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Onliners versus On-grounders in Higher Education: A Two-Step Cluster Analysis

Alan Peslak
arp14@psu.edu
Information Sciences and Technology, Penn State University
Dunmore, PA 18512 USA

Lisa Kovalchick
kovalchick@pennwest.edu
Computer Science and Information Systems
Pennsylvania Western University
California, PA 15419 USA

Wenli Wang
wangw@rmu.edu

Paul Kovacs
kovacs@rmu.edu

Computer and Information Systems
Robert Morris University
Moon Township, PA 15108 USA

Abstract

Are students who prefer online education different from those who prefer on-ground education, and how? This is an important question because educational institutions need to better understand student segmentations. This research answers this question by examining 251 survey responses of students enrolled in Computer Information Systems courses at three universities over five years (2016-2021). It reviews student attitudes, perceived skills, and their sociological characteristics. Through two-step cluster analysis unsupervised machine learning, two distinct clusters of students emerged -- Onliners and On-grounders. Eleven group characteristics are identified. The top nine out of these 11 characteristics for Onliners, in comparison to the On-grounders, are: select more online courses, regard online instruction as effective, work better without supervision, rely less on classroom interactions in learning, value convenience, can prioritize, are better organized, better prepared, and older. Identifying student segmentations by group characteristics supports decision making in student recruitment and retention as well as educational resource allocation.

Keywords: Online education, face-to-face instruction, cluster analysis, machine learning, persona, cluster

1. INTRODUCTION

As the onset of the COVID-19 pandemic brought about an abrupt transition from traditional on-ground education to online learning, online education has become a focal point of research for educators. Although online education existed pre-pandemic, the pandemic has made it much more prevalent. Now with the shift to more relaxed COVID-19 restrictions and, hopefully, the end of the pandemic, decision-makers in Higher-Education face challenges in making the right decisions concerning online versus on-ground education such as student recruitment/retention, resource allocation, and policy making.

These decision-making challenges concerning online versus on-ground education have resemblance to those faced by CEOs concerning remote versus in-office work. Some firms such as Yelp, AirBnB, 3M, Lyft and Spotify have gone fully-remote (Lufkin, 2022). PayPal posts both "fully remote" and "opt for remote" jobs. SAP allows employees to choose from remote, in-office, or hybrid work (Smith, 2022). JPMorgan Chase's CEO, Jamie Dimon, on the contrary, has a long-held preference of in-office work (Shevlin, 2022).

Despite some CEO's preference, many firms have based their decisions of employee work locations on meeting employees' expectations. Microsoft surveyed over 31,000 employees in 31 countries in 2022, and 52% of them were willing to switch to fully-remote or hybrid jobs (Microsoft, 2022). Employees are now more likely to prioritize their health and wellbeing over work; this is especially true of employees who are parents and/or women (Microsoft, 2022).

Although in-office work may help strengthen culture, improve collaboration, and reinforce purpose (Markman, 2021) and remote work may reduce costs and offer flexibility, the long-term impact of remote work is inconclusive. Similarly, Peslak, Kovalchick, Wang, and Kovacs (2021) have shown there are mixed-results pertaining to online education. Just as employees in different clusters have varied expectations and performances, students in different clusters could have varied attitudes and learning effectiveness (Peslak et al., 2021). For instance, 81% of under-35 year olds fear loneliness from long-term homeworking (Bishop, 2022). Do young students fear more adverse effects of online education?

In order to better understand online versus on-ground education, it is important to utilize cluster analysis to identify distinct student groups and their characteristics. Therefore, this research aims to answer the following research questions.

RQ1: Do students, who prefer online education, and those, who prefer on-ground education, comprise different clusters?

RQ2: Is there a different set of characteristics of each cluster – students preferring online versus students preferring on-ground?

Cluster analysis is used in a number of industries to distinguish attributes of a large population of subjects. Over the years, cluster analysis has been commonly used in a variety of areas including: biology, psychology, social sciences, medicine, etc. (Tan, Steinbach, Karpatne, & Kumar, 2019). Cluster analysis, as an often-deployed methodology of studying market segmentations, is applied in this research to identify student segmentations. Since the field of online education is relatively new in comparison to the field of, for example, biology, there is a lack of research in group characteristics in online education using cluster analysis. This study aims to fill this gap.

Research in student profiling exists, but with different emphasis. Ortega-Maldonado, Llorens, Acosta, and Coo (2017) emphasized post-graduate student profiling and built student profiles of face-to-face versus online education before the COVID-19 pandemic. Our research includes both undergraduate and post-graduate students in both pre-pandemic and pandemic time. It examines the survey responses from students enrolled in Computer Information Systems (CIS) courses at three universities over five years (2016 to 2021). It reviews students' attitudes towards online learning, their perceived skills, and sociological characteristics. It aims to identify student segmentations. By better understanding student segmentation, this research aims to provide insights into the types of students who prefer online versus on-ground education. It provides decision support regarding resource allocation, policy making, and how to better market to, recruit, and retain students within these two potentially distinct groups.

