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The Usage of Cloud and Web Based Mobile Applications By Students at Higher Education: The Two-Step Cluster Analysis

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Abstract: It is possible to see the successful implementation of cloud and web based mobile technology solutions in key industries such as finance, retailing, healthcare, manufacturing, etc. Along with these key industries, cloud and web based technologies also have its significant effect in education sector. These technologies are significantly changing the learning and teaching landscape in various types of educational institutions. The way students learn, teachers teach and educational institutions maintain their key functions have been transformed and become more effective and efficient via these technologies. This research focuses on the students' use of cloud and web based mobile educational tools in higher education. In this research, Two-Step cluster analysis has been conducted in order to identify different student groups with respect to their use of cloud and web based mobile apps in higher education. Cluster analysis has been conducted around seven key attributes. Five of these attributes have been adopted from the "Diffusion of Innovations" theory which is one of the well-known social sciences theories that seeks to explain how, why, and at what rate new technological ideas spread across societies. These factors are relative advantage, compatibility, complexity, trialability, and observability. The other two factors are perceived data security and perceived social pressure. As a result of Two-Step cluster analysis, four different student groups have been identified. Behavioral characteristics of each student group has been discussed with respect to their use of such key technologies in higher education context. Results of this study are expected to guide practitioners and marketers to develop more effective cloud and web based mobile apps and associated marketing strategies to improve the adoption and usage rate of their apps in higher education.

Keywords: Mobile Learning, Cloud-Based Mobile Apps, Web-Based Mobile Apps, Higher Education Students, Diffusion of Innovation, Two-Step Cluster Analysis

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INTRODUCTION

Mobile digital platforms have become an integral part of our life. In 2018, global mobile app revenues amounted to over 365 billion U.S. dollars and this figure is projected to be nearly 935 billion U.S. dollars in 2023 (Statista, 2019). It is possible to see the successful implementation of mobile technology solutions in key industries such as financial services, retailing, healthcare, manufacturing, etc. Along with these key industries mobile technologies also have its significant effect in education sector. Advancements in mobile technologies have transformed the education sector and introduced any new term mobile learning, also known as, m-learning. Mobile learning is simply education via the Internet or any computer network using various types of handheld mobile devices to obtain learning materials through mobile apps, social interactions and various types of online educational platforms. Mobile technologies are revolutionizing the learning in various types of educational institutions. This technology is significantly changing the way students learn, teachers teach and educational institutions maintain their key functions. Through mobile learning platforms educational institutions can deliver knowledge, educational content and materials to students on any platform, at any place and at any time whenever needed. Mobile digital technologies provide both learners and educational practitioners with a great number and variety of cloud and web based applications that can be utilized to support a great variety of learning scenarios. These applications are accessible anywhere and anytime, thus extending the exposure time to learning of students. These technologies support students and teachers with tools and resources that can be deployed on-demand for lectures and labs. These technologies enable students to complete and submit assignments to lecturers, download course materials and work in online social groups to complete assigned tasks. Currently, there are more than 200,000 education and reference apps available at App Store of Apple company (CNET, 2018) and this figure is not much different at Play Store of Android.

Even though, cloud-based and web-based mobile technologies are being used interchangeable by many and even though they are very much the same in certain aspects, they are not exactly the same technologies. It is worth to mention about the subtle differences between these two important technologies. All cloud-based apps are web-based but not all web-based apps are cloud-based. It can be said that cloud apps are advanced and improved version of web-based apps. Web-based apps are almost exclusively designed in such a way that they run in a web browser. The main benefit of this kind of computing model is that it is accessible from anywhere via the web browser. Cloud-based apps can also be accessed via web-browser; however, they do not solely depend on web browsers to function. Web-based apps require the Internet connection to work, on the other hand, cloud apps can work partially or fully in an offline mode. Since multiple data centers can be utilized in cloud-based computing model, in robustness and scalability cloud apps are one step ahead of web-based apps which are usually resides in a single web-server.

