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Implementation of Flipped Classroom as Element of IoT into Learning Process of Computer Networks Subject in Suleyman Demirel University

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Abstract

The research paper describes concept of Internet of Things (IoT), interaction of IoT with educational model, and implementation of Flipped Classroom as an element of IoT into learning process of Computer Networks subject instead of Traditional learning approach. Survey provided for students at the end of the research shows feedback from listeners. Impact of Flipped Classroom implementation is reported at the end of research paper with graphics and comparison tables.

Keywords: Flipped Classroom, FP-IoT, Internet of Things, IoT.

Introduction

Nowadays Internet is not just the way of exchanging files, emails or surfing web pages, it has become an integral part of modern live. “Business Insider” estimates that the number of IoT equipment installed worldwide will be more than 5 billion in 2015 and about 24 billion in 2020 that will form market of about $13 trillion dollars (Intelligence, 2016). IoT expands to almost all types of application domains like, smart house, health care, smart city, military, logistics, education, and etc. (Juan Hern´andez-Serrano, 2016). IoT as a main notion in Information Technologies (IT) dramatically changed the way of how people can gain information in the school classroom, university or outside the education environment (Maksimovic, 2017). Unfortunately, not all schools and universities have switched to educate with the help of new technologies. We still may observe that in universities lessons are delivered by old methodology without implementing technological solutions. By the help of Internet of Things model we may build the environment in which students and instructors will improve their results and achieve more success. The work describes implementation of Flipped Classroom as part of Internet of Things in learning process of “Computer Networks” subject that is integrated with Cisco Networking Academy (netacad.com).

The remaining part of the paper is organized as follows. In Section II we observe model and principles of IoT. Observation of related works are described and compared in Section III. Section IV is dedicated to describing the implementation of Flipped Classroom as part of IoT to Computer, Section V show research results. Finally, Section VI concludes the paper and gives recommendations for future work.

Section II – IoT concepts and components

Four phases of Internet evolution

Connectivity, which started over 20 years ago, digitizes access to information: email, web browsing, and search.

Networked economy started in late 1990s and it digitizes business process: e-commerce, digital supply chain, and collaboration.

Collaborative experiences from the early 2000s, digitizes interactions (business and social): social networks (Facebook, VK, YouTube, LinkedIn etc.), mobility and cloud (dropbox, google drive, mail cloud etc.), and video cloud (YouTube, VK etc.).

Internet of Things (IoT), current phase of internet evolution, connects people, things, data and processes.

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IoT Pillars

Network connection has become more valuable and relevant because IoT consists of four pillars: things, people, data, and process.

IoT pillar "Things" are physical devices (objects) that are connected to Internet and able to interact with multiple servers and clients to provide different types of services and statistics periodically or/and on demand. Smart scales are good examples which show how IoT can impact on human health.

IoT "People" are represented as wearable devices. Today most people connect socially through web-enabled devices. As the IoT evolves, we will connect in new and valuable ways. Wearable devices and clothing are already changing the way of connection to the global network. Jaquard is a good example of wearable smart clothes (device) that Google and Levi's lunched in 2016. The Jacquard is a smart jacket with sensors that can send instructions to smartphone like pausing or skipping a song that is played by double tapping on your wrist (Statt, 2017).

IoT "Data" is the information generated by people, sensors and things. The data, when combined with analytics, delivers actionable information to people and machines. Better decisions are made and better results are achieved. By using data, it is possible to analyze situation from different perspectives and enhance process of any including transportation, healthcare, education, and others. Last years, amount of data that been generated surprise humanity. Data is growing faster than at any time before, by 2020 about 1,7 megabytes of fresh information will be generated by every person on the planet and amount of data will grow from 4,4 zettabytes (today) to about 44 zettabytes which makes around 44 trillion gigabytes (Marr, 2015).

IoT "Processes" occur between all of the other pillars in the IoE. With the correct processes, connections become more valuable. These connections provide the right information, delivered to the right person, at the right time and in the most relevant way. Example of process pillar in IoE: One of the good examples is IFTT (If This Then That) web, iOS, and Android based platform that allows you to run process if something happens, user is able to send SMS or email message to his/her wife when he/she will enter to work area or to any other geographical area, or when you miss call on mobile phone, IFTT service can send email message or SMS message to any phone number or email service. Another example of Process in IoE is Google document, table, form and a lot of other services of Google, which can be very useful in many fields of industry including education process. In university or school Google services can be used to share students grades via Google table with students, instructors, and parents so that all the process of grade evaluation will be transparent and if someone has a question, he/she can ask questions according to that in spot.