2. LITERATURE REVIEW

Online versus on-ground education

The onset of the COVID-19 pandemic has caused the abrupt transition from on-ground education to online education. Although there were studies on the impact of the transition (Leboff, 2020), as

well as students' preferences (Lederman, 2020; McKenzie, 2021; Castro & George, 2021) and students' performances (Almahasees, Mohsen, & Amin, 2021; Peslak et al., 2021) in different educational modes, there is limited literature that has examined student clusters and investigated whether there are distinct characteristics of students' preferring online education versus those preferring on-ground education.

As mentioned earlier in this paper, studies have been conducted, in an industry setting, which examine different characteristics of employees preferring remote versus in-office work. However, the education sector has not conducted comparable research.

Cluster Analysis

Cluster analysis is a statistical process wherein data are placed into groups (i.e., clusters) based on how closely each item relates to a given set of variables. Classification is considered the most common use of cluster analysis; subjects are separated into groups such that each subject is more similar to other subjects within its group than to subjects outside of the group (Qualtrics, 2022). The success of clustering lies in the distinctness of the clusters that result from its application; the goal is to increase the similarity of items within a group (i.e., cluster) and to increase the difference between groups (Tan et al., 2019).

Although it is getting renewed interest with the emerging field of data science, cluster analysis is not a new concept, as it is often used to identify groups. As Scoltock (1982) noted, cluster analysis was first developed to study the fields of biology and zoology; within these fields, clusters were used to group plants and animals and to create taxonomies for the resulting groups.

In the field of medicine, cluster analysis is commonly used to group patients for the purpose of diagnosis and treatment. Ortega, Suruki, Albers, Gordon, & Yancey (2014) used cluster analysis to characterize groups of patients with severe asthma to determine the appropriate treatments for each group of patients. McLachlan (1992) examined cluster analysis methods used to characterize patients on the basis of clinical and/or laboratory type observations. Dilts, Khamalah, and Plotkin (1995) applied cluster analysis to make decisions regarding medical resource allocation in an effort to cut costs of medical expenses.

The social sciences often employ cluster analysis to group individuals who share similar characteristics. Henry, Tolan, and Gorman-Smith (2005) examined the use of cluster analysis in family psychology research. Their work discusses the potential use of various clustering methods and presents cautions to the use of such methods when studying family psychology. Borgen (1987) studied the use of cluster analysis in counseling psychology research.

Cluster analysis is also popular in the field of business, where it is often utilized in marketing research and market segmentation. Punj and Stewart (1983) reviewed numerous applications of cluster analysis used for market research and recommended alternative clustering methods including the two-stage method. Tu, Dong, Rau, and Zhang (2010) used cluster analysis to present a case study on persona creation. Using these methods, they were able to group the participants of their case study by similarities in their goals and decision-making preferences.

More recently, cluster analysis has been used in the online realm. Shiau, Dwivedi, and Yang (2017) conducted a meta-study of 2,565 articles and 81,316 citations on social-networking-related publications between the years of 1996 and 2014 and used cluster analysis to group (i.e., factor) seven core characteristics of social networks. As a relatively new methodology to the field of online education, Perrotta and Williamson (2018) examined the relevance of cluster analysis in categorizing and measuring online education, specifically focusing on algorithms used in learning analytics. They focused on introducing the social science methodology to education, rather than profiling online students.

3. METHODOLOGY

An online survey regarding students' perceptions of the effectiveness of various course delivery methods was administered between the years of 2016 and 2021 at three universities: one private, one state-owned, and one state related. The survey was IRB approved at each of the three universities and QuestionPro online survey software was used to administer the survey to students enrolled in CIS courses, regardless of major.

Two-step cluster analysis was employed to answer the two research questions regarding: whether there are specific groups of students who shared similar characteristics with regard to their attitudes toward online education, and, if so, identifying these characteristics.

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Cluster analysis, or clustering, is an unsupervised machine learning task. It involves automatically discovering natural groupings in data. Unlike supervised learning (like predictive modeling), clustering algorithms in unsupervised learning only interpret the input data and find natural groups or clusters in feature space (Wilson, 2020).

Silhouette score (i.e., silhouette coefficient) is a typical measure of the goodness of a clustering technique. It ranges from -1 to 1. A silhouette score of 1 means that the clusters are very dense and nicely separated; whereas, a silhouette score of 0 means that clusters are overlapping. A silhouette score of less than 0 means that data belonging to clusters may be incorrect.

Cluster results are considered appropriate when the silhouette score is greater than 0.2. Though 0.2 is regarded as a fair score (Boos, Wang, Karst, Hymel, & Pediatric Brain Injury Research Network, 2021), the goal in this study was to obtain a minimum silhouette score of at least 0.3 as an indication of more robust clustering. To achieve this outcome, an iterative process of eliminating variables was deployed.

SPSS 27 was used to perform a two-step cluster analysis on the data set. Rundle-Thiele, Kubacki, Tkaczynski, and Parkinson (2015) explained that two-step cluster analysis in SPSS uses the log-likelihood measure to reveal natural groupings in a data set. It forms clusters based on both continuous and categorical data (Chiu, Fang, Chen, Wang, & Jeris, 2001; Norusis, 2008). Data transformation prior to analysis is also unnecessary.