Numerous studies in the given field have assessed the influence of mobile learning on students' learning process. Findings of these studies showed that students hold positive attitudes towards mobile learning (Çavuş and Uzunboylu, 2009; Kutluk and Gülmez, 2014; Sırakaya and Sırakaya, 2017). It was found that mobile learning has positive influence on students' motivation and attitudes towards classes (Jeno, Grytnes and Vandvik, 2017; Martin and Ertzberger 2013, Meriçelli and Uluyol, 2016). Students' academic achievement was also found to be positively influenced with the use mobile learning technologies (Martin and Ertzberger, 2013; Köse, Koç and Yücesoy, 2013; Jeno et al., 2017).

This research focuses on the higher education students' use of cloud and web-based mobile applications in higher education context. This research aims to contribute to the relevant literature by identifying different groups of student in general student audience in terms of their use of cloud and web-based mobile applications in education. Behavioral characteristics of each identified student group are aimed to be determined in this study. That is, it is aimed to clarify how these groups differ from each other when it comes to adopt these key technologies for educational purposes. In the identification of different groups this study utilized the well-known theory of "Diffusion of Innovations" (Rogers, 2003). This theory seeks to explain how social members adopt the new technological and other advancement and how they make the decision towards it. According to "Diffusion of Innovations" theory, there are five attributes that determine adoption rate of any given innovation. These attributes are relative advantage, compatibility, complexity, trialability, and observability. These five attributes were utilized in identification of different student groups. In addition to these five attributes this study also utilized perceived data security and perceived social pressure in the grouping process. Results of this study are expected to guide practitioners and marketers to develop effective apps and marketing strategies to further improve the adoption rate of their products.

In line with the purpose of this exploratory study, two main research questions were determined:

RQ 1: What kind of groups exist in a higher education student audience in terms of using cloud and web based mobile apps for educational activities?

RQ 2: What kind of characteristics make these groups differ from each other?

The rest of the paper is organized as follows. Instruments, sampling, procedures, and statistical techniques used in the research are given in "Methodology" section. "Data Analysis" section presents clustering analysis conducted on the study data. Finally, "Discussion and Conclusion" section discusses the characteristics of each identified group by comparing and contrasting it with other groups. This section also mentions about limitations of this research and recommends future research directions based on these limitations.

METHODOLOGY

Instruments

Data for clustering analysis were collected through Likert-type scale. Measurement of the scale ranged from 1 (strongly disagree) to 5 (strongly agree). In total there were seven different constructs in clustering analysis and items measuring each construct was adopted from the relevant literature. These constructs are as follows: perceived data security (Smith, Milberg and Burke, 1996; O'Cass and Fenech, 2003; Flavian and Guinaliu, 2006), perceived social pressure (Järveläinen, 2007), observability (Moore and Benbasat, 1991), trialability (Moore and Benbasat, 1991), complexity (Moore and Benbasat, 1991), compatibility (Moore and Benbasat, 1991), and relative advantage (Moore and Benbasat, 1991).

Sampling

This study is about university students' use of cloud and web-based mobile educational tools in higher settings. Therefore, university students are utilized in the sampling process. Data collection was conducted in one foundation university in Istanbul. One of the non-probability sampling techniques, convenience sampling was used in finding the participants of the study. In this study survey participants were selected according to their ease of access.

Procedures

Students joined to the survey in a volunteer basis. Before filling the survey students were given necessary information about the study and they were also informed about the confidentiality of their responses. Students are distributed the study survey in printed and online format. Printed copies are distributed in during classes. On the other hand, online format is prepared by using an online survey tool and distributed in an online environment. In 3-month time period, 274 responses were acquired from students. While 67.5 percent of respondents were male, females constituted 32.5 percent.

Statistical Techniques

The statistical tool used in this research is the Two-Step clustering method. Two-Step clustering method was conducted in IBM SPSS version 21. Two-Step clustering method can handle large datasets with both categorical and continuous variables (SPSS Inc., 2001). Furthermore, Two-Step clustering method also enable to automatically determine optimal number of clusters based on the input variables.

