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MEASURING THE JOINT IMPACT OF IT ADOPTION AND TRAINING ON ACADEMIC WORKLOAD AND ON RESEARCH PRODUCTIVITY

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Abstract

Universities carry a prestigious history with their best academics being awarded Nobel prices for their excellent research. However, some universities suffer from high academic workload and from low and skewed research productivity despite the adoption of ICT by their academics. Having learned from existing literature how ICT adoption and ICT training has influenced productivity in domains such as manufacturing and banking, this paper aims to measure the joint impact of ICT adoption and of ICT training on academic workload and on research productivity in universities. This aim is achieved through an experiment with three IT Masters that also responded to a short questionnaire. The design of the experiment was based on an existing training needs assessment model [1], and the design of the questionnaire was based on the Technology Acceptance Model [2]. One student wrote his Masters' research proposal without the help of the EndNote software. A second student wrote his research proposal with the EndNote software but without training, and the third student worked on his research proposal with the EndNote software and with a one week's EndNote training. Results from this study confirm the joint impact of ICT adoption and of ICT training on research productivity; but such an impact was not proven on academic workload, leaving that second aspect as an area for future research. The analysis of the data collected by the questionnaire designed by this study also confirms TAM as a theory to explain how ICT training also affects ICT adoption for the improvement of academic workload and of research productivity.

Introduction

The history of universities goes back to the 13th century with the establishment of the University of Paris by the Roman Catholic Church and by the French monarch as one of the first and most significant universities [3]. Universities were initially created as a social entity able to create, store, and transmit knowledge for various professions including legal, medical and religious [4]. Since then, they have evolved to become the cornerstone of what is now called "higher education"

It is well established that higher education has four objectives: *first*, to provide formal education and training for various careers, *second*, to offer outreach services to the community at large; *third*, to engage in research and prepare scholars to extend the frontiers of knowledge; and the *fourth*, to educate the world towards an intelligent and responsible life [5].

These objectives of higher education are also well represented in the following extract from [3].

> "In the contemporary period, the teaching mission of the university is a central responsibility. The goal is to educate people to work effectively in an increasingly technological world-that is, to provide the technical skills needed for a growing number of jobs and professions that require sophisticated knowledge and an education that instills the ability to think critically. In many countries, general education is also considered a key university goal. Teaching has been the core role since the beginning. However, this function has become more complex and variegated, ranging from general education for undergraduates to advanced doctoral instruction and supervision in the most specialized fields.
>
> Research is the other core function of universities, dating back to the establishment of the University of Berlin by Wilhelm von Humboldt in the early 19th century [6]. It has come to be the central value of top-tier universities in all countries, and academic rewards and institutional prestige for individual faculty members are bestowed largely on the basis of research productivity. Research is defined in different ways by various disciplines and can take many forms. Pure research-the discovery of new knowledge-is generally considered the gold standard in terms of recognition and prestige. Nobel

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> prizes are won for pure research. Applied research increasingly emphasized as universities seek to generate income from research output-applies scientific discoveries to problems, commercial products or related practical goals".

One may argue that the above description of universities does not include community service, and one may also wonder whether the prestige historically attached to universities for their active involvement in the discovery of new knowledge, still applies nowadays.

Problem Statement

According to [7] cited in [8] who examined the "research productivity of 890 staff at 18 Australian higher education institutions over a 5-year period", the "average research output in Australian universities" is low and "heavily skewed". According to the findings of a survey conducted in 2001 in Norway by [9] cited in [8] , research productivity may seem high in Norway, but there are "inequalities in research output". Similar concerns of "consistent inequity in distribution of research output" are raised by [10] cited in [7].

One can imply from the above mentioned Australian and Norway cases by [7] cited in [8], by [9] cited in [8], by [10] cited in [7] that the research productivity of academics is low and skewed, at least in some universities; in other words, many university academics do not do as much research as required.