4. RESULTS

The overall survey response at three universities in years between 2016 and 2021 was nearly 700. However, some of the respondents did not complete the entire survey; therefore actual number of responses to each survey question varied by question. For this two-step cluster analysis unsupervised machine learning methodology, our research focused on the student responses that answered all 34 survey questions. Since there were already over 250 survey responses with all 34 survey questions answered, the dataset for this research contains these 251 responses. Due to the lack of time to examine each and every survey question, this research did not apply statistical methods, such as imputation, to replace missing values in order to increase the size of the data set. Regardless of this caveat, the sample size of 251 still represents a robust group for valid research.

Among the 251 students who completed the survey, 36% were female and 64% were male. The majority of these survey respondents (59%) were in the age group of 18-21. The percentage of respondents in other age groups decreased, as the ages increased, as shown in Figure 1. This basic demographic information demonstrates that the sample is representative of the population of students enrolled in CIS courses at all three universities between the years of 2016 and 2021.

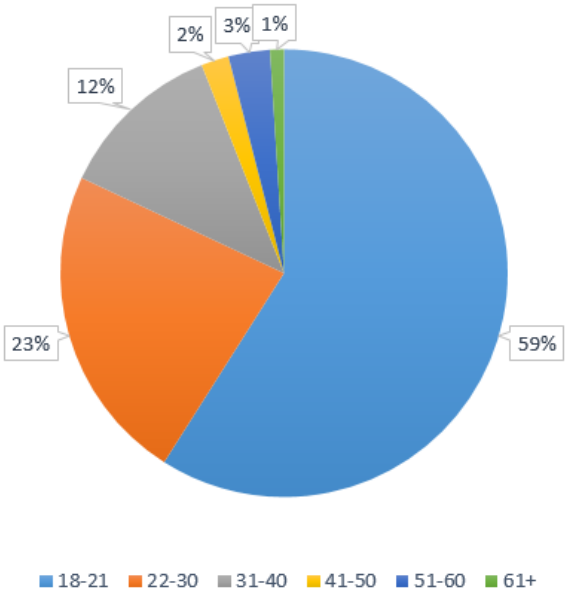

Figure 1: Percentage of Survey Respondents Grouped by Age

Research Question 1: Do students, who prefer online education, and those, who prefer on-ground education, comprise different clusters?

To answer the first research question, the following steps were taken in the data analysis.

The first step was to include all possible relevant variables in the cluster analysis. This pass included 26 relevant variables (out of 34 total variables) and did not produce any clustering, resulting in a lack of differentiation of any distinct groups or differentiated clusters.

Next, a review began to eliminate variables that were non-relevant or non-independent. This reduced the number of variables from 26 to 20. The questions where these 20 variables were extracted are shown in Appendix A. When cluster

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analysis was performed on these variables, two clusters were identified, as shown in Figure 2.

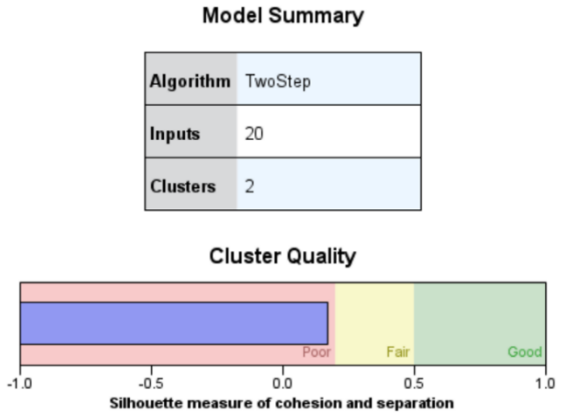


Figure 2: Clusters Obtained by Analyzing 20 Variables

The output of the 20-variable analysis depicts two clusters that were obtained from the two-step analysis. Details of the output are not illustrated in this paper due to the limitation of space. Variables were ordered based on importance, with the most important variable listed at the top. In this iteration, the most important variable was the expectation of online effort required. The first cluster had a highest selection of "less effort expected for online courses" with 68.5% expecting less effort; while the second cluster had a highest selection of "same effort expected for online and on-ground courses" with 53.2% expecting the same amount of effort. Similarly, each variable from the output can be interpreted in this fashion. The second most important variable was perception of online course effectiveness. Moving down through the list of variables, the importance of each variable becomes less in each cluster. And the last two variables have no effectiveness. Since this second pass resulted in only an acceptable silhouette average of 0.2 and many variables had low or no impact, these low or no impact variables were regarded as less relevant and hence eliminated iteratively in subsequent passes in order to create more robust clusters, indicated by achieving a higher average silhouette such as 0.3.

In the next iteration, after eliminating the last two variables of the second pass that showed no effectiveness, the silhouette results remained at 0.2. Thus, variable eliminations were iteratively performed until achieving a silhouette of 0.3. This occurred when eleven (11) variables remained as predictors.

The model summary graphic from SPSS is shown in Figure 3. The silhouette, though fair, has achieved the 0.3 goal.