DATA ANALYSIS

Descriptions of seven factors used in the clustering process are given in Table 1. These factors are perceived data security, perceived social pressure, observability, trialability, complexity, compatibility and relative advantage. Table 1 also shows reliability measures of each factor which was assessed by utilizing Cronbach's Alpha technique. Cronbach's Alpha reliability score of each factor has been found to meet the recommended threshold of 0.70. Therefore, all of the seven factors considered for the clustering process were found to be reliable.

Table 1. Description of segmentation factors

Factor	Cronbach's alpha (# items)	Description
Perceived Data Security (PDS)	0.841 (5)	The perception about being protected from risks related to data security on digital platforms.
Perceived Social Pressure (PSP)	0.820 (4)	The influence on people by important others to change their attitudes or behaviors to conform to those of the influencing others.
Observability (OBS)	0.762 (4)	The extent to which the results of an innovation are visible by others.
Trialability (TRL)	0.770 (4)	Possibility of experimenting innovation before adoption.
Complexity (CMX)	0.775 (3)	Perceptions about difficulty of using the given innovation.
Compatibility (CMP)	0.820 (4)	Consistency of innovation with the existing values, needs, and past experiences of user.
Relative Advantage (RA)	0.837 (5)	The extent to which an innovation is perceived to be better than its predecessors.

Two-Step Clustering analysis has been conducted with Log-likelihood distance measure and Schwarz's Bayesian Information (BIC) clustering criterion. The results of the auto clustering process are provided in Table 2.

Table 2. Auto-clustering output

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change[a]	Ratio of BIC Changes[b]	Ratio of Distance Measures[c]
1	1404.537			
2	1182.756	-221.781	1.000	1.731
3	1087.864	-94.892	.428	1.687
4	1063.616	-24.248	.109	1.930
5	1088.926	25.311	-.114	1.360
6	1128.331	39.405	-.178	1.209
7	1174.501	46.170	-.208	1.239
8	1226.928	52.427	-.236	1.030
9	1280.120	53.192	-.240	1.123
10	1336.085	55.965	-.252	1.139
11	1394.808	58.723	-.265	1.073
12	1454.879	60.071	-.271	1.075
13	1516.245	61.365	-.277	1.144
14	1579.778	63.534	-.286	1.098
15	1644.657	64.878	-.293	1.060

In the determination of optimal number of clusters, different cluster solutions are compared using Schwarz's Bayesian Information Criterion (BIC) as the clustering criterion. Smaller value of the

BIC, a reasonably large value Ratio of BIC Changes and a large Ratio of Distance Measures help to identify the optimal number of clusters. In this research the Two-Step Clustering algorithm suggested four clusters to be extracted from the data (BIC=1063.616, Ratio of BIC changes=0.109, Ratio of distance measures=1.930). Goodness-of-fit of the clustering result was assessed by utilizing Silhouette measure of cohesion and separation. While cohesion represents average distances between all entities in a cluster, separation refers to average distance of any entity to all other entities not exist in the same cluster. This index ranges between -1 and +1. Values less than 0 indicate inappropriate fit, values between 0 and 0.2 represents poor fit, values between 0.2 and 0.5 indicates fair fit, and values above 0.5 are accepted to be good. Silhouette coefficient in this research were found to be 0.3 which is within the recommended ranges (Rousseeuw, 1987).

In Table 3 the size of each cluster is provided. Cluster 1 (12.4 percent) and Cluster 2 (33.9 percent) have 34 and 93 observations respectively. Cluster 3 (27.2 percent) and Cluster 4 (25.4 percent) have 76 and 71 observations respectively. The ratio of the largest group (Cluster 2) to the smallest group (Cluster 1) is 2.74 which was below the maximum recommended value of 3.

Table 3. Cluster details

		Cluster 1	Cluster 2	Cluster 3	Cluster 4
Cluster details	Segment size (%)	12.4%	33.9%	27.7%	25.9%
	Segment size (#)	34	93	76	71
	Gender				
	Male	23	66	50	46
	Female	11	27	26	25
Segmentation factors (centroid values)	Perceived Data Security (PDS)*	-1.10	0.16	0.04	0.27
	Perceived Social Pressure (PSP)*	-1.50	-0.11	-0.14	1.01
	Observability (OBS)*	-1.62	-0.28	0.07	1.06
	Trialability (TRL)*	-1.56	-0.20	0.03	0.98
	Complexity (CMX)*	-0.10	0.72	-0.91	0.07
	Compatibility (CMP)*	-1.75	-0.30	0.29	0.92
	Relative Advantage (RA)*	-1.60	-0.35	0.36	0.83

Notes: *Shows standardized scores. 0.00 shows the entire sample average. + and - represents standard deviation units above or below the entire sample average.

