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Individual Learning Experience in Connectivist Environment: A Qualitative Sequence Analysis

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Abstract

Although extensive research has been carried out on massive open online courses (MOOCs) as representative of connectivist environment, none of them has succeeded to enlighten our understanding about the individual learning experience in connectivist environment at higher educational context. This paper taped into this crucial issue and traced the individual learning experiences of nine students at regular universities. The participants engaged into a connectivist learning environment by solving 10 tasks each and were tracked using retrospective think-aloud protocols. The patterns of similarities and differences among participants and among tasks were analyzed using qualitative data analysis, supported by visual inspection of the participants' steps. The experimental work presented in this study provides fresh insight into the way at which students at higher education institutes perceive and experience connectivist environment.

Introduction

Connectivism—an emerging learning theory in digital age (Aldahdouh, Osório, & Caires, 2015; Downes, 2008a; Siemens, 2005)—has been considered one of the recent trends in distance learning. This conclusion was reached by a recent literature-review study which tracked 861 research articles in distance learning published in seven of the peer-reviewed journals (Bozkurt et al., 2015). Researchers in the distance learning field may hold that the former learning theories, namely constructivism and cognitivism, have fallen short of their expectations to provide a useful framework in understanding the student's activities in a technology-enabled environment (Siemens, 2005). As Bell (2010) noted, the basic assumption in former theories is that students are taught by teachers, usually in a classroom. The problem in this view is that it appeals to teachers to collect and actively present useful resources for their students, but the students in a technology-enabled environment can readily access these resources and maybe before their teachers (Siemens, 2018). The technology-enabled learning environment (or we shall call it connectivist environment) has challenged our understanding of how students learn and what the role of teachers is.

Showing the inadequacy of the former learning theories is an important matter, but presenting a robust alternative theory is definitely more important (Bell, 2011). After all, practitioners and researchers need a theory to guide their activities. In his seminal work, Siemens (2005) proposed a connectivism as a learning theory for digital age, although some researchers would prefer not to address it as a learning theory on its own (Kop & Hill, 2008) or maybe not a theory at all (Bell, 2011; Clarà & Barberà, 2014; Verhagen, 2006). The work of Siemens (2005), however, has continued to attract the attention of the researchers, as it appeared as the ninth most cited study in the field of distance learning (Bozkurt et al., 2015). Among those supporting connectivism, Downes (2006, 2008a, 2012) has backed up connectivism philosophically and integrated it to the idea of distributed knowledge. And more recently, Aldahdouh and colleagues (Aldahdouh, 2017; AlDahdouh, 2018; Aldahdouh et al., 2015) have succeeded to present concrete examples of different aspects of the theory, ranging from an artificial neuron in a machine learning software programs to a learner in a learning community.

Investigating the robustness and worthiness of connectivism as a learning theory is approaching 15 years now and the researchers in the field have not addressed some of the critical issues around the theory yet. Most of the efforts in the early stages of the theory development were devoted to examine or critique connectivism theoretically (Bell, 2010, 2011, Clarà & Barberà, 2013, 2014; Kop & Hill, 2008; Verhagen, 2006). Later, the works were oriented more toward examining the theory experimentally (AlDahdouh, 2018; Johansson, Contero, Company, & Elgh, 2018; Skrypnyk, Joksimovic, Kovanovic, Gaš, & Dawson, 2015; Wang, Anderson, & Chen, 2018). However, most of those recent efforts—as Tschofen and Mackness (2012) noted—tended to ignore the

individual experience of learning in connectivist environment, not to mention the common assumption which states that the testing ground for connectivism as learning theory is MOOCs. It may be clear as to why most researchers associated MOOC with connectivism, since the first MOOC was presented in 2008 by George Siemens and Stephen Downes to portray the principles of connectivism (Aldahdouh & Osório, 2016; Downes, 2008b). However, whoever ponders on the core principles of connectivism knows perfectly well that it has not been proposed exclusively for MOOC, or for distance learning settings in a wider perspective (Aldahdouh et al., 2015; Kop & Hill, 2008); and the fact that MOOC was presented as an example of the theory does not mean that the theory is confined to it. As a result of these assumptions, there is still uncertainty whether connectivism's principles apply to students at regular universities in the same manner as they apply to the public participants in MOOC. This paper identifies this gap in the literature and attempts to shift the attention away from analyzing group-level learning experiences in MOOC, toward individual learning experience of students at regular universities while participating in a connectivist environment.

Connectivism

Connectivism is a developing learning theory which tries to draw connections between the mechanisms at which students orient themselves in technology-enabled environment and the learning mechanisms at various levels of learning networks. In granular level, the learning network refers to the neural network (real or artificial) and how neurons react within this system. In significant level, the learning network refers to the social groups (organizations or communities) and how social units are interacting with each other (Siemens, 2018). According to connectivism, although these networks are different in their scale, they still similar in the way they learn, and in the way they adapt to changes. Thus, in order to understand how students learn, one can legitimately gain insights from the learning mechanisms of artificial neural network (Aldahdouh, 2017).

The underlying assumption in connectivism is that a network—as a data structure—has a set of characteristics which nominate it to represent the structure of knowledge perfectly (Aldahdouh et al., 2015; Downes, 2008a). A network can be defined as simple as a set of nodes which relate to each other with connections. Despite its simplicity, it is so powerful structure which allows it to represent a lot of human complex concepts with very limited number of elements. To exemplify how the network structure is so powerful we give an example of integer numbers with its undefined ends ($-\infty,+\infty$). The integer number system, especially with the concept of infinity, is not a simple system (Russell & Norvig, 2010, p. 303), but to represent this system as a network you only need a set of one node and two links (see Figure 1).

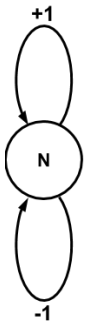


Figure 1. Integer number system as a network

In this simple network, let N be zero. By following the action labeling the upper connection (+1), zero becomes one, then two, and so on until it theoretically reaches positive infinity. The same applies to the lower connection which drags N to negative infinity. And regardless of the initial value of N (provided it is an integer value), this simple network ensures to cover the whole integer numbers.

It is also easy to prove that any other data structures are, in fact, subsets of a network structure. That is to say a network structure is inclusive. Take for example a *list* and a *tree* data structure. A list data structure is a *network* in which each node is connected to exactly two nodes: a predecessor and a successor node. A tree data structure is a *network* which contains no loop where each node has only one parent (see Figure 2). Therefore, the network is a powerful and inclusive structure. But this powerful network does have some inherited and undesirable characteristics such as complexity and chaos (Aldahdouh et al., 2015; Siemens, 2006).

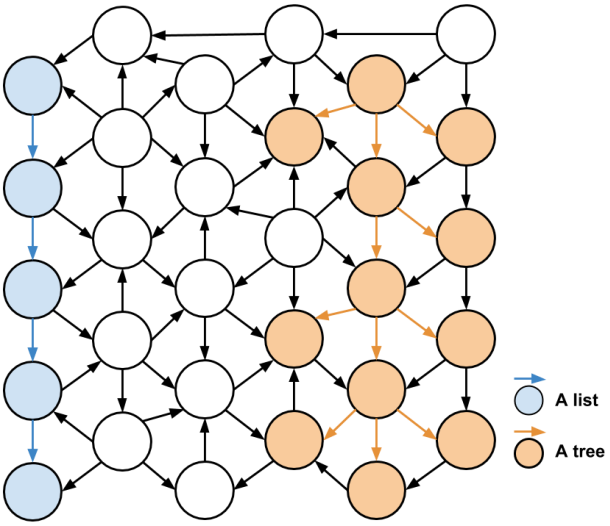


Figure 2. A list and a tree are subset of a network

We put forward those illustrations, so that the reader may take heed that connectivism has a genuine perspective of knowledge which is different from that of constructivism and cognitivism. Constructivism, for example, assumes that the knowledge is constructed inside human mind one block after another in a semi-systematic way. If we were to map the constructivist perspective of knowledge onto the network structure, it would be much like a tree structure where each building block is placed on the top of its parents. Connectivism goes beyond this standpoint of knowledge to include a full network structure which supports cyclic, nested and complex relationships (for more discussion about connective knoweldge, see Aldahdouh et al., 2015; and Downes, 2008a).

Connectivists pay attention to the position of node within a network because the position, as they usually justify (Aldahdouh et al., 2015; Downes, 2006; Siemens, 2006), determines what and when the node can see the information passing through the network. The more connections the node has, the more it moves toward the center, and the faster it will receive information. The node is an autonomous agent and has the power to accept, reject and create connections by its own. Therefore, connectivism defines learning as the process of network formation (Siemens, 2005).

Siemens and Tittenberger (2009) claim that the principles of connectivism apply to three separate learning networks: neural, conceptual, and external. The research to date has tended to focus on external level rather than neural and conceptual level. Examining the validity of connectivism's principles at neural level has not thoroughly been conducted, with an exception of the study by AlDahdouh (2017) in which he matched the connectivist assumptions with how the artificial neural network learns. The studies at conceptual level are not far better in terms of number than the studies at neural level, although Downes (2006, 2008a, 2010) and AlDahdouh et al. (2015) contributed very well in this direction. We also see some supporting evidence to connectivism's principles coming from cognitive science literature. Sloman (2005), for example, presents in his book a host of studies which come down to one point: a human uses causal models in many areas of cognition including decision making, planning, and evaluating and these causal models are best be represented using a sort of networks called Bayesian network, a network with no cycles.

The point of interest in this study, as in most of the studies in the distance learning field, lies in investigating the applicability of connectivism at external level. Connectivism assumes that the knowledge network at external level has a diversity of node types which comprises human and non-human agents. The node in the external level can be any object capable to connect to: website, book, student, Artificial Intelligence (AI) agents, teacher, etc. (see Figure 3). When a student refers to a book, that would be considered as a connection. Asking a teacher (face-to-face or online), interacting with fellow students, visiting a website, and even talking to oneself are considered connections as well. Therefore, learning at the external level is a process in which the student finds his/her way through this knowledge network and makes sense of the existing patterns.