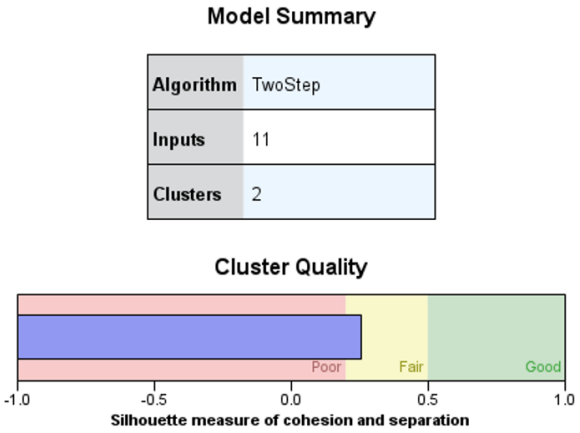
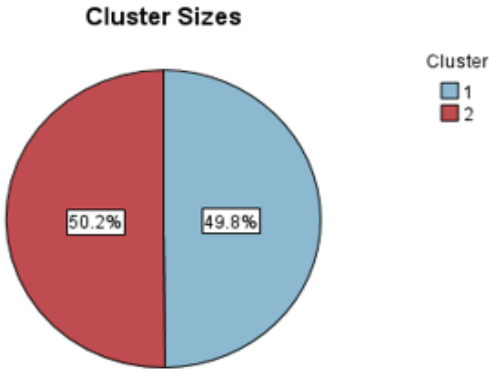


Figure 3: Clusters Obtained by Analyzing Remaining 11 Variables

As shown in Figure 4, there are two clusters of nearly equal size. These two clusters demonstrate that there are two distinct groups of students; those who prefer online education (Onliners) and those who prefer on-ground education On-grounders). Cluster 1 includes 49.8% of the survey respondents and represents Onliners and Cluster 2 includes 50.2% of the survey respondents and represents On-grounders.



Size of Smallest Cluster	125 (49.8%)
Size of Largest Cluster	126 (50.2%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.01

Figure 4: Cluster Sizes

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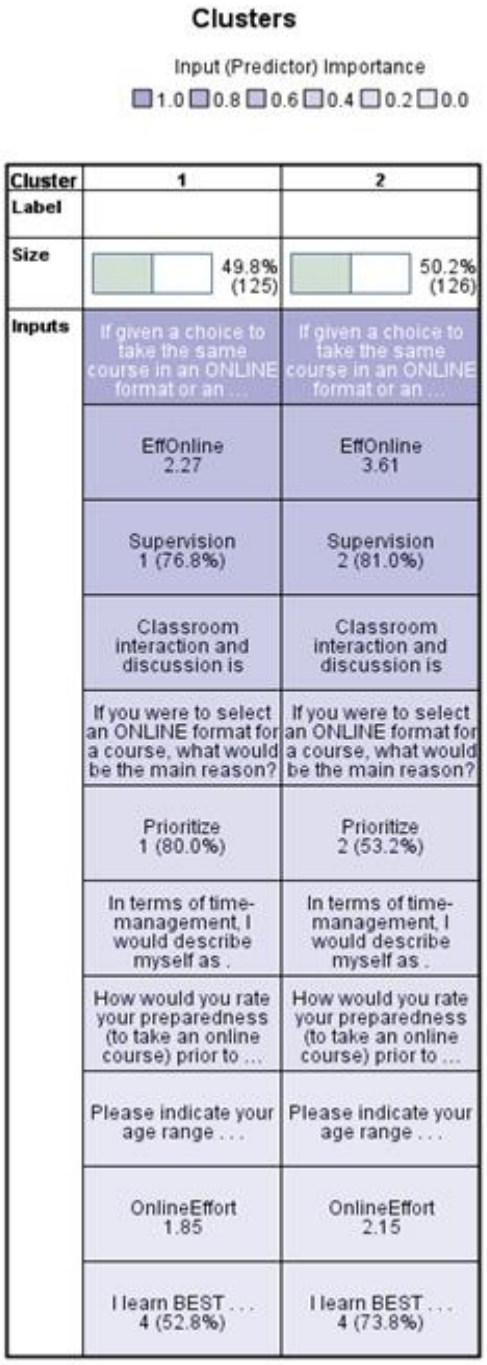

Table 1: Variables Identifying the Characteristics of Each Cluster, Listed in Order of Importance, and with Some Descriptive Statistics

It should be noted that during the iterative variable elimination process, some variables regarding demographics were eliminated such as gender, employment status, full-time versus part-time student status, etc. These eliminations indicated the non-significant impact of these demographics in cluster identification. The only impactful demographic variable in the remaining 11 variables was age, which will be discussed briefly later in the paper.

Research Question 2: Is there a different set of characteristics of each cluster – online versus on-ground?