Section III – Observation of related works

Research of Maksimovic (Maksimovic, Green Internet of Things (G-IoT) at engineering education institution: the classroom of tomorrow, 2017) describes a model of IoT in education and compares it with traditional education approach. Online content, online community platform, smart portfolio systems, advanced data analytics, and gamification with virtualization are parts of IoT education model.

(Roy, 2016) raised the question about cost reduction of education with the help of IoT. Roy made a research concerning how IoT based innovations can help in education of poor people in big cities. Roy found that one of the main problems for the urban poor is that they spend much money on buying printed learning materials (books, notebooks etc.), slum children remained poor despite regularly attending school. The situation can be improved by providing digital information on demand for students.

Section IV - Flipped Classroom and IoT

Flipped Classroom is the part of IoT in education field. It is a new approach that is not implemented yet into learning process of our country's educational sector. Flipped Classroom is a model in which homework and lecture elements of a course are "Flipped" (MF, 2012). Mostly Flipped Classroom involves students watching pre-recorded video lectures before they attend class and uses classroom time to engage in activities like problem solving, inquiry, seminar, and playing games. It can also be used for many other forms of time spending in class (Moraros, 2015). One of the main goals of Flipped Classroom implementation is to provide an opportunity for students to learn course material any time and any place, it can be morning or night, at home or at bus station. When students come to class, they solve problems by using knowledge from video lessons and online reading materials. Flipped Classroom is a part of IoT in "Process" and "Data" pillars of IoT model.

Participants of IoT Flipped Classroom

There were 84 Bachelor students of Computer Sciences sophomore students enrolled into class of Computer Networks 1 (integrated with Cisco Networking Academy and CCNA RS1, RS2 courses) during the academic year 2016-2017. 73 students out of 84 (86%) agreed to participate in this study. More than 70% (44) of them were 20 years old or younger and all of them represented 4 groups of junior students in Computer Science. Figure 2 demonstrates the age histogram of participants. There were 50 (68,5%) of males and 23 (31,5%) females. Gender statistics is represented in Fig.1. In the form of a pie chart. The majority of the participants agreed and strongly agreed that they feel comfortable when using computer and Internet to learn material. Figure 2 and 3 describe statistics of progress by gender, 17 (34%) male students under GPA 2,5, where 33 (66%) are with GPA more than 2,5. Females GPA is better than males, only 4 are (17%) under GPA 2,5 and 19 (83%) are with greater than 2,5.

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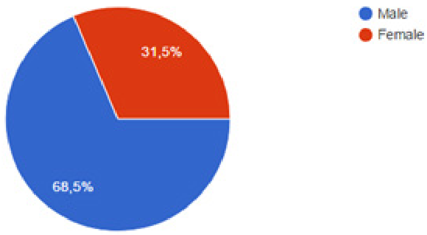

Figure 1. *Gender Statistics*

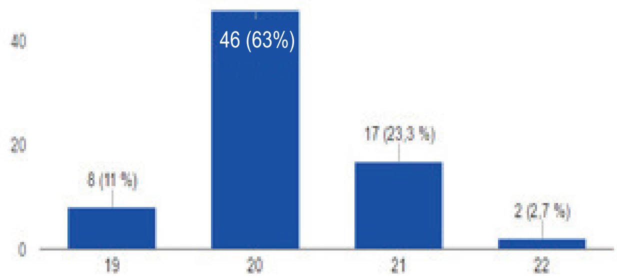

Figure 2. *Age of participants*

Structure and setting of Flipped Classroom

We flipped classroom this year by our initiative, without asking administration of university this year. For next year we have permission to flip course from the administration.