Concerns of "unfair and inequitable distribution of teaching workload" among universities academics are also reported by some studies from existing literature [11]. According to [11], there is a "perception of some academic staff that they [are] working much harder than others without any proper compensation". Similar concerns are revealed by a survey conducted by cited in [12] in an Australian university, that a significant number of academic staff are dissatisfied with their long working hours and with their teaching workload.

The above acknowledgement of heavy and inequitable teaching workload for universities academic staff, considered together with the low and "heavily skewed" nature of universities research productivity profiles, leads to situations of heavy research workloads for the few university academics actively involved in the production of universities research outputs. The main problem addressed by this paper evolves around the combination of these concerns of low and skewed research productivity, and of heavy and inequitable teaching workload in universities.

Aims and Objectives

It seems natural for this paper to look at the above stated problem from an ICT perspective so as to propose an ICT based solution for it. However, results from [13] indicate that ICT adoption amongst universities academics does not always lead not increased research productivity nor to fair workloads; hence the important question of how to complement ICT adoption amongst academics for it to improve research productivity and academic workload. An overview of existing literature on the impact of ICT adoption on workloads and work performance was then conducted for various domains of activities (See literature review section below), in search of an answer to the above formulated question. According to this literature review, ICT training is seen as an important factor that combines with ICT adoption to improve workloads and productivity in many various domains of activities including banking and manufacturing; but surprisingly, these domains do not include the higher education sector, hence the aim of this paper.

The aim of this research is to measure the joint effect of ICT training and of ICT adoption on research work performance and on academic workload in universities.

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Literature Review

The aim of this section is to present existing literature on the joint effect of technology adoption and of technology training on work performance and on workload for various domains including manufacturing, airport security, and banking. Unfortunately, existing literature is almost silent on the joint effect of technology adoption and of technology training on research productivity and on academic workload.

Manufacturing: According to research conducted by [14], "firms that adopt advanced technologies and at the same time provide strategic training are, on average, more productive than other technology adopters who, in turn, are more productive than those who do not use advanced technologies. Since strategic training for a technology is defined as those types of training whose provision is most influenced by the technology, the results indicate that the majority of firms providing strategic training are pursuing the right business strategies to use the adopted technologies to best effect, at least, in terms of productivity performance". They also found that "appropriate combinations of new technologies and training lead to higher productivity than adoption of new technologies alone".

Airport security: According to research conducted by [15], "Computer-based training (CBT) is a powerful tool to increase detection performance and efficiency of screeners

in x-ray image interpretation". Moreover, the results of "training could be generalized to the real life situation as shown in the increased detection performance in threat image projection (TIP) not only for trained items, but also for new (untrained) items". These results illustrate that "CBT is a very useful tool to increase airport security from a human factors perspective". Similar study was done by [16] and found that "training not only leads to an increase of detection performance but also results in faster response times when an x-ray image contains a threat object. Thus, recurrent CBT can be a powerful tool to increase efficiency in x-ray image interpretation by airport security screeners".

Banking: Training is a vital factor for technology diffusion for the following three hypotheses set by a study conducted by [17]: Training increases the rate of technology diffusion, training increases relative advantages, and training increases sales.

Research Methodology

This research is grounded within two theoretical frameworks: a training needs assessment framework and an ICT adoption model. The role of these two frameworks was respectively to guide the design of the ICT training experiment, and of the ICT adoption questionnaire run by this study as described below. Three Masters' students were selected as participants in this research because they had the same research supervisor, they were all at the early stage of their research proposal, they shared the same academic background, and Information Technology was their field of specialization. The approach adopted by this study was to measure research performance or productivity in terms of the percentage of correct citations and of correct references in a research proposal; and to measure academic workload in terms of the time taken to check citations and references in a research proposal. In other words, proposals with higher percentages of correct citations and references were deemed to belong to highly performing students, and proposals whose citations and references took little time to be checked were assumed to give a light workload to their supervisor.