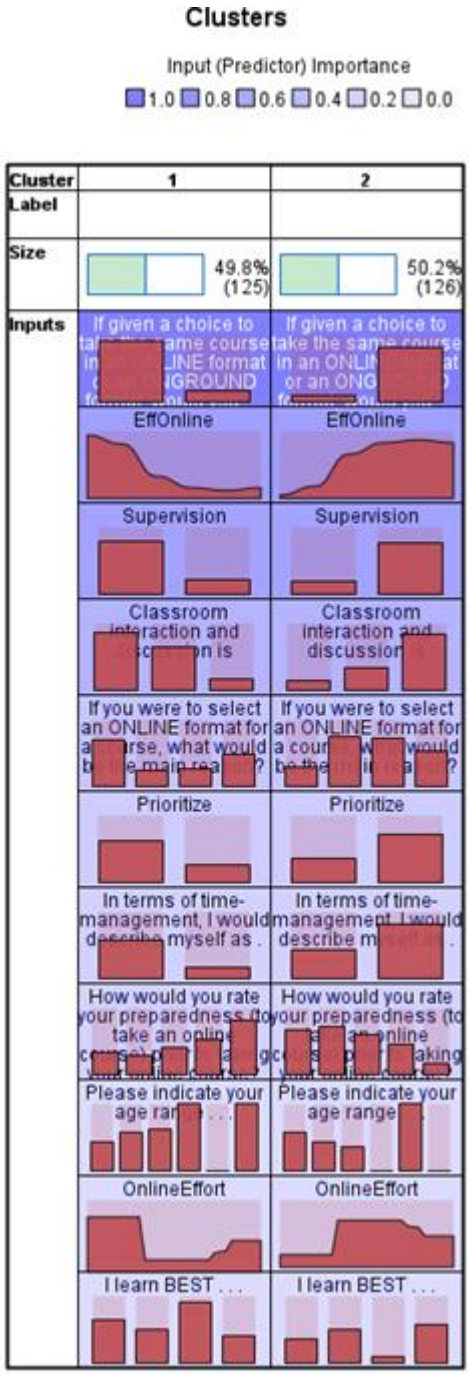

Table 2: Relative Frequencies of Responses to Each Question/Characteristic in Graphical Form

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Table 1 and Table 2 roughly demonstrate the clusters and the variables used to identify the characteristics in the clusters. These characteristics are listed in order of importance, with the most important variable listed first. Table 1 depicts some descriptive statistics; whereas, Table 2 provides some rough graphical presentations. Precise data analysis is provided in detail in later tables and figures.

Figure 5 displays a graphical presentation of predictor importance of each variable.

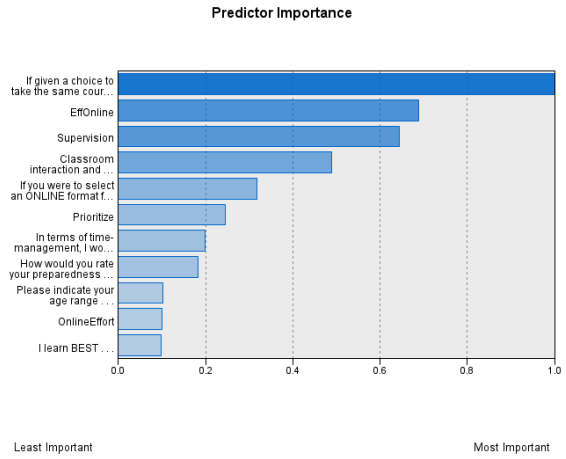

Figure 5: Predictor Importance for Each Variable

Next, key variables were reviewed in detail, in terms of predictor importance and how they define clusters, with regard to online education.

The variable with the highest predictor importance, shown in Table 3, is the question regarding selection of the online versus on-ground course format. Here, there is a clear dichotomy with 91% of the respondents in Cluster 1 preferring online and only 18% of the respondents in Cluster 2 preferring online. Hence, this reinforces the clarity of the conclusion that two discrete clusters exist in the data set, one that prefers online (i.e., Cluster 1, the Onliners) and another that prefers on-ground (i.e., Cluster 2, the On-grounders).

The second most important predictor is the rating of the effectiveness of online instruction. As shown in Table 4, Cluster 1 (the Onliners) rated online education to be effective with an average rating of 2.27; while Cluster 2's (the On-grounder's) rating of online education leaned more towards somewhat ineffective with an average rating of 3.61.

If given a choice to take the same course in an ONLINE format or an ONGROUND format, would you select the ONLINE format?				
	Yes		No	
Cluster	Freq.	%	Freq.	%
1: Onliners	100	**91%**	25	18%
2: On-grounders	10	9%	116	**82%**

Table 3: Frequency and Percentage Results, by Cluster, for "Select ONLINE Format"

	Effective Online	
Cluster	Mean	Std.
1: Onliners	**2.27**	.928
2: On-grounders	**3.61**	1.103
Combined	2.94	1.219

Table 4: Rating Results, by Cluster, for "Effectiveness of Online Instruction"

The ability to work with or without direct supervision was the next most important predictor. As shown in Table 5, 80% of the respondents in Cluster 1 (the Onliners) indicated they work best without direct supervision compared to those in Cluster 2 (the On-grounders), of which 78% work better with direct supervision.

Work better				
	Without Supervision		With Supervision	
Cluster	Freq.	%	Freq.	%
1: Onliners	96	**80%**	29	22%
2: On-grounders	24	20%	102	**78%**

Table 5: Frequency and Percentage Results, by Cluster, for "The Ability to Work without Direct Supervision"

As shown in Table 6, classroom interaction and discussion are not essential in learning for 86% of the respondents in Cluster 1 (the Onliners) and somewhat helpful for 65% of them; whereas, classroom interaction and discussion are always helpful for 83.5% of the respondents in Cluster 2 (the On-grounders).