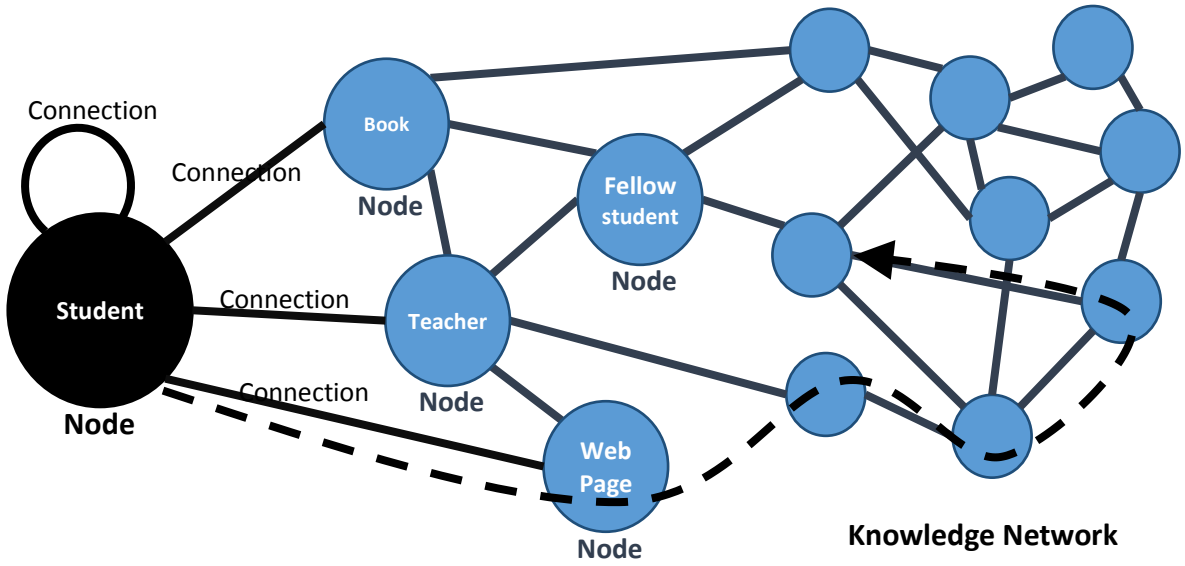


Figure 3. Knowledge network in external level

Connectivists identified their aim as to help students in building their own Personal Learning Environment (PLE; Downes, 2006, 2009, 2016; Kop, Fournier, & Mak, 2011). They suggested that learners may follow four consecutive stages to build their networks: aggregate, remix, repurpose, and feedforward (Downes, 2009; Kop et al., 2011). The paradigm shift in connectivists' view is to focus on the connections for the content instead of the content itself (Siemens, 2006). In other words, the learners should pay their attention on how to follow the source rather than the current information generated from the source. More recently, Aldahdouh (2018) presented a model showing how learners form connections. In this model, three consecutive stages were found to be important in network navigation: planning (select one node from among surrounding nodes), cognitive processing (interact with the selected node), and evaluation (determine the value of the selected node). The planning stage was further analyzed, and the findings showed that learners used three main criteria to select the node: self-efficacy (a perceived ability to do a given task by oneself), eligibility (the degree to which one believes that a node has the information needed or has the ability to solve the task), and feasibility (the degree to which the participants perceived the node as reachable). Downes (2010) determined four principles to build a democratic learning network: autonomy, diversity, openness, and interactivity. A learning network fosters autonomy when it is organized as to give a student the ability to guide him/herself. A learning network fosters diversity when it does not have rules that force students to be 'carbon copies' of each other. A learning network fosters openness when it allows students to enter and leave the network and to share and interact freely with the whole community. According to Downes, learning network fosters interactivity when it encourages students to discuss and sharpen their ideas together.

In 2008, George Siemens, Stephen Downes and Dave Cormier started developing a concept for a course portraying connectivism principles (Aldahdouh & Osório, 2016; Downes, 2012). Because of the influence of MOOC in practice, most of the researchers in the field tend to adopt it as a testing grounds of connectivism's principles (Skrypnyk et al., 2015; Wang et al., 2018). For example, Wang et al. (2018) tracked the traces left across the internet of the participants in Change 11 MOOC, one of the earliest connectivist MOOCs. They identified the interaction between participants using #change11 hashtag distributed across different Web 2.0 technologies and digital platforms such as Blogs, Twitter, Facebook groups, and video conferences. To analyze the interaction, two Twitter participants (A and B) were coded to have an interaction (or connection), when participant A addresses participant B using @B in a tweet. The interaction in this case was recorded as (A → B). The Social Network Analysis (SNA) was the main research methodology in the study. The analysis revealed that the participants used a large set of technologies, engaged in the course with one of four participation patterns (unconnected floater, connected lurker, connected participant, active contributor), and formed six basic structures of social networking (self-looping structure, triangle structure, bridge structure, isolated structure, star structure, network structure). They concluded that some of connectivism's principles have found some support especially regarding the role of the facilitators since the central position of those facilitators was not so obvious and some other participants played an equal (or sometimes more) important role in the network interaction.

Three main observations can be made in regards to these studies (Skrypnyk et al., 2015; Wang et al., 2018). First, they all presume that connectivist MOOCs are the testing ground of connectivism. And as it was argued earlier, although connectivist MOOC may be a good example of connectivism principles, that does not mean

that connectivism is confined to it. Second, they adopted a SNA as the main research methodology which is a typical method to analyze the pattern of interactions in a network of large number of participants. SNA does have a serious drawback, however, in that it fails to report on the individual learning experience. Third, because the individual learning experience was not considered (or maybe inaccessible), these studies tended to ignore the learning that happens outside the mediation role of technology (Czerkawski, 2016). Only the learning traces left over the internet were included but what about the learning that happened outside this framework. Connectivism recognizes both, the technology-mediated and un-mediated learning (AlDahdouh, 2018; Aldahdouh et al., 2015). Tschofen and Mackness (2012) may be the first to identify this gap in the literature. They suggested that connectivists should expand their understanding of the main four principles of a democratic learning network (autonomy, diversity, openness, and interactivity) to recognize the psychological diversity of the learners. For example, connectivists stigmatized the lurkers (participants who follow the course and subscribe to the newsletter, but do not make any contribution to the course) by describing them as self-focused, self-centered, or selfish participants (Siemens, 2010). Tschofen and Mackness (2012) recognized the importance of interaction for MOOC's success, but they also emphasized on the freedom of participants to be 'introverts'. The lurkers should not be stigmatized on the basis of their participation level because that would put them under a psychological pressure (pushing them to do what they really do not feel like to do).

A search of the literature revealed few studies which tracked the individual experience empirically (Saadatmand & Kumpulainen, 2014). And to our knowledge, no single study exists which explores the individual experience of connectivist environment at higher education institutions. The study that is presented in this paper does form part of a large-scale research project which focuses on investigating the applicability of connectivism for students at higher education institutes (Aldahdouh, 2017, 2018; AlDahdouh, 2018; Aldahdouh et al., 2015). Three research questions were formulated to guide the work in this study:

1. What kind of nodes does a student contact?
2. Are there consistent patterns of selected nodes across tasks for a given student?
3. Are there consistent patterns of selected nodes among students for a given task?

Method

Participants

Following the recommendations found in literature (Byrd, 2016; Conole, de Laat, Dillon, & Darby, 2008; Dujardin, 2009; Limbu & Markauskaite, 2015; Sharpe & Benfield, 2012; Symeonides & Childs, 2015; Zhang & Kenny, 2010), this study sought to find informative participants who are willing to generate rich information about the phenomenon. Fifteen Palestinian students from Gaza Strip accepted the informed consent terms (Table 1 shows a list of participants), of whom nine have completed the ten tasks of the experiment. Data generated from only those nine participants were included in the analysis. Each participant received a monetary gratification (about US$26) upon completing the tasks. The final sample includes two males and seven females.

Research Design and Procedure

The study employed an aided retrospective think-aloud (RTA) as a main research method. Each participant received 10 tasks and participated in RTA sessions (Kuusela & Paul, 2000; M. J. Van Den Haak, De Jong, & Schellens, 2004). An aided RTA is also known in the literature in different names such as "prompted retrospective protocol" (Kuusela & Paul, 2000), "retrospective verbal protocol" (Ericsson & Simon, 1980), "actual retrospective protocol" (M. van den Haak, De Jong, & Jan Schellens, 2003) and "stimulated retrospective think-aloud" (Guan, Lee, Cuddihy, & Ramey, 2006). In an aided RTA, participants are usually instructed to complete the tasks silently (often in a lab) and to join a follow-up session immediately after the task resolution. In the follow-up session, the participants watch a recording of their activities and report whatever was on their minds while performing those activities. The distinction should be made between unaided and aided RTA. In an unaided RTA condition, the participants are instructed to recall their thoughts without presented by any stimuli. In most studies which tried to compare between concurrent think-aloud protocol, unaided, and aided RTA (Beach & Willows, 2017; Guan et al., 2006; Kuusela & Paul, 2000; Nielsen, Clemmensen, & Yssing, 2002; Petrie & Precious, 2010; Peute, de Keizer, & Jaspers, 2015; M. van den Haak et al., 2003; M. J. Van Den Haak et al., 2004), aided RTA and concurrent think-aloud were proved to be very much comparable in terms of the quality of the verbal reports generated by the participants, while unaided RTA was reported to be much less valuable. In this study, a modified version of aided RTA was used. First, the participants were not monitored while solving the tasks and that was because of two reasons: (1) Connectivism

insists on giving the participants the freedom to do whatever they want to achieve their tasks (Aldahdouh et al., 2015; Downes, 2010) and thus, the learners should not be under the constraint of searching for answer in a specific time and location. In addition, (2) the recent findings in the think-aloud literature indicated that the presence of the monitor is less functional and more harmful to the participant's performance (Peute et al., 2015; M. van den Haak et al., 2003; M. J. Van Den Haak et al., 2004). The second modification on the aided RTA is that RTA was not conducted in a lab; the participants were located in Palestine and the researcher was located in Finland. The online setting may suit the purpose of this study very well because the participants were supposed to enjoy learning in a *democratic* learning network (Downes, 2010).