Experiment: Each of the three students was requested to work on his research proposal under the guidance of the research supervisor, except for referencing for which the following three mutually exclusive options were available to them: referencing without the help of a bibliographic software, referencing with the help of the EndNote bibliographic software (Please see [18-22] for an overview of the EndNote software) but without EndNote training, referencing with the help of the EndNote bibliographic software and with EndNote training. Option choices were made on a voluntary basis but two or more students were not allowed to choose the same option. Training was therefore conducted on EndNote with one student for one week, almost daily from 2PM to 4PM; but each of the three students was required to update citations and references in their proposals for submission before the beginning of each training session. These submissions were then evaluated in terms of their percentage of correct citations and references, and of the duration of the time that it took to check them. It is worth noting that all the three students first went through a training session on manual referencing.

A brief description of the above mentioned training needs assessment framework now seems in order, anchored around its why, who, how, what, and when five questions.

The "why" question refers to the identification of the aspects in which the performance of an organization is deficient, and to the comparison of the training cost against the training remedy. In this study, the identification of the above mentioned deficiencies was conducted by analyzing the citations and referencing mistakes in the research proposals. There were no financial cost attached to the training.

The "who" question refers to the identification of the people in the organization who may benefit from the training. The training was designed for the three participants identified earlier in this section.

The "how" question refers to the identification of how the performance deficiency can be corrected through training. Students were trained on how to fix the above identified referencing and citations and mistakes using EndNote, and on the following general referencing concepts: referencing styles (Harvard, Oxford, IEEE, Vancouver, APA 6th, etc.), in text and end text referencing for different referencing styles, single author and multiple authors referencing, multiple referencing, etc.

The "when" question refers to the identification of the time scheduling of training so as to minimize disruptions in the functioning of the organization. The trained student had a two hours training sessions almost every afternoon for a week and each student was working on his own on his research proposal for the rest of the time.

In the "what" question, the best way of performing the problematic tasks is proposed. In this experiment, the use of the EndNote software was identified as the best way of dealing with citations and references in a research proposal, with

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a clear warning of the dangers of mixing it with "manual referencing".

Questionnaire: Each of the three students was given a questionnaire at the end of the experiment in order to analyze their perceived acceptance of the EndNote software training for its perceived impact on research productivity and on academic workload. The questionnaire questions were inspired by TAM, the Technology Acceptance Model that stipulates that the two main factors that affect the acceptance of a technology are its perceived ease of use and its perceived usefulness. The following questions were therefore asked to each of the participants: Before the EndNote training experiment, how useful and how easy to use did you perceive the EndNote software for the referencing of your research proposal? After the EndNote training experiment, how useful and how easy to use do you perceive the EndNote software for the referencing of your research proposal? Before the EndNote training experiment, how useful and how easy did you perceive the EndNote software training for the referencing of your research proposal? After the EndNote training experiment, how useful and how easy to use do you perceive the EndNote software training for the referencing of your research proposal? Before the EndNote training experiment, what was your perceived acceptance level of the EndNote software for the referencing of your research proposal? After the EndNote training experiment, what is your perceived acceptance level of the EndNote software for the referencing of your research proposal? Before the EndNote training experiment, what was your perceived acceptance level of the EndNote software training for the referencing of your research proposal? After the EndNote training experiment, what is your perceived acceptance level of the EndNote software training for the referencing of your research proposal?

Research Results

The data collected from the experiment conducted by this study is presented by Table 1, Table 2, and Table 3 whose graphical illustrations are respectively given by Figure 1, Figure 2, and Figure 3. However, for data analysis purposes, this data is also presented by Table 4, Table 5, Table 6, Table 7, and Table 8 whose graphical illustrations are respectively given by Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8. Abbreviations used by these tables and figures are decoded below.