Classroom interaction and discussion helpfulness in learning						
	Not		Sometimes		Always	
Cluster	Freq	%	Freq	%	Freq	%
1: Onliners	24	**86%**	86	**65%**	15	16%
2: On-grounders	4	14%	46	35%	76	**84%**

Table 6: Frequency and Percentage Results, by Cluster, for "The Helpfulness of Classroom Interaction and Discussion in Learning"

The ability to prioritize also distinguished Cluster 1 from Cluster 2. As shown in Table 7, 63% of the respondents in Cluster 1 (the Onliners) can prioritize well; whereas, 73% of the respondents in Cluster 2 (the On-grounders) lack the ability to prioritize.

Prioritize				
	Can		Can't	
Cluster	Freq.	%	Freq.	%
1: Onliners	100	**63%**	25	27%
2: On-grounders	59	37%	67	**73%**

Table 7: Frequency and Percentage Results, by Cluster, for "The Ability to Prioritize"

As shown in Table 8, time management skills are much more honed for Cluster 1 (the Onliners) than Cluster 2 (the On-grounders). Fifty-seven percent of the respondents in Cluster 1 consider themselves well organized, when it comes to time management skills; whereas, over 83% of the respondents in Cluster 2 indicated that they have difficulty completing assignments and/or projects.

Time-management				
	Well-organized		Not organized	
Cluster	Freq.	%	Freq.	%
1: Onliners	117	**57%**	8	17%
2: On-grounders	88	43%	38	**83%**

Table 8: Frequency and Percentage Results, by Cluster, for "The Time Management Skills"

As shown in Table 1 and Figure 5, age is the only impactful demographic predictor for cluster identification but its impact was less important than the predictors discussed above in detail.

The distinctive characteristics of all eleven variables for Cluster 1 and Cluster 2 are summarized in Table 9.

Overall, the members of Cluster 1 (the Onliners) are better organized, able to prioritize, more self-reliant, and see classroom interaction as "not essential" and only "somewhat helpful." They also tend to be slightly older, slightly less inclined to learn using hands-on methods, and believe that online courses require the same effort as on-ground courses. The Onliners view online education as effective and choose online courses for convenience; over a quarter of them feel that they are extremely prepared for online learning.

Variables	**Cluster 1: Onliners**	**Cluster 2: On-grounders**
Choose online	Yes (80%)	No (92%)
Effectiveness of Online	Effective (57%)	Somewhat effective (40.5%)
Need Supervision	No (77%)	Yes (81%)
Classroom interaction importance	Sometimes helpful (69%)	Always helpful (60%)
Reason for Online	Convenience (72%)	Scheduling (56%)
Able to Prioritize	Yes (80%)	No (53%)
Time management	Well-organized (94%)	Well-organized (70%)
Preparedness for Online	Extremely prepared (29%)	Extremely prepared (6%)
Age range	18-21 (50%)	18-21 (67.5%)
Effort required for Online	Same effort (44%)	Less effort (64%)
Learn best by	Hands-on (51%)	Hands-on (74%)

Table 9: Summary of Distinctive Characteristics, by Cluster, in Descending Order of Importance, for All 11 Variables

In a similar fashion, using the data in Table 9, a profile can also be built to describe Cluster 2 (the On-grounders), who view online learning as only

somewhat effective. The On-grounders need supervision and consider classroom interaction important. They are less able to prioritize and less organized than the Onliners. They also tend to be younger, more inclined to learn using hands-on methods, and believe that online courses require less effort than on-ground courses. These students often choose online learning due to its ease of scheduling; however, very few of them consider themselves extremely prepared for online learning.

The above results of student segmentation regarding online education are somewhat in alignment with the employee segmentation regarding remote work. For instance, younger people have more difficulty embracing fully online education or remote work modality.

Regarding the age demographic characteristic, the result in this research echoes with previous research conducted by the authors which depicts that for those students choosing online education due to scheduling, age rather than gender, plays a significant role in choosing the online modality (Wang, Peslak, Kovacs, & Kovalchick, 2019). Deeper investigation regarding other demographics such as different age groups and generations like those applied in the Microsoft (2022) study would provide further insights.

5. CONCLUSIONS

Through an iterative process of performing two-step cluster analysis using our survey data and eliminating non-relevant variables, two distinct student clusters emerged in the context of online education -- Onliners and On-grounders. The eleven (11) variables used to create the clusters indicate the characteristics of students within each cluster.

The 11 characteristics, found in this study, can be used to build a profile of a typical online student and that of a typical on-ground student. These profiles can be used by decision makers in higher education when making policies and allocating resources. For instance, this research suggests post-graduate programs embrace more online education than undergraduate programs.

These profiles can also be used in strategic planning with regard to how to market, recruit, and retain students for both online and on-ground educational programs. For instance, online post-graduate programs can be better marketed to employees who have already adopted fully-remote work.

The identification of specific online versus on-ground clusters and their identifying characteristics provides important insights to better understand students and also to better assist them in improving their acceptance and performance of online education, when necessary. Who knows what the future will bring – another pandemic or a climate change disaster could move education 100% online again. It is better to be prepared for the unknown.