Table 1. Participant information

Name[1]	Gender	Age	Field of Study	GPA[2]	Tasks Completed[3]	Length (in days)
Weaam	F	22	Pharmacy	87.95	10	30
M. AbuNour	M	20	Public Relations	76.20	1	46
K. AbuNour	M		Information Security		0	0
Khaled W.	M	21	Share'a and Law	76.80	10	194
Khaled D.	M	19	Journalism	81.50	10	183
Talla	F	19	English Literature	82.70	10	87
Sabha	F	21	Education	85.50	10	82
M. Musharawi	M		Share'a and Law		0	8
Redaa	F	20	Science Education	93.6	10	24
Salwa	F		Science Education		0	31
Neran	F	21	Math Education	80.74	10	37
Khoula	F	21	Math Education	82.00	0	7
Nawal	F	28	Arabic Literature	93.25	10	51
Khaled A.	M		English Literature		0	11
Amal	F	21	Math Education	80.50	10	42

[1]All names used are pseudonyms; [2]GPA stands for Grade Point Average (in percentage); [3]Only participants who completed 10 tasks were included in the analysis.

Data Collection Tools

Tasks

According to the recommendations presented in connectivism literature (Aldahdouh et al., 2015; Downes, 2009; Siemens, 2006) and digital literacy studies (Coiro, 2011; Kiili, 2012; Leu et al., 2013; Leu, Kinzer, Coiro, & Cammack, 2004), we refined four premises the experiment tasks should adhere to:

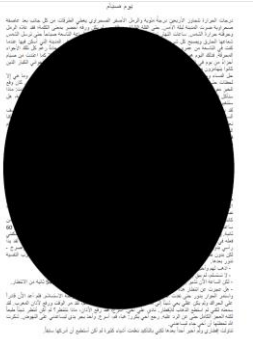
1. A task should be real-life problem; i.e. it should be related to the participants' daily life, inside or outside the academic setting;
2. Participants should be given freedom to find a solution on their own way, without any constraints (no constraints on time, place, resources).
3. A task should induce participants to search and to make their minds out of different resources (facts-retrieval question should be avoided).
4. A participant should be given a set of different tasks (graded from simple to very complex) to track the changes in the participant's performance over different tasks.

All in all, the tasks were organized into 10 different categories as shown in Table 2 below:

Table 2. Categories and the questions provided for the participants

Code	Category	Description	Example
Q01	Information Search	Simple task that requires gathering information which is available but scattered over the internet. The participant should find information from different resources.	Prepare a comprehensive list of toxins and antibiotics.

Code	Category	Description	Example
Q02	Investigation of Person	Search for a Palestinian character and create a complete profile of him/her. Plenty of information about the character already exist on internet. The participant should be able to orient him/herself and decide which information to read and which one to skip. The participant should also be able to provide an opinion about the character.	Gather info about a Palestinian character, Imad Farajin. Prepare a complete profile of his life, history, and achievements. Include your opinion about him.
Q03	Question in a Field of Study	Each participant has a unique question related to his/her field of study at the university. The task should induce the participant to search for an evidence-based information in his/her major specific area. The participant should search in trustworthy resources.	Search for the medicine named "Gaviscon." Specify for what purposes it has been used and what its components are. Prepare a list of all equivalent medicines and their prices.
Q04	Self-Motivation Question	The participant is given a chance to pick the topic they wish to search for. The question is designed to allow the participants to exercise their volition and pursue the topic they really interested in.	There might be a question that you had encountered and did not find time to search for or to read about in the past. Take your time to remember and to search for it.
Q05	Info Validation	This task induces a participant to search for a topic which is controversial or uncertain on the internet. The participant should be able to make his/her decision based on uncertain information.	Check the validity of the information that eating fish with milk (or any dairy products) is unhealthy? Support your answer with details and evidences.
Q06	Compound Task	This task involves sub-tasks. The participant is asked to search for a named scholarship and to apply for it. The task involves writing essays and gathering information for a scholarship.	Search for a “Hani Qaddumi Scholarship Foundation.” Prepare your files to apply for a scholarship to cover your tuition fees in the next year.
Q07	Essay Writing	The participant is asked to write a scientific essay about a topic related to his/her field of study. The participant should gather information from trusted resources, remix and repurpose them in a blend.	Write an essay about citrus fruits. The essay should include the gossips about their harmful effects on human health along with the reality and misconceptions of their benefits.

Code	Category	Description	Example
Q08	Design Question	A participant is asked to provide a new sketch or design for something he/she is familiar with. The task targets the ability to imagine. The participant should use his/her imagination to see old things differently.	Design a sketch for your mobile's home-screen as you wish it to be.
Q09	Creativity	This High-level task requires the participant to be greatly creative. In this question, the participant is also invited to imagine, but his/her imagination should be guided and framed by a given set of clues and constraints. The participant should make use of the clues and the connections between them while using his/her imagination in the rest. The task should not exist on the internet at all.	The sheet, you have, is a short story with a hole appearing on in the middle. The hole covers a considerable part of the script. Do your best to recover the missing part. Note, you should make use of all parts shown so the whole story becomes consistent. 
Q10	Technical Question	This task is out of the participant's field of study. It is for an expert in the field of Information Technology. It is a call for action which is very difficult for anyone out of the field. The task is meant to monitor how the participant establish a connection to one of the experts in a field.	You have an Excel file that you work with every day. You need to backup this file every day at a certain time. You should name the backup file as the same as the file name followed by the date, and to keep those backup files up to one week. This backup mechanism should be done automatically.

Questionnaire

In addition to carrying out the above tasks, participants also had to fill in a questionnaire to measure their level of technology usage in order to increase the trustworthiness of the results and our interpretations (Sharpe & Benfield, 2012). The questionnaire, handed out to the participants together with the first task, was Media and Technology Usage and Attitudes Scale (MTUAS), developed by Rosen et al. (2013). The questionnaire consists of 60 items distributed into 2 scales: technology usage (44 items) and attitudes toward technology (16 items). In this study, we reported the technology usage scale which contains eleven technologies subscales: smartphone (9 items, e.g., check the news on my mobile phone), social media (9 items, e.g., reach social media postings), internet searching (4 items, e.g., search the internet for information on any device), e-mailing (4 items, e.g., check your personal e-mail), media sharing (4 items, e.g., watch video clips on a computer), text messaging (3 items, e.g., send and receive text messages on a mobile phone), video gaming (3 items, e.g., play games on a computer, video game console or smartphone by yourself), online friendships (2 items, e.g., number of people you regularly interact with online that you have never met in person), Facebook friendships (2 items, e.g., Facebook friends you know in person), phone calling (2 items, e.g., check for voice calls on a mobile phone) and TV viewing (2 items, e.g., watch video clips on a TV set). The items were translated into Arabic language. An electronic survey was built to collect participants' responses using Google Forms. Participants were instructed to report any difficulty in understanding the translated version of the survey (a full questionnaire is displayed in the study by Rosen et al., 2013).

Analysis

Siemens and Tittenberger (2009) identified three broad levels of learning networks: neural, conceptual, and external. This study adopted Siemens and Tittenberger's classification and put the focus only onto the conceptual and external levels of learning networks (hereafter referred to as 'internal' and 'external', respectively). Nevertheless, the aim of this study is to provide a detailed description of a higher-level categorization matrix proposed by connectivism rather than providing a rich description of data set (Braun & Clarke, 2006). The qualitative content analysis included the videos of RTA together with all other documented activities of the participants (e.g. Facebook conversations with friends, face-to-face recordings with relatives, and diaries recording the hard-copy materials used). ATLAS.ti 7 was also used in the data analysis.

Furthermore, the study employed a visual inspection approach to analyze the participants' steps (Aldahdouh, 2018). At the beginning of each RTA session, the participants provided a sequence of the actions they followed throughout the course of a given task. For instance, a sequence of actions may include referring to a book and then searching the internet, followed by sending a message to a friend on Facebook. The sequence of actions of each participant in each task was recorded in a separate Microsoft Word file. Since the experiment involved nine participants and 10 tasks for each, 90 files were generated in total. The average number of steps per task was 4.82 and the range was 1-16 steps. The participants followed 434 steps through all tasks. The visual inspection of sequential data aimed at spotting and understanding the patterns of similarities and differences in, and among, sequences by depicting these sequences in graphs. We followed the procedures suggested by Aldahdouh (2018) to generate meaningful differences between nodes.

Results and Discussion

What kind of nodes does a student contact?

Throughout the course of the experiment, the participants engaged into a very wide list of learning activities and contacted various node types, summarized in Table 3. The table was built based on the steps used in solving the tasks, as reported by the participants.