T Time taken to check a proposal (in minutes)
CT Total number of citations in a proposal
CC Total number of correct citations in a proposal
CP Percentage of correct citations in a proposal
RT Total number of references in a proposal
RC Total number of correct references in proposal
RP Percentage of correct references in a proposal
$ES_{i,j}$ Evaluation of student i before training session j
FES_i Final evaluation of student number i
S1 Student who did not use a computer
S2 Student who used e-Notes without training
S3 Student who used e-Notes with training
CP_i Percentage of correct citations before training session i
CPF Percentage of correct citations at the end of the experiment
RP_i Percentage of correct references before training session i
RPF Percentage of correct references at the end of the experiment
T_i Time taken to check a proposal before training session i (in minutes)
TF Time taken to check a proposal at the end of the experiment (in minutes)
CTi Total number of citations before training session i
CTF Total number of citations at the end of the experiment
RTi Total number of references before training session i
RTF Total number of references at the end of the experiment

Table 1. Research productivity and workload data for the student who did not use EndNote

	ES1,1	ES1,2	ES1,3	ES1,4	FES1
CT	29	32	34	31	32
CC	4	3	11	9	12
RT	21	44	61	61	61
RC	3	0	3	4	2
CP	14	9	32	29	38
RP	14	0	5	7	3
T	20	15	31	21	28

Table 1 presents the results on the evaluation of research proposal of the student who worked on his research proposal without the help of the EndNote software, and Figure 1 is a graphical representation of Table 1.

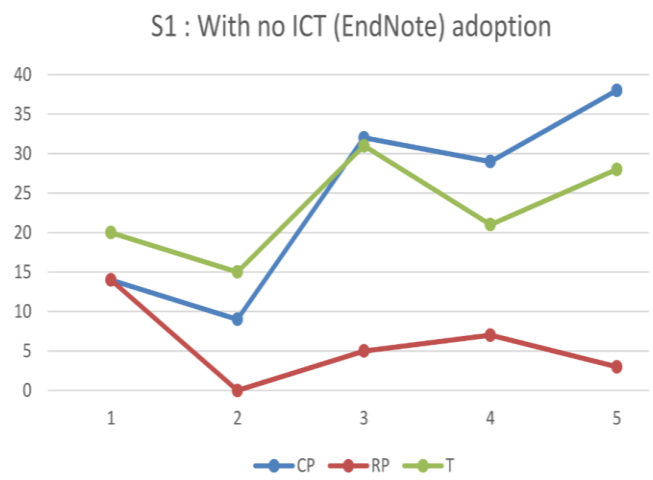

Figure 1. Graphical representation of the Research productivity and workload data for the student who did not use EndNote

Table 2 presents the results on the evaluation of research proposal of the student who worked on his research proposal with the help of the EndNote software, but without any training on the EndNote software.

Table 2. Research productivity and workload data for the student who used EndNote without training

	ES2,1	ES2,2	ES2,3	ES2,4	FES2
CT	55	66	87	92	91
CC	26	28	58	59	59
RT	25	36	50	50	52
RC	4	8	36	39	37
CP	47	42	67	64	65
RP	16	22	72	78	71
T	37	63	43	58	36

Figure 2 is a graphical representation of Table 2. As already mentioned below, figures 4 to 8 provide a better presentation of these results.

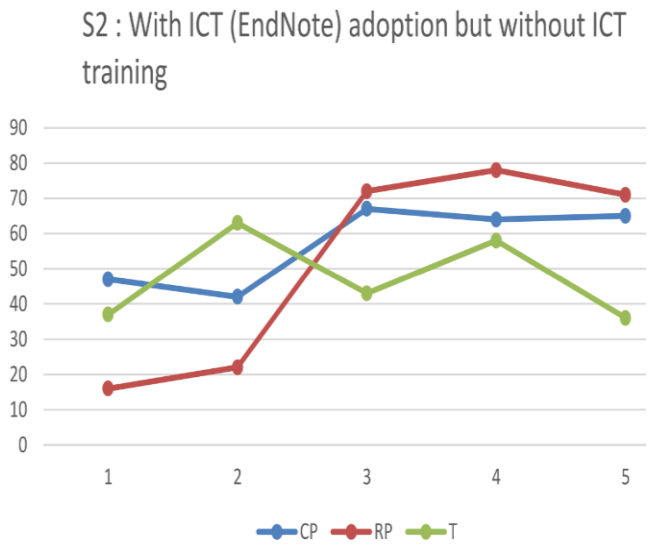

Figure 2. Graphical representation of the research productivity and workload data for the student used EndNote without training

Table 2 presents the results on the evaluation of research proposal of the student who worked on his research proposal with the help of the EndNote software, and who was also trained on the EndNote software.