A radar chart (Figure 1) has been created to visually show each cluster's average score on each of the seven factor. A radar chart is a two-dimensional chart designed to plot one or more series of values over multiple quantitative variables. In a radar chart each variable has its own axis and all axes are joined in the center of the figure. Each respondent's score on each factor was calculated in terms of z-scores and these z-scores were used in developing the radar chart. Z-scores have a distribution with a mean of 0 and a standard deviation of 1. The z-scores enabled to see how many standard deviations below or above the mean a given score is. Therefore, the value 0.0 in the chart shows entire sample mean and the numbers above or below 0.0 shows the number of standard deviations from the entire sample mean.

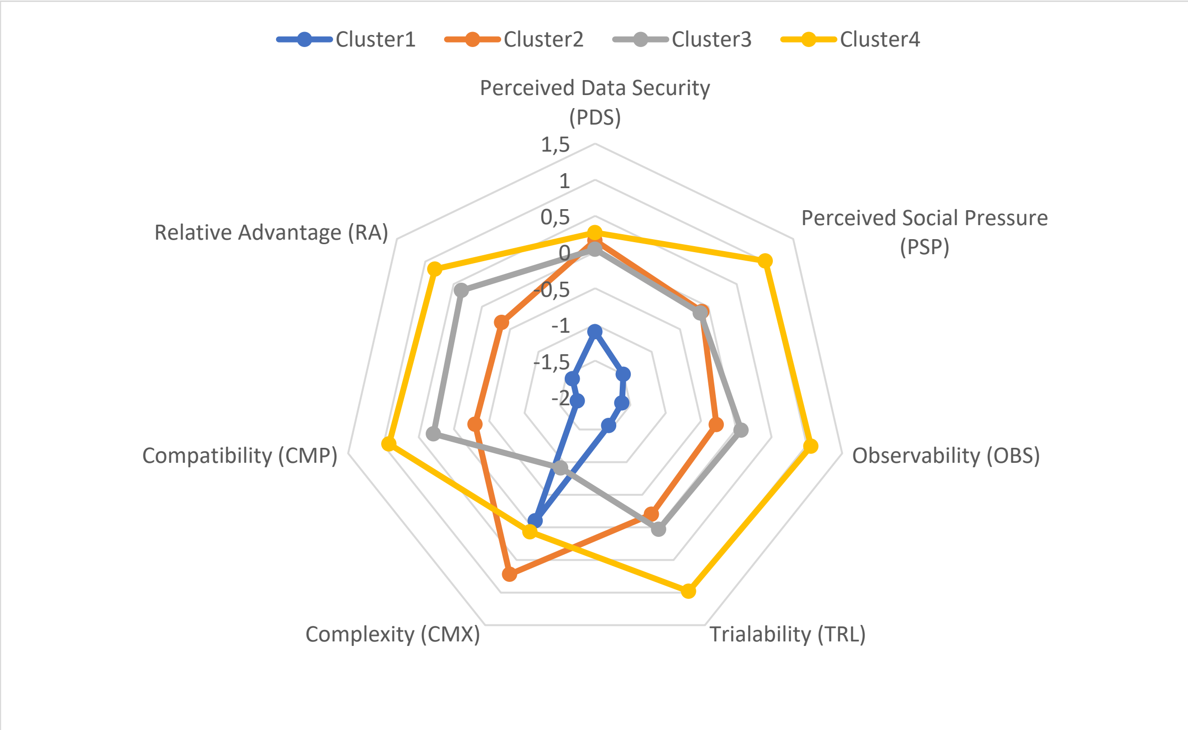

Figure 1 – Radar chart of clusters

Table 4 show reasons of the members of the different clusters for using web and cloud-based educational tools. On the other side, Table 5 shows major concerns of students about using such tools in education. Figures in these two tables are given in the form of frequencies and percentages and calculated for each different cluster separately. Easily accessing data and apps, sharing data with classmates and friends, and making backups of files were found to be the top reasons for using mobile apps in education across four determined student groups. On the other side, privacy and data security issues were found to be top concerns about such tools across four identified student groups.