Table 3. Learning nodes (times of occurrence)

<table>
<tr><td rowspan="2">Internal (80)</td><td colspan="4">Cognitive processes (34)</td></tr>
<tr><td colspan="4">Writing (46)</td></tr>
<tr><td rowspan="15">External (347)</td><td rowspan="2">Internet Searching (169)</td><td colspan="3">Laptop or Desktop (133)</td></tr>
<tr><td colspan="3">Mobile (36)</td></tr>
<tr><td rowspan="13">Ask People (139)</td><td rowspan="3">Face-to-Face (48)</td><td colspan="2">Friends (9)</td></tr>
<tr><td colspan="2">Family members (26)</td></tr>
<tr><td colspan="2">Teachers (13)</td></tr>
<tr><td rowspan="11">Online (91)</td><td colspan="2">Email (2)</td></tr>
<tr><td rowspan="2">WhatsApp (10)</td><td>Friends (9)</td></tr>
<tr><td>Teacher (1)</td></tr>
<tr><td rowspan="4">Facebook Messenger (57)</td><td>Researcher (6)</td></tr>
<tr><td>Friends (26)</td></tr>
<tr><td>Family members (7)</td></tr>
<tr><td>Teachers (18)</td></tr>
<tr><td colspan="2">Facebook Groups/Pages (19)</td></tr>
<tr><td colspan="2">Skype call (3)</td></tr>
<tr><td colspan="3">Paper resource (30)</td></tr>
<tr><td colspan="3">Digital Resource (9)</td></tr>
<tr><td colspan="5">Give up (7)</td></tr>
</table>

From the table, it is evident that the participants tended to depend heavily on external nodes to complete the tasks of the experiment (N=347 times), in comparison to the internal nodes (thinking or writing on their own) which occurred 80 times. An important note here is that thinking and writing are also occurring in external nodes while reading or chatting with friends, family members and/or teachers. But the point is that, the internal nodes, in Table 3, refer to when the participants depended solely on their intellectual capabilities to complete part of the task. Examples of such intellectual capabilities were: recalling facts; analyzing the problem into sub parts; structuring and relating distinct parts into single whole; and putting hypothesis and imagining possible outcomes.

In addition to the internal and external nodes, the participants gave up and ended the process of finding the answer in some occasions (N=7 times). This is in contrary to Connectivism's assumption which contended that learners may experience high tension and the tension will force them to make new connections (Aldahdouh et al., 2015; Downes, 2009; Siemens, 2006). In the experiment, some participants preferred not to continue with the task after reaching a high-level of negative and deactivating feeling (frustration, hopelessness, boredom). The result is congruent with Kop's (2011) findings who identified the challenge of self-direction as one prerequisite of learning in the connectivist MOOC. Kop found that some participants faced serious difficulty to learn without instructions or guidance from the instructors. The results of the current study look similar to Kop's results and cast doubts on the applicability of connectivist principles for learners who have scarce self-regulation skills.

Throughout the experiment, the participants referred to various kinds of external nodes, which include: searching for answers in the internet, asking people, referring to paper resources, and digital resources. As Table 3 shows, both searching the internet (N=169) and asking people (N=139) were almost alike in the number of occurrences and they were the most common activities under the external nodes. This result may contradict the idea that new generations prefer going online more than other methods of gathering information. It is clear that the participants' behaviors in the experiment confirmed the results of net generation's (Net Gen) literature that described them as socially active and that this tendency is no less important than searching the internet (Hartman, Moskal, & Dziuban, 2005; D. Oblinger & Oblinger, 2005). Even though that searching the internet and asking for other people's help were the dominant activities, the participants did not abandon the paper resources as a central way of getting information. Thirty times the participants referred to paper resources (books, classroom notebooks). Visiting the library at the university and reading books at homes were considered as a formal way of learning, according to some participants. In comparison, referring to digital resources (e-books or software applications) were much less common. One participant indicated that she does not even like to open PDF files and another student conceived that 'real' knowledge is on 'paper' books and not on the internet.

Searching the internet was done using laptops, desktops, or mobiles. The results showed that the dominant tools to search the internet were laptops and desktops. This result contradicts with the global trend of using mobiles and contradicts with United Nations International Telecommunication Union's report (ITU, 2016) which clarified that the Palestinian society is no exception to the global trend. Although only one out of the nine participants reported to have an old mobile (no smartphone), the other eight participants decided not to use their mobiles heavily in the experiment, and that was for a variety of reasons. For example, one participant stopped using her mobile because she found it difficult to record video for her mobile's screen while searching, a required procedure for the experiment's documentation (something which can be addressed as an effect of the research design in this current study on the participants' behavior). Another participant indicated that she uses her mobile for small enquiry, which does not require a lot of searching and writing. For most of her academic tasks at the university, she uses her laptop. Still, the participants were using their mobiles for purposes other than information searching. For example, most of the participants used their mobiles for communicating with their friends.

Communicating and asking people via online channels (N=91) was about double that of face-to-face communication (N=48). The results emphasized the role of technology as a communication channel between people. In the Palestinian context, this method may be the only choice to communicate with others due to the restriction on movement by Israeli occupation. This result is also congruent with one of Connectivism's principle: "Knowledge may reside in non-human appliances, and learning is enabled/facilitated by technology" (Siemens, 2006, p. 31). Some participants also showed their preference to stay connected almost always, which is one of Net Gen characteristics (D. Oblinger & Oblinger, 2005). Even though, they were forced to be disconnected due the electricity shortage in Gaza Strip. Being forced to be disconnected made some of them feel angry.

Face-to-face communication was distributed between three main categories: friends, family members, and teachers. The face-to-face communication with family members was the dominant category (N=26) which accounted to more than the sum of the other categories: friends (N=9) and teachers (N=13). Sharing and discussing the question with relatives were mostly not for the purpose of solving the task itself. Rather, they were mostly for asking advice on how to approach the task. Therefore, discussing the task with relatives often resulted in changing the course of the solution. These family interventions can consequently be categorized within the planning stage in the model of connection formation reported in the study by AlDahdouh (2018). The second more frequent face-to-face communication was with teachers. Visiting academics in their office hours and chatting with them after the classroom were some of the methods to get help or advice to solve the tasks. Unexpectedly, during this process, the participants did not communicate face-to-face very often with their friends. Taking into account that all participants were regular students who were registered in regular (on campus) universities, it was expected that the participants would communicate with their colleagues face-to-face regarding the tasks of the experiment. Part of the explanation of such result is that the tasks given to the participants were not common for all students in the classroom, as it would be the case of homework for example. Some participants recognized that answering the tasks of the experiment were their own responsibility and that their classmates did not share their concerns to solve the tasks.

Online communication with people was more intense (N=91) and diverse in comparison to face-to-face communication. It included sending emails; chatting with others via WhatsApp and Facebook Messenger; posting and discussing with others on Facebook groups and pages; and calling people on Skype™ platform. Before delving into details, it is clearly seen that the formal online environment such as a Learning Management System (LMS) is completely absent from the list of tools used throughout the experiment. The result confirmed the previous studies in Palestinian context (Aldahdouh, 2012) which indicated that LMS such as MOODLE are not used to initiate communication between students. Instead, most students are using MOODLE just to deliver their assignments and to solve quizzes. The result also came in accordance with Conole's et al. (2008) study which was conducted in a different context (United Kingdom) and indicated that students are moving beyond the formal LMS where a lot of them 'dislike' it. The general distribution of online communication in the current study showed a greater tendency towards new technologies such as social networking sites (SNS), in comparison to old technologies such as email. WhatsApp (N=10), Facebook Messenger (N=57), and Facebook Groups and pages (N=19) account for more than 94.5% of the online communication tools. In comparison, traditional technologies of communication such as email and Skype™ occurred only 5 times and were used by only two participants. Actually, Skype™ accounts were created for most of the participants (n =7) as part of the planned method of communication in the experiment. In addition, some participants reported that they have created their email accounts just because it was a required step to create the Facebook account. And when they were asked to install Google Drive on their devices (as part of the experiment's procedures), they struggled to remember their Gmail account's passwords. The tendency towards recent technologies was accompanied by surprise and rejection of using traditional technologies. The following Facebook conversation between Neran and her teacher clarifies this concept.

Neran:	Could you please mention a name of someone who works there? I mean someone who has Facebook account.
Teacher:	[mentioned a name]
Neran:	Oh, really! so she has Facebook account?
Teacher:	Yes, but she responds on her Gmail faster.
Neran:	What!!

Among a long list of available social networks, Facebook Messenger (N=57) and Facebook Groups and Pages (19) were the most consulted. Facebook Messenger was used to communicate with the researcher, friends, family members, and teachers. The dominance of using Facebook network in communication confirmed Aldahdouh's (2012) results which reported that more than 90% of the students (N=330) were using Facebook. Surprisingly, some participants considered communicating with their professors at university on Facebook Messenger as regular and as formal as communicating in email. One participant wondered – with resentment – on why academics were so slow to reply on her messages on Facebook Messenger. Facebook Messenger was also used to communicate with family members who were, sometimes, living in the same house. One participant, for instance, preferred to discuss the task with her sister via Facebook Messenger while each of them was searching for the solution on her own device (parallel processing). In some occasions, the participants decided to go outside the cycle of their friends and posted the task on public Facebook groups and pages. WhatsApp was used less frequently and as a backup plan if the communication did not succeed on Facebook. Some participants (N=5) considered WhatsApp a personal network more than the Facebook (because it is associated with their mobile numbers). Participants used SNS mainly for texting (text messages). This is partly

because of their preference and partly owing to the low internet connectivity in Gaza Strip (ITU, 2016; Ministry of Telecom and Information Technology, 2015).

In addition to the previous qualitative data of the study, the participants filled in MTUAS questionnaire (Rosen et al., 2013). Table 4 shows the results related to technology usage items of this scale.

Table 4. The results of Media and Technology Usage Scale

Subscale	Response Scale	*M*	*SD*
E-mailing	10-point scale	4.78	1.761
Text messaging		6.37	2.143
Phone calling		4.83	1.436
Smartphone usage		5.15	1.643
TV viewing		2.89	2.826
Media sharing		2.72	0.785
Internet searching		5.81	1.643
Video gaming		1.59	0.828
General social media usage		5.33	1.34
Facebook Friendships	9-point scale	5.39	1.318
Online Friendships		2.06	0.917

The mean score of E-mailing subscale was below the average (M=4.78, SD=1.761), taking into account the fact that the response scale involved 10 points. E-mailing score was still higher than expected since that, in the qualitative study, most participants (N=7) reported that they do not use their emails. Regarding the mean scores of Text Messaging (M=6.37, SD=2.143), General Social Media Usage (M=5.33, SD=1.34), and Facebook Friendships (M=5.39, SD=1.318) subscales, they were all above the average and among the highest scores on the technology usage scale. This indicates that the participants were using social media heavily and more than other technologies and, thus, came in accord with the qualitative results and the previous studies (Aldahdouh, 2012). An exception to this tendency was the mean score of Online Friendships (M=2.06, SD=0.917) which was clearly below the average. The subscale contains 2 items (How many people have you met online that you have never met in person? and How many people do you regularly interact with online that you have never met in person?). The low rating of those items is logically justified considering the Palestinian context where the participants were under the pressure and fear of the occupation.

