and obtain their entitlement.

References

1. Banditvilai, C., 2016. Enhancing students' language skills through blended learning. *Electronic Journal of e-Learning*, 14(3), pp.220–229.

2. Charbonneau-Gowdy, P., 2018. Beyond stalemate: seeking solutions to challenges in online and blended learning programs. *Electronic Journal of e-Learning*, 16(1), pp.56–66.
3. Clark, R.E., 1994. Media will never influence learning. *Educational technology research and development*, 42(2), pp.21–29.
4. Clark, R.E., Kirschner, P.A. and Sweller, J., 2012. Putting students on the path to learning the case for fully guided instruction. *American Educator*, 36(March), pp.6–11.
5. Cronje, J.C., 2006. Paradigms regained: toward integrating objectivism and constructivism in instructional design and the learning sciences. *Educational Technology Research and Development*, 54(4), pp.387–416.
6. Davis, N.T., Jo McCarty, B., Shaw, K.L. and Sidani-Tabbaa, A., 1993. Transitions from objectivism to constructivism in science education. *International Journal of Science Education*, 15(6), pp.627–636.
7. Driscoll, M., 2002. Blended learning: let's get beyond the hype. *E-learning*, 1(4), pp.1–4.
8. Al-malah, duha khalid, 2020, "*The Interactive Role Using the Mozabook Digital Education Application and its Effect on Enhancing the Performance of eLearning*", Northern _Technical University(NTU), Mosul, Iraq.
9. Elander, K.R., 2012. *Merging paradigms: The integration of objectivist and constructivist approaches in university settings*. [online] *ProQuest Dissertations and Theses*. Capella University. Available at: <https://search.proquest.com /docview/1035351588?accountid=8144>. [Accessed 6 Nov 2019]
10. Elander, K. and Cronje, J.C., 2016. Paradigms revisited: a quantitative investigation into a model to integrate objectivism and constructivism in instructional design. *Educational Technology Research and Development*, 64(3), pp 389 - 405.
11. Elen, J., 2017. Implications: cherishing the middle ground. In:L. Lin and J.M. Spector, eds. 2017. *The Sciences of Learning and Instructional Design*. Routledge, pp.85–93.
12. Friesen, N., 2012. Defining blended learning. *Learning Spaces*, [online] (August), p.10. Available at: https://www.normfriesen.info/papers/Defining_Blended_Learning_NF.pdf. [Accessed 6 Nov 2019]
13. Graham, C.R., 2006. Blended learning systems. In C.J. Bonk and Graham, eds. 2012.*The handbook of blended learning*, Hoboken, NJ: Wiley E Sons. pp.3–21.
14. Gynther, K., 2016. Design Framework for an adaptive MOOC enhanced by blended learning:. *Electronic Journal of e- Learning*, 14(1), pp.15–30.
15. Jakab, I., Ševčík, M. and Grežo, H., 2017. Model of higher GIS education. *Electronic Journal of e-Learning*, 15(3), pp.220– 234.
16. Jonassen, D.H., 1991. Objectivism versus constructivism: do we need a new philosophical paradigm? *Educational technology research and development*, 39(3), pp.5–14.
17. Harrell Jr, F. E., Regression modeling strategies: with applications to linear models, logistic and ordinal regression, and survival analysis. Second ed.; Springer: 2015.
18. Harrell, F. E.; Lee, K. L.; Mark, D. B., Multivariable prognostic models: Issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. Statistics in Medicine 1996, 15 (4), 361-387.

19. Kintu, M.J. and Zhu, C., 2016. Student characteristics and learning outcomes in a blended learning environment intervention in a Ugandan University, Mountains of the Moon University and Vrije Universiteit Brussel. *The Electronic Journal of e-Learning*, 14(3), pp.181–195.
20. Kozma, R., 1994. Willmedia influence learning? Reframing the debate. *Educational technology research and development*. [online] Available at: <http://link.springer.com/article/10.1007/BF02299087> [Accessed 1 Jul. 2016].
21. Kurtz, C.F. and Snowden, D.J., 2003. The new dynamics of strategy: sense-making in a complex and complicated world. *IBM systems journal*, 42(3), pp.462–483.
22. Lowrey, A.E., 2013. *Behaviorism vs. constructivism*. Available at:<https://athenaeum.libs.uga.edu/handle/10724/29910>. [Accessed 6 Nov. 2019]
23. Nakayama, M., Mutsuura, K. and Yamamoto, H., 2016. Student's reflections on their learning and note-taking activities in a blended learning course. *Electronic Journal of e-Learning*, 14(1), pp.43–53.
24. Nortvig, A.-M., Petersen, A.K. and Hattesen Balle, S., 2018. A literature review of the factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement. *The Electronic Journal of e- Learning*, 16(1), pp.46–55.
25. McCullagh, Peter. "Regression models for ordinal data." Journal of the Royal Statistical Society: Series B (Methodological) 42.2 (1980): 109-127.
26. Onguko, B., 2014. JiFUNzeni: A Blended Learning Approach for Sustainable Teachers' Professional Development. *Electronic Journal of e-Learning*, 12(1), pp.77–88.
27. Russell, T.L., 1999. *The no significant difference phenomenon: a comparative research annotated bibliography on technology for distance education: as reported in 355 research reports, summaries and papers*. Raleigh, NC: North Carolina State University.
28. Shipley, P., 2017. Coaching and evidence-based learning. *Journal of Community Safety and Well-Being*, 2(3), pp.116–118.
29. Soeiro, D., de Figueiredo, A.D. and Ferreira, J.A.G., 2012. Mediating diversity and affection in blended learning: a story with a happy ending. *Electronic Journal of e-Learning*, 10(3), pp.339–348.
30. Tshabalala, M., Ndeya-Ndereya, C. and van der Merwe, T., 2014. Implementing blended learning at a developing university: obstacles in the way. *Electronic Journal of e-Learning*, 12(1), pp.101–110.
31. Uziak, J., Oladiran, M.T., Lorencowicz, E. and Becker, K., 2018. Students' and instructor's perspective on the use of blackboard platforms for delivering an engineering course. *Electronic Journal of e-Learning*, 16(1), pp.1–15.
32. Vignare, K., 2007. Review of literature, blended learning: using ALN to change the classroom–will it work. In:AG Picciano & CD Dziuban (Red.), *Blended learning: research perspectives* (pp 37-63). Needham, MA: Sloan Consortium.
33. Weegar, M.A. and Pacis, D., 2012. A comparison of two theories of learning-behaviorism and constructivism as applied to face-to-face and online learning. In: *Proceedings, e-leader conference, Manila*.
34. https://statistics.laerd.com/spss-tutorials/ordinal-regression-using-spss-statistics.