The Flipped Classroom implemented unofficially during Spring semester of 2016-2017 academic year using pre-class activities (online video lessons on YouTube https://www.youtube.com/channel/UCcQLKoayxTjAD28TVNAYzBw, interactive eBook provided by Cisco Networking Academy https://www.netacad.com/) and in-class activities (seminars, laboratory works, interviews, hand-on-lab laboratory works and interactive tasks). Students had one hour of lecture (due to that fact that we "flipped" course unofficially we still had 1 hour of official lectures, but at that time students made presentations according to viewed video lessons and online materials from netacad.com), two hours of laboratory works and one hour of seminar.

Pre-class activity was mandatory for students who were planning to come for seminar and laboratory work hours. During each pre-class activity students had to watch the video lesson/s (for different chapters' different length and amount of videos) recorded and uploaded by instructor to YouTube channel, and read online material from material from netacad.com.

YouTube statistics of video channel that was created for Flipped Classroom at the beginning of Spring semester 2017 shows that the video from channel was watched during 21,976 minutes, and it had 3,513 views. Most of the videos were watched from Kazakhstan for 20,320 minutes, 3,178 views (92,5%), second place took France by 299 minutes and 30 views (1,4%). Table 1 demonstrates detailed statistics by geography, videos were shared by Kazakhstan viewers 80 times and 93 (89,4) people subscribed from our country out of 104 subscribers. Highest average percentage of viewed videos took Australia (111%) and lowest Germany (1,5%). Table 2 shows that mostly computers/laptops were used to view vides for 18,438 minutes, 2,840 views (83,9%), smartphones took second place by 2,719 minutes and 540 views (12,4%), then tablets with 813 minutes, 131 views (3,7%) and last place took TVs with 6 minutes and 2 views. Table 3 describes rating of videos, first video lessons had more views than new, students in our university had issues to view YouTube starting from the middle of the term. They solved issue by downloading YouTube videos by using grabbers and shared them with each other. That is why statistics of the last videos is not so good.

Table 1. *Statistics by geography*

Geography	Watch time (minutes)	Views	Average percentage viewed	Likes	Shares	Subscribers
Kazakhstan	20320	3178	15.97	80	26	93
France	299	30	28.19	0	0	0
Iraq	234	46	10.88	4	0	1
United States	219	48	10.7	0	0	1
Austria	150	14	28.5	1	1	0
Hungary	129	11	32.85	0	0	0
Russia	126	23	14.29	0	0	3
United Kingdom	108	17	17.74	0	0	1
Denmark	52	4	36.32	0	0	0
Costa Rica	51	1	80.59	0	0	0
Malaysia	49	8	19.09	0	0	0
Latvia	48	2	41.89	0	0	0
Australia	32	1	111.11	0	0	0
South Africa	31	4	17.01	0	0	0
Saudi Arabia	30	8	11.3	0	0	0
India	25	34	1.8	0	0	3
Netherlands	13	5	7.7	0	0	0
Canada	10	7	4.77	0	0	0
Argentina	7	1	20.93	0	0	0
Germany	6	11	1.5	0	0	0
Ghana	4	3	5.35	0	0	0

Table 2. *Statistics by type of used devices*

Device type	Watch time (minutes)	Views
Computer	18,438	2,840
Mobile phone	2,719	540
Tablet	813	131
TV	6	2
Total	**21,976**	**3,513**