The participants were not supposed to communicate with strangers in such environment. The mean scores of TV Viewing (M=2.89, SD=2.826) and Phone Calling (M=4.83, SD=1.436) were below the average and may indicate that the participants are moving away from old technologies which confirm the results of the qualitative observation. The mean score of Media Sharing (M=2.72, SD=0.785) was very low and challenges one of the recent trends in western societies (Rosen et al., 2013). Some items in this subscale are 'Watch TV shows, movies, etc. on a computer' and 'Download media files from other people on a computer'. The results of this subscale are expected considering the low internet connectivity in Gaza Strip and are in agreement with the qualitative study, despite contrasting with the Net Gen characteristics (D. Oblinger & Oblinger, 2005). Regarding the mean score of Video Gaming (M=1.59, SD=0.828), it was the lowest among other technologies and lays right in the opposite of the recent trends observed in western societies as indicated by Rosen et al. (2013).

Are there consistent patterns of selected nodes across tasks for a given student?

To answer this question, we conducted visual inspection of the participants' steps as described by Aldahdouh (2018). The hierarchical tree of relations among the categories was built following the hierarchy of nodes described in Table 3. The steps were rearranged to investigate the pattern of similarities and differences across all tasks for each participant. Figure 4 below shows Weaam's steps (and her selected nodes) throughout the course of the study.

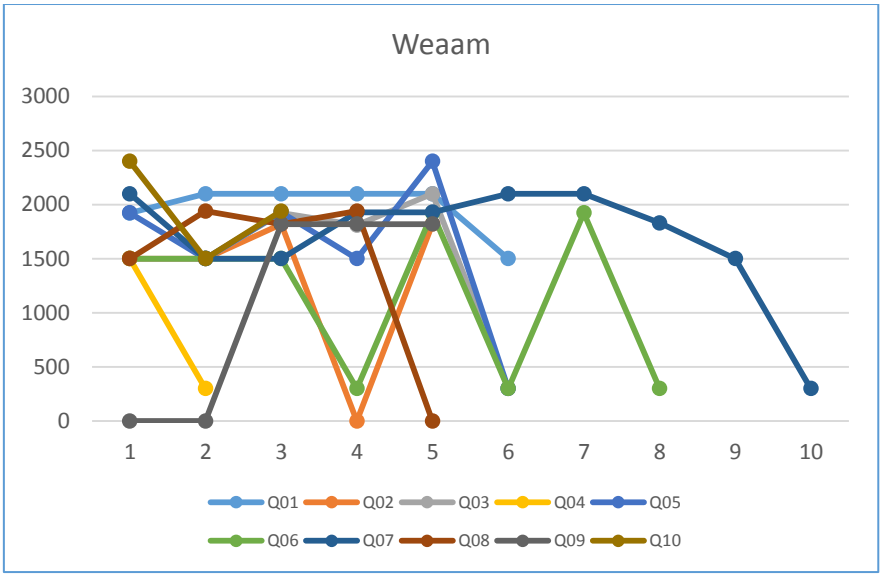


Figure 4. Weaam's steps from Q01 to Q10

The horizontal axis represents the steps while the vertical axis represents the selected nodes. The lower values on the vertical axis (0 to 300) are those nodes belonging to Internal nodes while the upper values on the vertical axis (1500 to 2400) are those nodes belonging to External nodes. The value 3000 represents Give Up node. Each colored line links Weaam's selected nodes of one out of 10 questions. Figure 5 shows all other participants' steps from Q01 to Q10.

Of great importance here to point to the fact that the numerical values assigned to each node on the vertical axis do not have meaning on their own, but the differences among these values indeed have. For example, there may be little if any logical grounds to assign the value of 0 to cognitive processing node, 300 to writing node, and 1500 to searching internet using laptop/desktop devices. However, the idea of the visual inspection of the sequential data is to assign these arbitrary values to the nodes automatically so that the differences among them correspond to our theoretical assumptions of how distinct those nodes should be.

For example, it sounds theoretically logical to assign numerical values to those nodes so that the difference between thinking and writing nodes appear much less than the difference between writing and searching the internet. And that is simply because when the participants fluctuate between thinking and writing on their own, that would be classified under one parent node (internal node); But when they moved from writing on their own to searching the internet, that would be classified as moving from one main node (internal node) to another main node (external node). For more discussion on the process of assigning these numerical values and on how the graph should be interpreted, the reader is directed to the study by Aldahdouh (2018).

Comparing between participants and by looking at the first step of each participant, it is noticeable that all participants started their steps mainly by consulting external nodes. This is to say that the participants usually started finding a solution for a given task by looking at external nodes such as searching the internet, referring to a book or asking a person. An exception of that is Redaa who started her steps consulting both internal and external nodes and in the same extension.

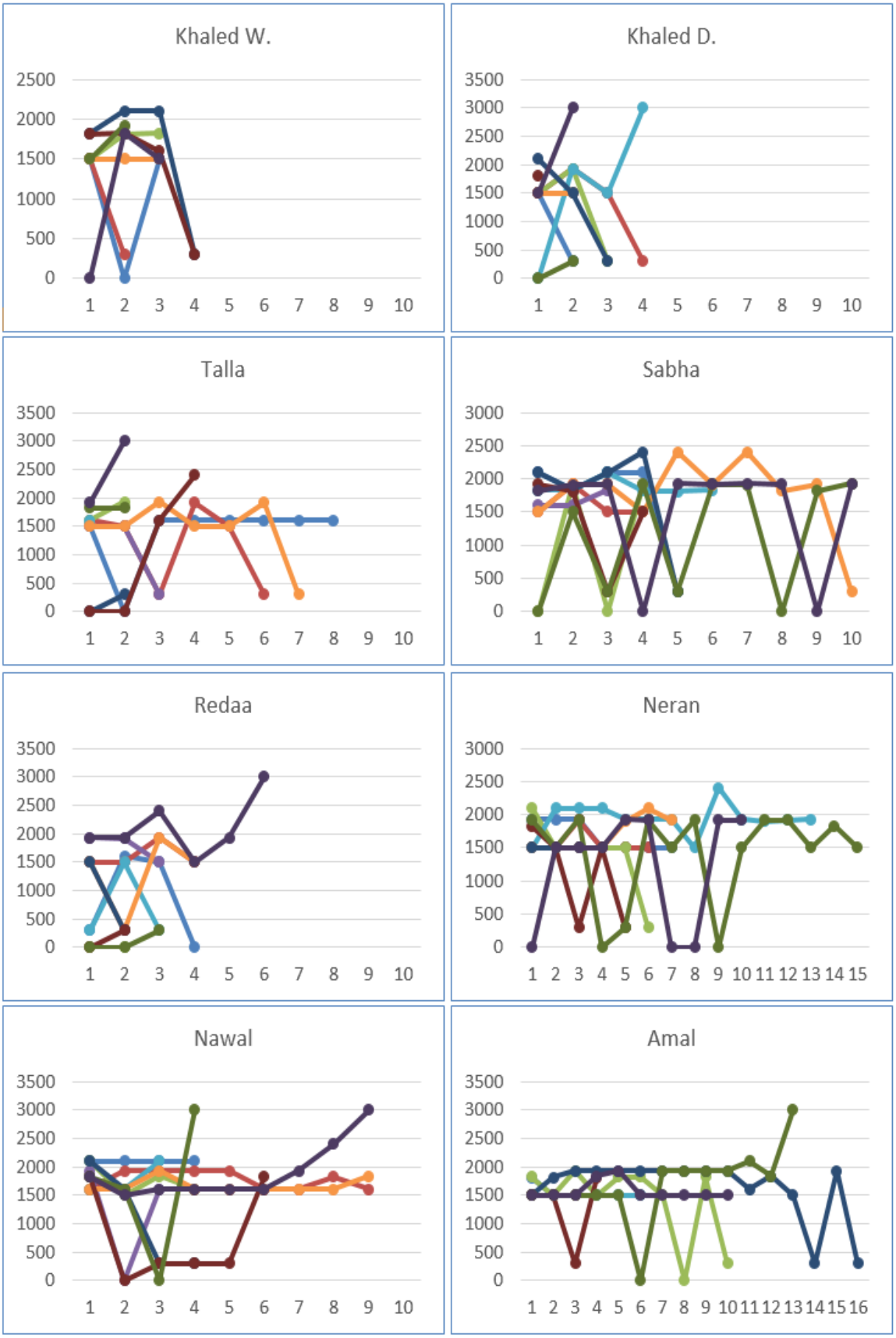


Figure 5. Participants' steps from Q01 to Q10

Table 5. Participants' first step and average number of steps

Participant	Average number of steps	Nodes in the first step	
		Internal	External
Weaam	5.6	1	9
Khaled W.	2.6	1	9
Khaled D.	2.4	2	8
Talla	3.7	2	8
Sabha	6.1	2	8
Redaa	3.3	5	5
Neran	7.3	1	9
Nawal	5.5	0	10
Amal	6.9	0	10

By looking at the average number of steps followed to solve the tasks (Figure 5 and Table 5), one may notice that some participants tended to simplify the process and completed it in an average of less than 4 steps such as Khaled W., Khaled D., Talla and Redaa. Other participants tended to exert more effort and consulted more nodes such as Weaam, Sabha, Neran, Nawal and Amal. The distinction should be made between the exerted effort and the time spent in the task. For example, while both Khaled W. and Redaa were reported to exert less effort in the task, there was a distinctive difference between them in the terms of the time spent in the tasks. As Table 1 shows (length in days), Redaa needed 24 days to complete the ten tasks of the experiment in comparison to Khaled W. who needed 194 days. Those participants who exerted less effort in the experiment tasks would have most likely classified as connected lurker or even as unconnected floater in connectivist MOOC environment (Siemens, 2010; Tschofen & Mackness, 2012; Wang et al., 2018). The results of the current study support the argument of Tschofen and Mackness (2012) that this classification does not map the complexity of the individual learning experience. Redaa, for example, did not exert much effort in the experiment because she reached to her goals very fast and did not have time to share her experience with others, but not because she is selfish. Khaled W., on the other hand, exerted less effort while spending a lot of time in the tasks because he showed less interest in the tasks of the experiment.