Table 3. Research productivity and workload data for the student who used EndNote with training

	ES3,1	ES3,2	ES3,3	ES3,4	FES3
CT	23	25	25	33	32
CC	5	3	9	23	29
RT	26	20	16	23	27
RC	3	2	14	21	25
CP	22	12	36	70	91
RP	12	10	88	91	93
T	19	13	29	18	12

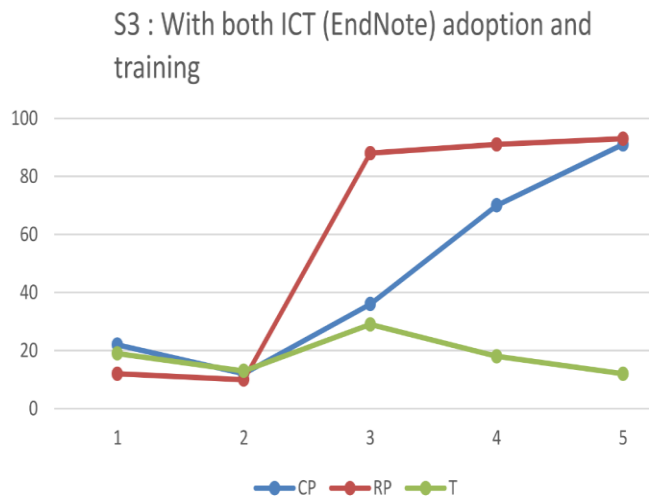

Figure 2. Graphical representation of the research productivity and workload data for the student used EndNote with training

Table 4. Comparison of students' productivity on citations

	CP1	CP2	CP3	CP4	CPF
S1	14	9	32	29	38
S2	47	42	67	64	65
S3	22	12	36	70	91

One can clearly see from Figure 4 that the citations' performance of the student S3 increases with the training compared to the other two students S1 and S2, to the point where S3 outperforms the other students once the training becomes effective, followed by S2, and S1 being in the third position.

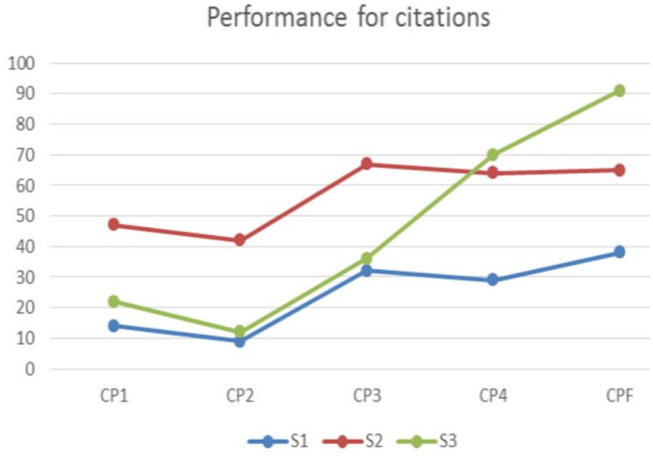

Figure 4. Graphical representation of the comparison of students' productivity on citations

Table 5. Comparison of students' productivity on references

	RP1	RP2	RP3	RP4	RPF
S1	14	0	5	7	3
S2	16	22	72	78	71
S3	12	10	88	91	93

Figure 5 shows that the references' performance of the student S3 increases with the training compared to the other two students S1 and S2, to the point where S3 outperforms the other students once the training becomes effective, followed by S2, and S1 being in the third position.