Table 4. Reasons for using web and cloud based educational tools

	Cluster 1		Cluster 2		Cluster 3		Cluster 4	
Reasons	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)
Ease of accessibility of data and applications	16	47.0%	57	61.3%	58	76.3%	50	70.4%
Programs can be used free of charge or low cost	9	26.4%	39	41.9%	29	38.2%	28	39.4%
Low cost storage of files	6	17.6%	19	20.4%	6	7.9%	23	32.4%
Share data with my classmate and friends	15	44.1%	44	47.3%	35	46.1%	41	57.7%
Make a backup of my files	10	29.4%	31	33.3%	10	13.2%	38	53.5%
Collaborating with friends on school projects	6	17.6%	22	23.7%	6	7.9%	30	42.3%
My Lecturer requires me to do so	6	17.6%	24	25.8%	18	23.7%	19	26.8%

Table 5. Concerns about using web and cloud based educational tools

	Cluster 1		Cluster 2		Cluster 3		Cluster 4	
Reasons	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)	Freq. (#)	Per. (%)
Worried about the privacy issue	12	35.2%	43	46.2%	30	39.5%	30	42.3%
Fear of losing my important data	13	38.2%	39	41.9%	19	25.0%	17	23.9%
Difficult to understand and use	7	20.6%	12	12.9%	14	18.4%	5	7.0%
Problems in Internet access	7	20.6%	23	24.7%	12	15.8%	10	14.1%
Don't understand the real benefits	1	2.9%	8	8.6%	4	5.3%	1	1.4%
I am not aware of these technologies	3	8.8%	4	4.3%	5	6.6%	2	2.8%

DISCUSSION AND CONCLUSION

Discussion

Clustering analysis in this study revealed four different student groups in terms of their perceptions about the use of cloud and web based mobile apps in education. Clustering analysis showed that different student groups have different perceptions and attitudes towards using such apps in education. The following paragraphs discuss the notable characteristics of each determined student group by taking into consideration the given group's scores on seven different factors used in the clustering analysis.

Among four determined student groups, Cluster 1 is the one with the smallest size (12.4%). Members of this cluster do not find cloud and web based apps to be complex to understand and use as this cluster's average score in this factor has been found to be slightly less than average (CMX = -0.10). However, members of this cluster perceive such apps not to be safe in terms of data security (PDS = -1.10). This group's concerns about data security may keep them away from using such tools for educational purposes. Observability (OBS = -1.62) and trialability (TRL = -1.56) scores in this cluster have been found to be well below the average. Very low score in observability imply that members of this cluster have not been influenced by what they observed as the benefits of using such apps in higher education. On the other side, low score in trialability imply that offering such apps to this group of users on trial basis will not be effective in their adoption decision. Even pressure from important other will not help to influence their behavior (PSP = -1.50). This cluster is very close to the idea of using such apps in education. Members of this group do not find such tools to be compatibly (CMP = -1.75) with the way they like to study. Furthermore, members of this cluster are not using such tools as they do not see any relative advantage (RA = -1.60) in doing so.

Among four student groups, Cluster 2 is the one with the largest size (33.9%). Distinguished features of this group is as follows. According to the members of this cluster cloud and web based mobile apps requires a lot of mental effort to understand and use (CMX = 0.72). This group also does not find such tools to be very compatible with they like to study (CMP = -0.30). As a result, members of this group usually do not see much advantage in using such tools in education (RA = -0.35). Another thing that makes this group to be skeptical about such technologies is the observably results of such technologies. That is, majority of participants in this group have not seen how others use such tools in education as observability score was found to be less than average (OBS = -0.28). Offering such apps to members of this group in trial basis will not have much desired effect as score in this factor has been found to be low (TRL = -0.20).