Are there consistent patterns of selected nodes among students for a given task?

In a similar way of analyzing the learning patterns between participants, an analysis of the learning patterns between questions was also carried out. Figure 6 below shows the steps followed by all participants while answering the first question (Q01 – information search) in the experiment.

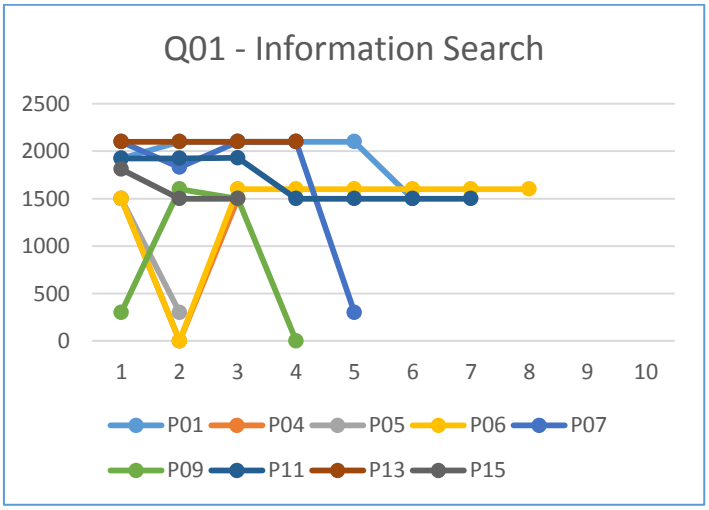


Figure 6. The steps followed by all participants in Q01

The horizontal axis represents the steps while the vertical axis represents the selected node. The lower values on the vertical axis (0 to 300) are those nodes belonging to Internal node while the upper values on the vertical axis (1500 to 2400) correspond to External node. The value 3000 represents Give Up node. Each colored line links the selected nodes of one participant out of 9 in the experiment. Figure 7 shows the rest of the questions.

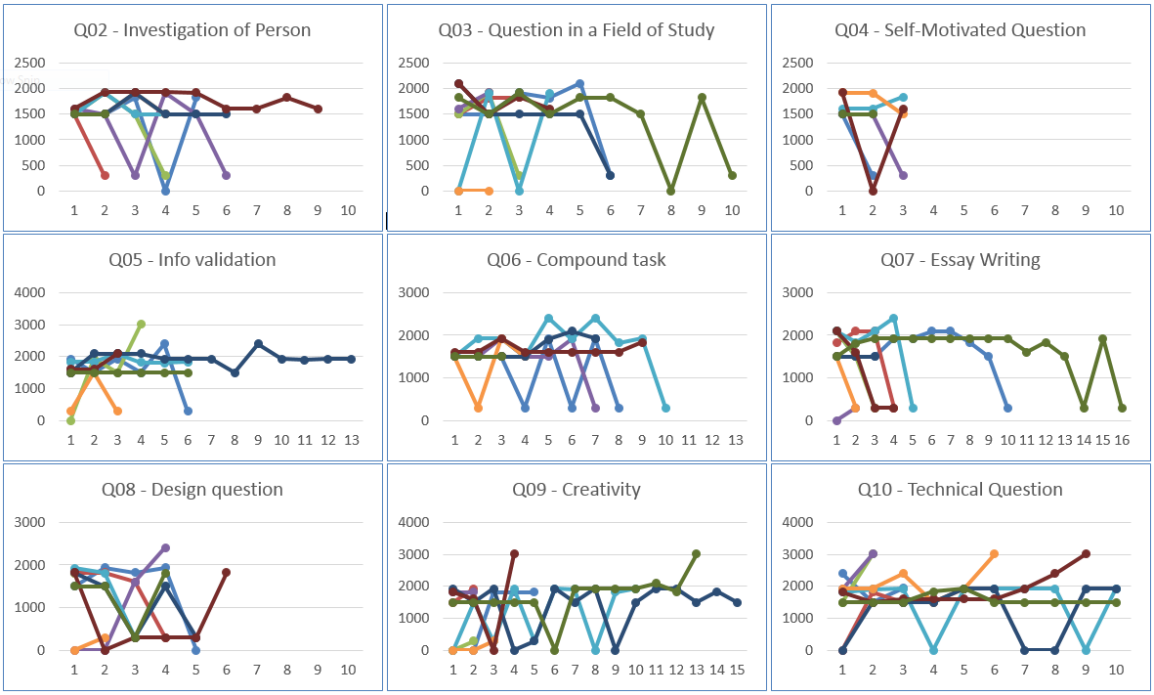


Figure 7. The steps followed by all participants in each question

Comparing between questions and by looking at the first step in each question, it is noticeable that all questions, except Q09 (as it will be explained shortly), was started mainly by consulting external nodes. In some questions (Q02, Q04, Q06), all participants started with external nodes.

Table 6. Questions' first step and average number of steps

Q#	Question Category	Average number of steps	Nodes in the first step	
			Internal	External
Q01	Information Search	4.67	1	8
Q02	Investigating a Person	4.67	0	9
Q03	Question in a Field of Study	4.44	2	7
Q04	Self-Motivation Question	2.11	0	9
Q05	Info Validation	4.78	2	7
Q06	Compound Task	5.89	0	9
Q07	Essay Writing	5.44	1	8
Q08	Design Question	3.89	2	7
Q09	Creativity	6.22	4	5
Q10	Technical Question	6.11	2	7

By exploring the average number of steps per question, surprisingly, Self-Motivation Question (Q04) appeared to be the shortest. The question was designed to let the participants be autonomous and exercise their volition to choose the topic they want to search for. The participants were also given a time to think of the topic, in order to avoid the effect of the anxiety and the pressure of finding the topic immediately. These results suggested that self-motivation questions do not induce learners to select topics far beyond their current knowledge. Tracking back the participants' selected questions clarifies that all of them, except Amal, formulated their questions around 'What is something?' In other words, they searched for facts. They mainly answered their questions by

simple search on the internet. In digital literacy studies (Coiro, Castek, & Guzniczak, 2011; Kammerer, Bråten, Gerjets, & Strømsø, 2012), fact-retrieval question was identified as trivial question which should be avoided for a learner who has access to the internet. More than that, when the participants were asked to clarify their motives of selecting their questions, many of them repeated the same proverbs, 'to kill two birds with one stone'. They picked up one of their assignments at the university as a task in the experiment. This result suspects the feasibility of using self-motivation questions as a means to encourage students' learning.

On the other hand, Compound Task (Q06), Creativity (Q09), and Technical Question (Q10) took very long for the participants to complete. Those questions seemed to be difficult for the participants considering the number of steps as a sign of complexity. This is in accordance with our theoretical classification of the questions, as in Table 3. Another sign of complexity is the number of participants who gave up (3000 on vertical axis) in each question. Technical Question (Q10) seemed to be the trickiest question (with 4 participants giving up) followed by Creativity (Q09) (with 2 participants giving up).

The average number of steps of Q07 (5.44; as shown in Table 6) was deceiving. The number is high in comparison to other questions but, by looking at Figure 7, one can notice that most participants completed the task within 5 steps. Only two participants (Weaam and Amal) needed additional steps to complete the task (10 and 16 steps respectively). In other words, the performance of Weaam and Amal acted as outlier and dragged the average towards high value. Tracking back Weaam's and Amal's performance, in comparison to other participants, clarified that both of them had paid a great attention to the aim of the question, to write a scientific essay. They struggled to gather *trustfulness* information from different resources. Weaam, for example, asked her professor at the university on how to find scientific articles on the internet after many failed attempts to find such articles on her own. She also searched on how to write a scientific article before she began to write. The other participants, however, answered the question by simply gathering information from websites without checking its credibility. For example, Weaam and Redaa reached the same information on the same website. Redaa copied and pasted the information in her answer while Weaam paused on the information and investigated its validity, and, eventually, ignored it because it was invalid. The result indicated that learners do not deal with writing tasks in the same manner and the majority do not check for the credibility of the information. This, in turn, indicated their need to be educated about the basics in digital literacy.

By investigating the consistent pattern between questions, one can find that Searching information (Q01) and Investigation of Person (Q02) apparently approaching each other. Tracking the performance of participants on both questions showed some similarity between participants: in both tasks, the participants usually began with external nodes and moved occasionally to internal nodes. However, Q02, in specific, posed the need for the participants to be aware of conflicting information on the internet environment. The aim of Q02 was to create a profile for a Palestinian person (television actor or social activist). The internet has a lot of information about the selected person, along with other people, and the participants should be selective. In the experiment, two participants, namely Nawal and Sabha, failed to recognize that some websites were presenting information about another person who fortuitously has the same name. Thus, both copied-and-pasted information of two persons and constructed a profile of a person who does not really exist.

Among all questions in the study, only Writing an Essay (Q07), Design Question (Q08), and Creativity (Q09) questions succeeded to encourage participants to consult internal nodes (think and writing) while only Q09 encouraged them to employ their cognitive processes (thinking) in specific. According to the study evidence, Writing an Essay (Q07) and Design Question (Q08) encouraged participants to consult Writing node. It was possible for the participants to copy or download the design from the internet, if they wished, but most of them preferred to gather the components from the internet and mix them in a new design. Neran and Nawal, for example, made two designs instead of one. This indicated that the participants are visual thinkers which is one of the Net Gen's characteristics (D. Oblinger & Oblinger, 2005).