6. REFERENCES

Almahasees, Z., Mohsen, K. & Amin, M. O. (2021) Faculty's and students' perceptions of online learning during COVID-19. *Frontier Education*. Retrieved August 29, 2022 from https://doi.org/10.3389/feduc.2021.638470

Bishop, K. (2022). Is remote work worse for wellbeing than people think? *BBC*. June 17, 2022. Retrieved August 29, 2022 from https://www.bbc.com/worklife/article/20220616-is-remote-work-worse-for-wellbeing-than-people-think

Boos, S. C., Wang, M., Karst, W. A., Hymel, K. P., & Pediatric Brain Injury Research Network (PediBIRN) Investigators. (2022). Traumatic head injury and the diagnosis of abuse: a cluster analysis. *Pediatrics*, 149(1).

Borgen, F. (1987). Applying cluster analysis in counseling psychology research. *Journal of Counseling Psychology*, 34(4), 456-468.

Castro, E. & George, J. (2021) The Impact of COVID-19 on student perceptions of education and engagement. *e-Journal of Business Education & Scholarship of Teaching*, 15 (1), pp. 28-39.

Chiu, T., Fang, D.-P., Chen, J., Wang, Y., & Jeris, C. (2001). A robust and scalable clustering algorithm for mixed type attributes in large database environment. *Proceedings of the 7th ACM SIGKDDD International Conference on Knowledge Discovery and Data Mining*, ACM SIGKDDD, San Francisco, CA, 263-268.

Dilts, D., Khamalah, J., & Plotkin, A. (1995). Using cluster analysis for medical resource decision making. *Medical Decision Making*, 15(4), 333-346.

Henry, D. B., Tolan, P. H., & Gorman-Smith, D. (2005). Cluster analysis in family psychology research. *Journal of Family Psychology*, 19(1), 121-132.

Leboff, D. (2020) Adrift in a pandemic: survey of 3,089 students finds uncertainty about

returning to college. *Top Hat*. Retrieved August 29, 2022 from https://tophat.com/blog/adrift-in-a-pandemic-survey-infographic/

Lederman, D. (2020). How college students viewed this Spring's remote learning. *Inside Higher Ed*. Retrieved August 29, 2022 from https://www.insidehighered.com/digital-learning/article/2020/05/20/student-view-springs-shift-remote-learning

Lufkin, B. (2022). The companies doubling down remote work. *BBC.* July 24, 2022. Retrieved August 29, 2022 from https://www.bbc.com/worklife/article/20220722-the-companies-doubling-down-on-remote-work

Markman, A. (2021). Why you may actually want to go back to the office. *Harvard Business Review*. July 1, 2021. Retrieved August 29, 2022 from https://hbr.org/2021/07/why-you-may-actually-want-to-go-back-to-the-office

McKenzie, L. (2021) Students want online learning options post-pandemic. *Inside Higher Ed.* Retrieved August 29, 2022 from https://www.insidehighered.com/news/2021/04/27/survey-reveals-positive-outlook-online-instruction-post-pandemic

McLachlan, G. J. (1992). Cluster analysis and related techniques in medical research. *Statistical Methods in Medical Research*, 1(1), 27-48.

Microsoft. (2022). Great expectations: making hybrid work work. Retrieved August 29, 2022 from https://www.microsoft.com/en-us/worklab/work-trend-index/great-expectations-making-hybrid-work-work

Norusis, M.J. (2008), SPSS 16.0 Guide to Data Analysis, 2nd ed., Prentice Hall.

Ortega-Maldonado, A., Llorens, S., Acosta, H. & Coo, C. (2017). Face-to-face vs on-line: an analysis of profile, learning, performance and satisfaction among post graduate students. *Universal Journal of Educational Research*, 5(10), 1701-1706.

Ortega, H., Li, H., Suruki, R., Albers, F., Gordon, D., & Yancey, S. (2014). Cluster analysis and characterization of response to mepolizumab. A step closer to personalized medicine for patients with severe asthma. *Annals of the American Thoracic Society*, 11(7), 1011-1017.

Peslak, A., Kovalchick, L., Wang, W. & Kovacs, P. (2021). Effectiveness of educational delivery modes: a study in computer information systems. *Journal of Information Systems Education*, 32(4), 253-261.

Perrotta, C. & Williamson, B. (2018). The social life of learning analytics: cluster analysis and the 'performance' of algorithmic education. *Learning Media and Technology*, 43(1), 3-16.

Punj, G. & Stewart, D. (1983). Cluster analysis in marketing research: review and suggestions for application. *Journal of Marketing Research*, 20(2), 134-148.

Qualtrics. (2022). What is cluster analysis? When should you use it for your survey results? (2022). Retrieved August 29, 2022 from https://www.qualtrics.com/experience-management/research/cluster-analysis/

Rundle-Thiele, S., Kubacki, K., Tkaczynski, A., & Parkinson, J. (2015). Using two-step cluster analysis to identify homogeneous physical activity groups. *Marketing Intelligence & Planning* 33, 522-537.

Scoltock, J. (1982). A survey of the literature of cluster analysis. *The Computer Journal*, 25(1), 130-134.