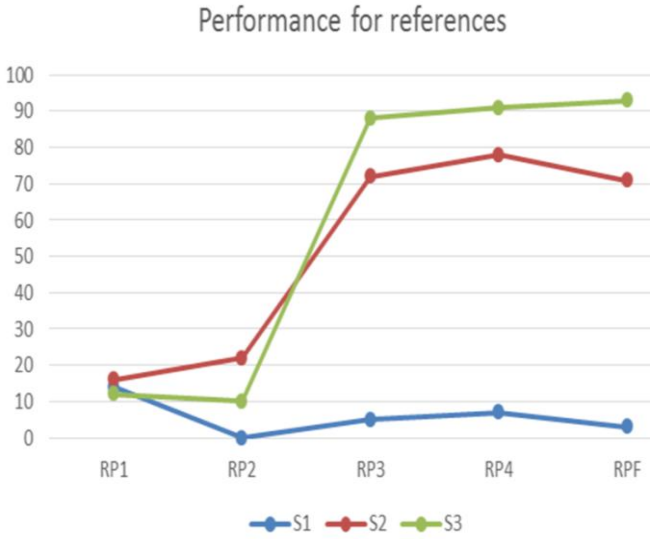

Figure 5. Graphical representation of the comparison of students' productivity on references

Figure 6 does not show a decrease in the time taken to check the research proposals of students S1 and S2, and it is only towards the end of training that it is starting to show a decrease in the time taken to check the research proposal of students S3. Moreover, it is difficult to compare the times of the three students because the three research proposals did not have the same number of citations and references, and these numbers also varied with time.

Table 6. Comparison of the durations of the checking of students' proposals evaluations

	T1	T2	T3	T4	TF
S1	20	15	31	21	28
S2	37	63	43	58	36
S3	19	13	29	18	12

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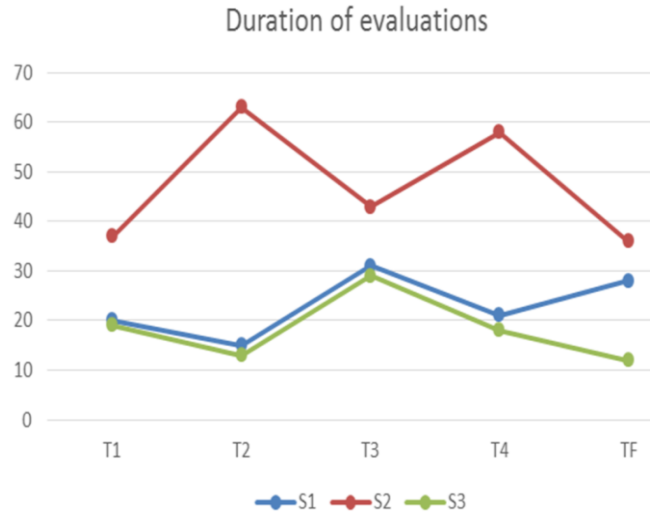

Figure 6. Comparison of the durations of the checking of students' proposals evaluations

Table 7. Comparison of students' number of citations

	CT1	CT2	CT3	CT4	CTF
S1	29	32	34	31	32
S2	55	66	87	92	91
S3	23	25	25	33	32

Figure 7 shows that student S2 has more citations than the other two students S1 and S3 who number of citations are almost similar. One will expect the same patterns to be seen on Figure 6, but this is unfortunately not the case.

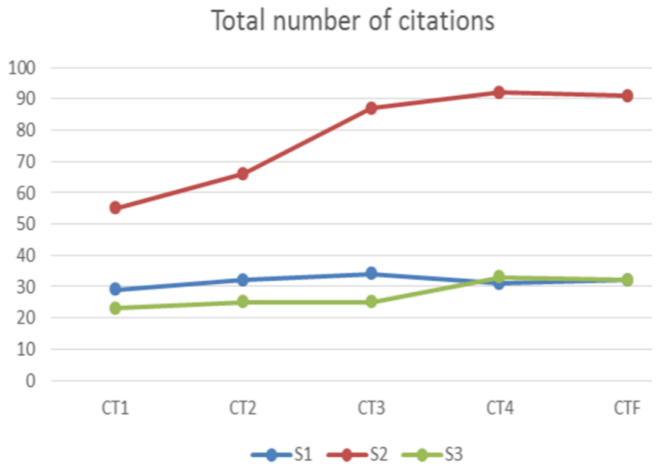

Figure 7. Graphical representation of the comparison of students' number of citations

Figure 8 shows that student S3 has less citations than the other two students S1 and S3 who number of citations are almost similar. One will expect the same patterns to be seen on Figure 6, but this is unfortunately not the case.