Table 3. *Rating of videos*

Video title	Watch time (minutes)	Views
CCNA RS1 - Lesson1: Intro to computer networks	1871	387
CCNA RS1 - Lesson 3: Transport layer protocol	1712	200
CCNA RS2 Lesson 1 Routing Concepts	1525	181
RS1 lesson5 IP addressing part II	1334	138
CCNA RS1 - Lesson5: IPv4 addressing part 1	1332	163
CCNA RS1 - Lesson#2: Computer Networks models, application layer protocols PART 1	1314	213
CCNA RS2 Lesson 3 Dynamic Routing	1302	152
CCNA RS1 - Lesson4: Network Layer	1207	167
CCNA RS2 Lesson2 Static Routing	1184	144
CCNA RS1 - Lesson#2: Computer Networks models, application layer protocols PART 2	988	183
CCNA RS1 - Lesson3: B BASIC IOS CONFIGURATIONS	869	142
RS1 lesson6 Data link layer	838	118
CCNA RS2 Lesson 6 - VLANs Part 1	807	90
RS1 lesson7 Physical Layer	704	87
CCNA RS2 Lesson 5 - Switch Configuration Part 1 664	106	
CCNA RS2 Lesson#7 - Part1 Standard ACL	652	101
CCNA RS2 Lesson 5 - Switch Configuration Part 2	554	96
CCNA RS2 Lesson#7 - Part 2, Extended ACL	543	77
CCNA RS2 Lesson 4 Switched Networks	485	117
RS1 Lesson 8 Ethernet	408	73
CCNA RS2 Lesson 6 - part2 Inter VLAN routing	314	79
CCNA RS2 Lesson#7 - Part3 Named ACL	253	74
CCNA RS2 lesson8 Part 1 - Basic DHCP configuration	216	46
CCNA RS2 Lesson 2 Part 2 - IPv6 Static Routing	215	70
CCNA RS2 lesson 10 - Device Discovery and Management	176	48
CCNA RS2 lesson 9 - Part 1, Static NAT	108	25
CCNA RS2 lesson 8 - Part 2 Advanced configurations of DHCP	102	34
CCNA RS2 lesson 8 - Part 3 DHCPv6	56	23
During quiz 2	49	71
CCNA RS2 lesson 9 - Part 2, Dynamic NAT and PAT configuration	45	16
CCNA RS2 lesson 9 - DHCP, Part 3, Port forwarding	40	19
CCNA RS3 Lesson 1 - Introduction to Scaled Networks	33	8
CCNA RS3 Lesson 2 - HSRP Hot Standby Routing Protocol	20	11

The in-class activities started with a short seminar questions that were broadcasted for all students and those who had answer gave signal for instructor, after short seminar questions student/s who took maximum amount of points took 100 points and others calculated according to highest results (competitive basis). Survey shows that 57 (78.1%) out of 73 agreed or strongly agreed that seminar questions came from video lessons and netacad.com recourses. After seminar questions instructor explained (not always) the task which was posted in cn1spring.blogspot.com, during completion of laboratory works students asked questions if they had according the task. Then instructor provided individual interview about work done by student and grade the student. All grades were available for students by using IoT "Process" pillar "Google Sheet" so that everyone could see it's result and if instructor forgot to give points or mistakenly gave them to another student, student could immediately improve the situation by contacting instructor by email (mostly) or personal in classroom.

Section V – Research Results

At the end of the course we provided survey for students about Flipped Classroom implementation to Computer Networks 1 subject. One of the question of provided survey

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to our students was "Quality of video lessons prepared by my instructor very good", to which 50% of students strongly agreed, about 44% of participants agreed, Fig.3 demonstrates pie chart of answers for question: "Quality of video lessons prepared by my instructor very good".

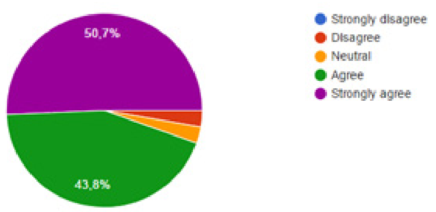

Figure 3. *Answer of participants for question: Quality of vide lessons prepared by my instructor very good*

Video lessons were clearly understandable for students according to answers, 28 (38,4%) of students strongly agreed, 37 (50,7%) agreed, 4 (5,5%) of listeners treated neutral for this question and same percent of students disagreed. There were no students who strongly disagreed, Fig.4 shows pie chart of answers for this question.

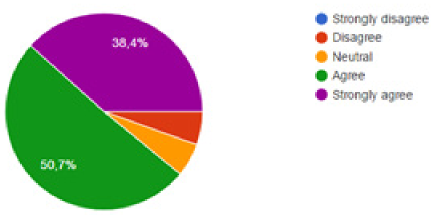

Figure 4. *Answer for question: Video lessons prepared by my instructor understandable for me*

During our research one part of students studied with Flipped Classroom IoT methodology and other by Traditional approach. After getting results of grading we could compare how Flipped Classroom impacted to learning process. Table 4 and Fig.6 describe comparison between Flipped Classroom and Traditional approaches. Attendance of students was higher by 15% in Flipped Classroom than in Traditional, lectures prepared by students were much interesting due to the fact that they understood and supported each other during lectures and almost all of them came to practical and seminar lessons already being aware of the technology or protocol they would have job by help of video lessons and online material from netacad.com. Labworks points in Traditional approach class were less than in Flipped Classroom by about 9%, Quiz 1 and Quiz 2 in average were greater by 32,5% in Flipped Classroom than in Traditional one. Online Quiz 1 results were almost the same in both approaches with about 55%, but difference between methodology according to Online Quiz 2 is big, 80,25% in Flipped Classroom and 58,78% in Traditional one. Final results differ by 20% in favor of Flipped Classroom. And ultimately Flipped Classroom technique bypassed Traditional with a difference of 19.51%.