Regarding the Creativity question (Q09), the question encouraged the participants to pause several times for thinking. In this question, they were asked to cover a hole in a story and the story did not exist on the internet (it was created by the researcher). The story was given to the participants in a digital format (PDF file) and it was named 'Story I - Fasting day'. Almost half of the participants (N=5) started solving the task by consulting external nodes: searching the internet (N=2) or asking people (N=3). Consulting the external nodes was based upon their perceptions about (1) the ease of finding information on the internet, and (2) the authority of knowledgeable people, together with their perceptions about (3) themselves (low self-efficacy). The following excerpt of Khaled W. clarifies this idea:

Khaled W.: When I first saw the story, I found out that most of the text is hidden. It may be – or certainly – impossible for me to recover the whole text. I said to myself "I will find it as it is on the internet".

….

Khaled W.: As I said to you, [I assumed the probability of] 1% that I will not find it on the internet.
Researcher: Aha, do you mean that you were sure you will find it on the internet?
Khaled W.: Yes. Ha ha.

The power of the participants' perceptions guided their behavior of selecting the internet and avoiding their thinking capabilities. Under these perceptions, they followed almost the same steps on the internet. First, they searched for the title of the story. When they did not find the answer, they assumed that the title was changed to mislead them. Therefore, they took some statements from the story and searched for them. When the results did not come, they assumed that the story was translated from English. Some participants clarified that they got this assumption from the title of the PDF file which was in English: 'Story I - Fasting day'. They took the title of the file as keywords for search engine. One participant even tried to find the story by searching for the meaning because she assumed that the story is a brief version of a longer one. When they began to consider the possibility that the story does not exist in the internet, they either handed out the story to their friends or depended on themselves. However, for those who tried to count on themselves, the period did not last too long. They went back to the internet but with new ideas. Neran, Amal, and Sabha, for example, searched the internet for a method to remove the "black hole" from the PDF file. Neran and Amal did not succeed but Sabha, with a help from her brother (an IT specialist), was able to remove the hole and delivered the answer with a complete story. Of course, what Sabha did would be considered as "cheating" in the rules of regular university. In Connectivism, however, the rules are different. In an attempt to understand the connectivity theory in one of our previous work (Aldahdouh et al., 2015), a made-up case was used as an example about the nature of information flow in the connectivist environment. The invented case was somehow replicated in Sabha's case.

> "consider a software company, which imposes a hierarchical personnel structure with managers on the head and closed groups of programmers on the bottom. The Chief Executive Officer (CEO) has realized, after a while, that there are leaks of the codes that were developed inside the company. He hired a security company to track the flow of information and to insure no intruder can reach those codes. The first investigation revealed no security threats and the flow of information is secured. The second investigation, however, revealed that the closed groups of developers were not closed at all. Some employees were using virtual work websites and hiring other developers to get their jobs done. Some administrators have seen this as a threat, others as an opportunity. The latter administrators have created many virtual companies, which gathered developers from all over the world. Similarly, educators may perhaps see these changes either as threats or as opportunities" (p. 11).

Other participants, namely Khaled D. and Redaa, followed a completely different path to solve Q09. They began with deep thinking and tried to solve the task by themselves. Their selection was mainly based on perception of themselves and other possible nodes. The following excerpt of Redaa clarifies her perspectives:

Redaa: I did not search the internet or asked anybody. I read the story about 5, 6, 10 times. I was trying to find the core of the story. Then I wrote some events and completed the story.
Researcher: You did not talk to anyone?
Redaa: No, I would like … [pause]. The question was designed to train my brain and to connect [between different parts of the story]. I kept the internet to the end. I preferred to depend on myself first.

Redaa succeeded to handout the answer to Q09 which closely approached to the original story depending merely on her intellectual capabilities.

Conclusion

The aim of the present research was to examine individual experiences of students at regular universities who engaged in connectivist environment. One of the most significant findings to emerge from this study is that connectivism provides a useful framework to interpret student's activities, yet it may not suit all students. The number of students who decided to give up the tasks indicated that connectivism may fit well students who have developed their self-regulation skills and who have a motivation to be persistent in the face of setbacks. In addition to the self-regulation skills and motivation, students should gain the basics of digital literacy. The

participants' behavior in different parts of the study revealed that they may lack those skills. The results of MTUAS (regarding media and technology usage) together with the qualitative study indicate that the Palestinian higher education students might have developed their own technology adoption trends which are apparently different from their counterparts in western societies. The main driver of their behavior might be the political situation and the deteriorated economic conditions in Palestine. With the aid of visual inspection of the participants' steps, it has also been shown that the performance of students in a connectivist environment depend heavily on the posed topic. Simple tasks and self-motivation tasks may fail to engage the learners in such environment. Course designers may take these conclusions into their account when preparing for connectivist courses. The findings of the study may be of interest to teachers at regular universities too. Whether teachers at regular universities like it or not, their students are most likely engaging in connectivist environment when solving their assignments. The most important limitation of this study lies in the fact that it counts on a learning experience of only nine students. More research using larger sample size is still needed. A further study could assess–more deeply–the emotional aspects of students participating in connectivist environment. Despite its limitations, this study certainly adds to our understanding of what it is like to participant in connectivist environment from the perspectives of students at higher education institutes.

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References

Aldahdouh, A. A. (2012). *A Proposed Model of using Facebook at Palestinian Universities*. Islamic University of Gaza. Retrieved from https://www.researchgate.net/publication/236619448_tswr_mqtrh_ltwzyf_alshbkt_alajtmayt_alfysbwk_fy_aljamat_alflstynyt_-_rsalt_almajstyr_A_Proposed_Model_of_using_Facebook_at_Palestinian_Universities

Aldahdouh, A. A. (2017). Does Artificial Neural Network support Connectivism's assumptions? *International Journal of Instructional Technology and Distance Learning*, *14*(3), 3–26. Retrieved from http://itdl.org/Journal/Mar_17/Mar17.pdf#page=7

Aldahdouh, A. A. (2018). Visual Inspection of Sequential Data: A Research Instrument for Qualitative Data Analysis. *The Qualitative Report*, *23*(1631–1649). Retrieved from https://nsuworks.nova.edu/tqr/vol23/iss7/10

AlDahdouh, A. A. (2018). Jumping from one resource to another: how do students navigate learning networks? *International Journal of Educational Technology in Higher Education*. https://doi.org/10.1186/s41239-018-0126-x

Aldahdouh, A. A., & Osório, A. J. (2016). Planning to Design MOOC? Think First! *The Online Journal of Distance Education and E-Learning*, *4*(2), 47–57. Retrieved from https://www.tojdel.net/journals/tojdel/articles/v04i02/v04i02-06.pdf

Aldahdouh, A. A., Osório, A. J., & Caires, S. (2015). Understanding knowledge network, learning and connectivism. *International Journal of Instructional Technology and Distance Learning*, *12*(10), 3–21. Retrieved from http://www.itdl.org/Journal/Oct_15/Oct15.pdf#page=7

Beach, P., & Willows, D. (2017). Understanding teachers' cognitive processes during online professional learning: a methodological comparison. *Online Learning*, *21*(1), 60–84. https://doi.org/10.24059/olj.v21i1.949

Bell, F. (2010). Network theories for technology-enabled learning and social change: Connectivism and actor network theory. In *7th International Conference on Networked Learning* (pp. 526–533). Retrieved from http://usir.salford.ac.uk/9270/1/Bell.pdf

Bell, F. (2011). Connectivism: Its place in theory-informed research and innovation in technology-enabled learning. *The International Review of Research in Open and Distributed Learning*, *12*(3), 98. https://doi.org/10.19173/irrodl.v12i3.902

Bozkurt, A., Akgun-Ozbek, E., Yilmazel, S., Erdogdu, E., Ucar, H., Guler, E., … Aydin, C. H. (2015). Trends in distance education research: A content analysis of journals 2009-2013. *International Review of Research in Open and Distance Learning*, *16*(1), 330–363. https://doi.org/10.19173/irrodl.v16i1.1953

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Byrd, J. C. (2016). Understanding the Online Doctoral Learning Experience: Factors that Contribute to Students' Sense of Community. *The Journal of Educators Online*, *13*(2), 102–135. Retrieved from https://www.thejeo.com/archive/archive/2016_132/byrdpdf

Clarà, M., & Barberà, E. (2013). Learning online: massive open online courses (MOOCs), connectivism, and cultural psychology. *Distance Education*, *34*(1), 129–136. https://doi.org/10.1080/01587919.2013.770428

Clarà, M., & Barberà, E. (2014). Three problems with the connectivist conception of learning. *Journal of Computer Assisted Learning*, (OCTOBER 2013). https://doi.org/10.1111/jcal.12040

Coiro, J. (2011). Predicting Reading Comprehension on the Internet: Contributions of Offline Reading Skills, Online Reading Skills, and Prior Knowledge. *Journal of Literacy Research*, *43*(4), 352–392. https://doi.org/10.1177/1086296X11421979

Coiro, J., Castek, J., & Guzniczak, L. (2011). Uncovering online reading comprehension processes: Two adolescents reading independently and collaboratively on the Internet. *60th Yearbook of the Literacy Research Association*, 354–369.