Cluster 3 has been found to be the second largest group in size (27.7%). One of the main distinguishing feature of this group is that this group is the one with lowest score in complexity (CMX = -0.91). This low score in complexity implies that when compared with other groups, members of this group do not think that using cloud and web based mobile apps require a lot of mental effort and they do not think that using such apps in education require too much technical skills. Members of this cluster consider such kind of mobile apps to fit well with the way they like to study (CMP = 0.29). Furthermore, this cluster consider cloud and web based mobile apps to be better than other alternatives (RA = 0.36). That is, they reported that using such apps in education enables them to accomplish their tasks more quickly, to increase their performance and as a result to improve the quality of work they do.

Cluster 4 is the final group which constitutes nearly one quarter of the studied sample (25.9%). Among four determined student groups, cluster 4 is the one which is the most open to the use of cloud and web based mobile apps in education. This group of students find such apps to be compatible with the way they like to study (CMP = 0.92). That's they reported that using such apps fits into their studying style. Furthermore, this group of students do not perceive such apps to be complex to understand and to use (CMX = 0.07). In this group, pressure from important others (e.g., friends, instructors, popular press) seems to play an important role in developing favorable attitudes towards such apps (PSP = 1.01). This group of students have also been found to be influenced by what they observed as the benefits of using such apps in education (OBS = 1.06). That is, they have seen how others use such apps in education and their observation influenced their decision in a positive way. Another important finding about this group is related to the trialability of such apps. Members in this group prefer to experiment with cloud and web based mobile apps before making the final adoption decision (TRL = 0.98). That is, for certain period of time they want to use such apps on a trial basis to see what they can do for them. By considering the above mentioned points it is not surprise to see that among four identified groups this group is the one that scored highest on relative advantage factor (RA = 0.83). This finding implies that members in this group believes that such apps help them accomplish their tasks more quickly, give greater control over their work, provide more performance on their tasks and as a result they improve the overall quality of work done.

It was interesting to find that in all identified student groups top concerns in using cloud and web based mobile apps in education was data security and privacy issues (Table 4). That is, possibility of losing important data and possibility of capturing sensitive personal information to unwanted third-parties makes students to think twice before using such tools in education. In information systems literature security and privacy issues have been subject to several studies (Huseynov and Yıldırım, 2016; Arrifin, Mohan and Goh, 2018; Changchit, Cutshall, Lonkani, Pholwan, and Pongwiritthon, 2018). Findings of these studies showed that users build positive attitude toward system if they believe it is secure to conduct transactions over the given system. If service providers want to increase the usage rate of their services and develop positive attitudes in the mind of users toward their products, they should clearly inform their users about security and privacy measures taken over their systems.

Conclusion

The implications of this study for marketers is that not all students perceive cloud and web-based mobile learning apps in the same way. Different factors play at different rate in influencing student's adoption of such technologies in education. For example, while cluster 2 finds such app to be difficult to understand and use, cluster 3 perceive such apps to be easy to figure out and implement. On the other side, while benefits of such tools are very visible to cluster 4, cluster 1 has not seen how others use such apps in education. Similarly, while offering such tools on a trial basis to cluster 4 will bring the desired effect, this approach will not be effective for cluster 1. The above discussed findings implies that our messages should not be the same for different student groups. By utilizing the findings of this research, practitioners should design their products in such a way that they will minimize the major concerns of students about these systems and meet various the needs and expectations of different student groups.

Limitations and Future Research Directions

Like any other research this study also have its own limitations. Participants of this research are limited to students of single foundation university. Future studies are recommended to carry out similar research on both foundation and state university students in order to further improve the generalizability power of the study findings. The second limitation of this research could be the sample size which is 274. In the future studies, researchers are suggested to carry out clustering analysis on relatively larger samples in order to derive more reliable results. As a final limitation, it is worth to mention that the majority of study participants were male (67.5%). Future studies are suggested to conduct similar studies by preserving equal proportion of male and female participants.

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