Table 4. *Comparison of Flipped Classroom results with Traditional classroom*

	Flipped Classroom	Traditional
Attendance	90,93	75,78
Labworks	60,96	51,78
Quiz 1	74,2	39,67
Quiz 2	75,22	45,35
Midterm	74,63	50,51
Online 1	57,32	55,57
Online 2	80,25	58,78
Final	80,45	60,41
Average	74,24	54,73

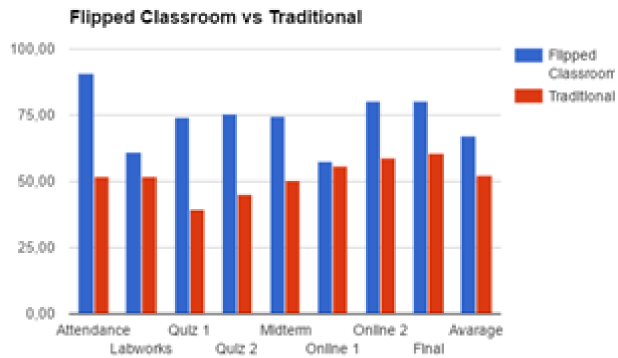

Figure 5. *Comparison of Flipped Classroom and Traditional methods*

Section VI – Conclusion and future works

In this research Flipped Classroom was implemented as a part of IoT into the learning process of Computer Networks and results were compared with Traditional education approach. At the end of the course a survey for students was implemented to get feedback, 24,7% of respondents strongly agreed that video lessons were better than traditional lectures in lecture hall, 45,2% agreed, 19,2% had neutral answer and 11% disagreed. Fig.5 displays answers for the question whether video lessons are betterthan traditional lectures in lecture hall."

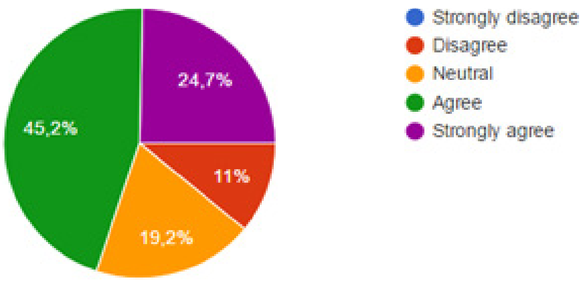

Figure 6. *Answer for question: Video lessons are better than traditional lectures in lecture hall*

Results of Flipped Classroom leads for 19% compared to Traditional approach. Fig.5 shows graphic of comparison two results.

In next semester (Fall 2017) we plan to "Flip" Computer Networks course officially, administration of university gave permission according to the research results. New options will be implemented during seminars. According to the survey, only 8,2% of respondents liked the same seminar format as it was, most of them (32,9%) selected variant of Team games, next famous choice was Test with 30,1%, after Kahoot (24,7%). Fig. 7 describes pie chart of answers according to seminar questions.

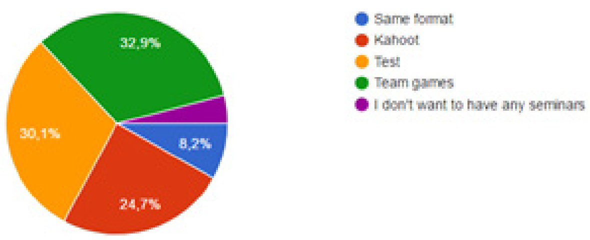

Figure 7. *Answer for question: If you don't like seminar questions format, select format which you like to see in next semester*

At the end of the next semester, we will make new report by offering to "Flip" other courses in Computer Science faculty of our university.

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