Shevlin, R. (2022). JPMorgan Chase gets "work from home" all wrong. *Forbes*. August 22, 2022. Retrieved August 29, 2022 from https://www.forbes.com/sites/ronshevlin/2022/08/22/jpmorgan-chase-gets-work-from-home-all-wrong/?sh=1badf24a7cb0

Shiau, W., Dwivedi, Y., & Yang, H. (2017). Co-citation and cluster analysis of extant literature on social networks. *Journal of Information Management*, 37(5), 390-399.

Smith, M. (2022). Twitter, Reddit and 8 other companies offering permanent remote or hybrid work—and hiring right now. *CNBC*. April 13, 2022. Retrieved August 29, 2022 from https://www.cnbc.com/2022/04/13/10-companies-that-switched-to-permanent-hybrid-or-remote-work-and-hiring-right-now.html

Tan, P.N., Steinbach, M., Karpatne, A. & Kumar, V. (2019). Cluster Analysis: Basic Concepts and Algorithms. *Introduction to data mining* (2, pp. 525-612). New York, NY: Pearson. Retrieved June 15, 2022 from https://www-users.cse.umn.edu/~kumar001/dmbook/ch7_clustering.pdf

Tu, N., Dong, X., Rau, P.P., & Zhang, T. (2010). Using cluster analysis in Persona

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v8 n5723

development. *2010 8th International Conference on Supply Chain Management and Information*.

Wang, W., Peslak, A., Kovacs, P., & Kovalchick, L. (2019). What really matters in online education, *Issues of Information Systems*, 20(1), 40-48.

Wilson, J. (2020). How are clustering algorithms different from supervised learning? *Technical-QA.COM*. Retrieved June 15, 2022 from https://it-qa.com/how-are-clustering-algorithms-different-from-supervised-learning/

APPENDIX A

Survey Questions Used for 20 Variable Cluster Analysis

Note: the number of the question refers to the number in the original survey which contains 34 variables

2) If given a choice to take the same course in an ONLINE format or an ONGROUND format, would you select the ONLINE format?

☐ Yes
☐ No

3) If you did select an ONLINE format for a course, what would be the main reason?

☐ Convenience
☐ Scheduling
☐ Delivery Method
☐ To take a particular professor
☐ Other (please specify)
If you selected other, please specify_____

4) I have taken (or am currently taking) a course that is completely online or is partially online.

☐ Yes
☐ No

6) What type of formal training did you receive to prepare you to take an online course?

☐ No formal training received
☐ Training and documentation provided by my school
☐ Self-trained
☐ Training from course instructor or other faculty member
☐ Training from another student
☐ Other (please specify)
If you selected other, please specify_____

7) How would you rate your preparedness (to take an online course) prior to taking your online course?

☐ Extremely unprepared
☐ Somewhat unprepared
☐ Neither unprepared nor prepared
☐ Somewhat prepared
☐ Extremely prepared

8) Do you perceive the OVERALL effectiveness of courses that are offered COMPLETELY online as…

☐ Very effective
☐ Effective
☐ Somewhat effective
☐ Somewhat ineffective
☐ Ineffective
☐ Very ineffective

9) Do you perceive the OVERALL effectiveness of courses that are offered PARTIALLY online and PARTIALLY onground (i.e., Hybrid) as…

☐ Very effective
☐ Effective
☐ Somewhat effective
☐ Somewhat ineffective
☐ Ineffective
☐ Very ineffective

10) Do you perceive the OVERALL effectiveness of courses that are offered ONGROUND but have an ONLINE SUPPLEMENT (i.e., online materials provided on BlackBoard or on an instructor's website) as…

☐ Very effective
☐ Effective
☐ Somewhat effective
☐ Somewhat ineffective
☐ Ineffective
☐ Very ineffective

15) Select one of the following choices

☐ I work better without direct supervision
☐ I work better when someone is there to keep me focused

16) Select one of the following choices

☐ I can prioritize my own workload
☐ I tend to put work off until later

17) Select one of the following choices

☐ I would allocate as much time and effort for an online course as I would for an on-ground course
☐ I feel that LESS time and effort is required for an online course (as compared to an on-ground course)
☐ I feel that MORE time and effort is required for an online course (as compared to an on-ground course)

18) In terms of time-management, I would describe myself as…

☐ Well organized
☐ Having difficulty completing assignments and/or projects

19) Classroom interaction and discussion is…

☐ Not essential for me to learn/understand
☐ Sometimes helpful for me to learn/understand
☐ Always helpful for me to learn/understand

20) Which of the following aspects could influence my decision to take an online course…

☐ Instructor teaching the course
☐ Design of the course
☐ Subject matter of the course
☐ Other (please specify)
If you selected other, please specify_____

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22) I learn BEST…

☐ By seeing (visually)
☐ By listening
☐ By reading
☐ By doing (hands-on)

26) Are you enrolled as a …

☐ Full-time student
☐ Part-time student

27) Which of the following best describes your living arrangement…

☐ Resident student (live on campus)
☐ Commuter student (live off campus)

32) Are you currently employed as a…

☐ Full-time employee (>40 hours/week)
☐ Part-time employee (
☐ Not currently employed

33) Please indicate your sex…

☐ Male
☐ Female

34) Please indicate your age range…

☐ 18 - 21
☐ 22 - 30
☐ 31 - 40
☐ 41 - 50
☐ 51 - 60
☐ 61 or older