Conole, G., de Laat, M., Dillon, T., & Darby, J. (2008). "Disruptive technologies", "pedagogical innovation": What's new? Findings from an in-depth study of students' use and perception of technology. *Computers and Education*, *50*(2), 511–524. https://doi.org/10.1016/j.compedu.2007.09.009

Czerkawski, B. C. (2016). Networked learning: design considerations for online instructors. *Interactive Learning Environments*, *24*(8), 1850–1863. https://doi.org/10.1080/10494820.2015.1057744

Downes, S. (2006). Learning Networks and Connective Knowledge. In H. H. Yang & S. C.-Y. Yuen (Eds.), *Collective intelligence and elearning* (pp. 1–26). New York: Information Science Reference. Retrieved from https://philarchive.org/archive/DOWLNAv1

Downes, S. (2008a). An Introduction to Connective Knowledge. In T. Hug (Ed.), *Media, Knowledge & Education: Exploring new Spaces, Relations and Dynamics in Digital Media Ecologies* (pp. 77–102). innsbruck university press. Retrieved from http://www.oapen.org/download?type=document&docid=449459#page=84

Downes, S. (2008b). Places to Go: Connectivism & Connective Knowledge. *Innovate: Journal of Online Education*, *5*(1). Retrieved from https://nsuworks.nova.edu/innovate/vol5/iss1/6

Downes, S. (2009). New Tools for Personal Learning. Retrieved May 11, 2016, from http://www.downes.ca/presentation/234

Downes, S. (2010). What is democracy in education. Retrieved February 1, 2016, from http://halfanhour.blogspot.pt/2010/10/what-is-democracy-in-education.html

Downes, S. (2012). *Connectivism and Connective Knowledge: essays on meaning and learning networks*. *Stephen Downes Web*. Retrieved from http://www.downes.ca/files/books/Connective_Knowledge-19May2012.pdf

Downes, S. (2016). Strategies for Personal Learning. Retrieved from http://www.downes.ca/presentation/382

Dujardin, A.-F. (2009). Conversations with an e-learner. *Brookes EJournal of Learning and Teaching*, *2*(4), 1–16. Retrieved from http://bejlt.brookes.ac.uk/paper/conversations_with_an_e_learner-2/

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, *78*(3), 215–250.

Guan, Z., Lee, S., Cuddihy, E., & Ramey, J. (2006). The validity of the stimulated retrospective think-aloud method as measured by eye tracking. In *Proceedings of the SIGCHI conference on Human Factors in computing systems - CHI '06* (pp. 1253–1262). New York, USA: ACM Press. https://doi.org/10.1145/1124772.1124961

Hartman, J., Moskal, P., & Dziuban, C. (2005). Preparing the Academy of Today for the Learner of Tomorrow. In D. G. Oblinger, J. L. Oblinger, & J. K. Lippincott (Eds.), *Educating the Net Generation*.

ITU. (2016). ITU | 2016 Global ICT Development Index. Retrieved December 8, 2016, from http://www.itu.int/net4/ITU-D/idi/2016/index.html#idi2016countrycard-tab&PSE

Johansson, J., Contero, M., Company, P., & Elgh, F. (2018). Supporting connectivism in knowledge based engineering with graph theory, filtering techniques and model quality assurance. *Advanced Engineering Informatics*, *38*(June), 252–263. https://doi.org/10.1016/j.aei.2018.07.005

Kammerer, Y., Bråten, I., Gerjets, P., & Strømsø, H. I. (2012). The role of Internet-specific epistemic beliefs in laypersons' source evaluations and decisions during Web search on a medical issue. *Computers in Human Behavior*, *29*(3), 1193–1203. https://doi.org/10.1016/j.chb.2012.10.012

Kiili, C. (2012). *Online reading as an individual and social practice*. *Jyväskylä Studies in education, psychology and social research*. Retrieved from https://jyx.jyu.fi/dspace/bitstream/handle/123456789/38394/978-951-39-4795-8.pdf?sequence=1

Kop, R. (2011). The Challenges to Connectivist Learning on Open Online Networks : Learning Experiences during a Massive Open Online Course. *International Review of Research in Open and Distance Learning*, *12*(3), 19–38.

Kop, R., Fournier, H., & Mak, J. S. F. (2011). A pedagogy of abundance or a pedagogy to support human

beings? Participant support on massive open online courses. *International Review of Research in Open and Distance Learning*, *12*(7 SPECIAL ISSUE), 74–93.

Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past? *International Review of Research in Open and Distance Learning*, *9*(3), 1–8.

Kuusela, H., & Paul, P. (2000). A comparison of concurrent verbal protocol analysis retrospective. *American Journal of Psychology*, *113*(3), 387–404. https://doi.org/10.2307/1423365

Leu, D. J., Forzani, E., Burlingame, C., Kulikowich, J., Sedransk, N., Coiro, J., & Kennedy, C. (2013). The new literacies of online research and comprehension: Assessing and preparing students for the 21st century with Common Core State Standards. In *Quality reading instruction in the age of Common Core Standards* (pp. 219–236).

Leu, D. J., Kinzer, C. K., Coiro, J. L., & Cammack, D. W. (2004). Toward a Theory of New Literacies Emerging From the Internet and Other Information and Communication Technologies. *Theoretical Models and Processes of Reading*, *5*(1), 1570–1613.

Limbu, L., & Markauskaite, L. (2015). How do learners experience joint writing: University students' conceptions of online collaborative writing tasks and environments. *Computers and Education*, *82*, 393–408. https://doi.org/10.1016/j.compedu.2014.11.024

Ministry of Telecom and Information Technology. (2015). *State of Palestine*. Gaza, Palestine. Retrieved from http://www.mtit.gov.ps/index.php/c_home/Download

Nielsen, J., Clemmensen, T., & Yssing, C. (2002). Getting access to what goes on in people's heads? Reflections on the think-aloud technique. *Proceedings of the Second Nordic Conference on Human-Computer Interaction - NordiCHI '02*, 101–110. https://doi.org/10.1145/572020.572033

Oblinger, D., & Oblinger, J. (2005). Is It Age or IT: First Steps Toward Understanding the Net Generation. In D. G. Oblinger, J. L. Oblinger, & J. K. Lippincott (Eds.), *Educating the Net Generation*.

Petrie, H., & Precious, J. (2010). Measuring user experience of websites: think aloud protocols and an emotion word prompt list. In *Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems - CHI EA '10* (pp. 3673–3678). New York, New York, USA: ACM Press. https://doi.org/10.1145/1753846.1754037

Peute, L. W. P., de Keizer, N. F., & Jaspers, M. W. M. (2015). The value of Retrospective and Concurrent Think Aloud in formative usability testing of a physician data query tool. *Journal of Biomedical Informatics*, *55*, 1–10. https://doi.org/10.1016/j.jbi.2015.02.006

Rosen, L. D., Whaling, K., Carrier, L. M., Cheever, N. a., & Rokkum, J. (2013). The Media and Technology Usage and Attitudes Scale: An empirical investigation. *Computers in Human Behavior*, *29*(6), 2501–2511. https://doi.org/10.1016/j.chb.2013.06.006

Russell, S., & Norvig, P. (2010). *Artificial Intelligence: A Modern Approach* (Third Edit). New Jersey: Prentice Hall. Retrieved from http://aima.cs.berkeley.edu/

Saadatmand, M., & Kumpulainen, K. (2014). Participants' Perceptions of Learning and Networking in Connectivist MOOCs. *MERLOT Journal of Online Learning and Teaching*, *10*(1), 16–30.

Sharpe, R., & Benfield, G. (2012). Internet-based methods. In J. Arthur, M. Waring, R. Coe, & L. Hedge (Eds.), *Research Methods and Methodologies in Education* (pp. 193–201). London: SAGE Publications Ltd.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, *2*(1), 3–10. Retrieved from http://www.itdl.org/Journal/Jan_05/article01.htm

Siemens, G. (2006). *Knowing knowledge*. Lulu. com. Retrieved from http://www.elearnspace.org/KnowingKnowledge_LowRes.pdf

Siemens, G. (2010). My Personal Learning Network is the most awesomest thing ever. Retrieved from http://www.elearnspace.org/blog/2010/12/01/my-personal-learning-network-is-the-most-awesomest-thing-ever/

Siemens, G. (2018). PhD. EdTech Winter School 2018. Retrieved August 5, 2018, from https://www.youtube.com/watch?v=tEvCITc87Ek

Siemens, G., & Tittenberger, P. (2009). *Handbook of emerging technologies for learning*. Manitoba, Canada: University of Manitoba. Retrieved from http://elearnspace.org/Articles/HETL.pdf

Skrypnyk, O., Joksimovic, S., Kovanovic, V., Gaš, D., & Dawson, S. (2015). Roles of Course Facilitators, Learners, and Technology in the Flow of Information of a CMOOC. *International Review of Research in Open and Distributed Learning*, *16*(3). https://doi.org/10.19173/irrodl.v16i3.2170

Sloman, S. (2005). *Causal models: How people think about the world and its alternatives*. Oxford University Press.

Symeonides, R., & Childs, C. (2015). The personal experience of online learning: An interpretative phenomenological analysis. *Computers in Human Behavior*, *51*, 539–545. https://doi.org/10.1016/j.chb.2015.05.015

Tschofen, C., & Mackness, J. (2012). Connectivism and dimensions of individual experience. *The International*

Review of Research in Open and Distributed Learning, *13*(1), 124. https://doi.org/10.19173/irrodl.v13i1.1143

van den Haak, M., De Jong, M., & Jan Schellens, P. (2003). Retrospective vs. concurrent think-aloud protocols: Testing the usability of an online library catalogue. *Behaviour & Information Technology*, *22*(5), 339–351. https://doi.org/10.1080/0044929031000

Van Den Haak, M. J., De Jong, M. D. T., & Schellens, P. J. (2004). Employing think-aloud protocols and constructive interaction to test the usability of online library catalogues: A methodological comparison. *Interacting with Computers*, *16*(6), 1153–1170. https://doi.org/10.1016/j.intcom.2004.07.007

Verhagen, P. (2006). Connectivism : a new learning theory? *University of Twente*.

Wang, Z., Anderson, T., & Chen, L. (2018). How learners participate in connectivist learning: An analysis of the interaction traces from a cMOOC. *International Review of Research in Open and Distance Learning*, *19*(1), 44–67.

Zhang, Z., & Kenny, R. (2010). Learning in an online distance education course: Experiences of three international students. *The International Review of Research in Open and Distributed Learning*, *11*(1), 17. https://doi.org/10.19173/irrodl.v11i1.775

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