Table 8. Comparison of students' number of references

	RT1	RT2	RT3	RT4	RTF
S1	21	44	61	61	61
S2	25	36	50	50	52
S3	26	20	16	23	27

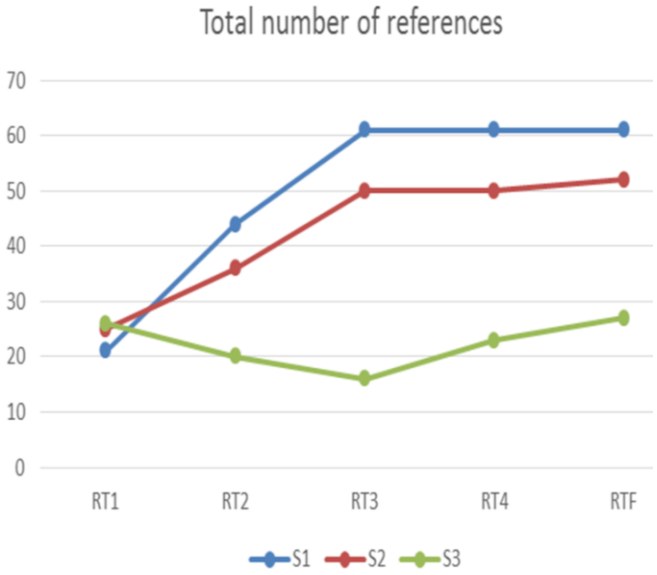

Figure 8. Graphical representation of the comparison of students' number of citations

The data gathered from the questionnaires collected by this study is presented by Table 9, Table 10, and Table 11 whose graphical illustrations are respectively given by Figure 9, Figure 10, and Figure 11. Abbreviations used by these tables and figures are decoded below.

US	Usefulness of Software
ES	Ease of Use of Software
AS	Acceptance of Software
UT	Usefulness of Training
ET	Ease of Use of Training
AT	Acceptance of Training
PSi, B	Perceptions of Student i before the EndNote training
PSi,A	Perceptions of Student i after the EndNote training

Table 9. Perceptions of student S1 before the EndNote experiment

	PS1,B	PS1,A
US	4	4
ES	5	4
AS	5	4
UT	5	4
ET	5	4
AT	5	4

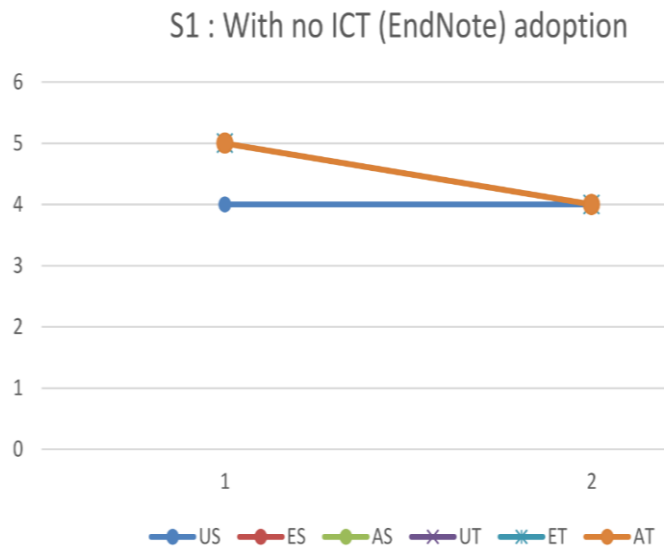

Figure 9. Graphical representation of the perceptions of student S1 before the EndNote experiment

Figure 9 shows that the training experiment did not increase the perceptions of student S1 for any of the TAM constructs. However, decreases in perceived usefulness and in perceived ease of use for S1 also translate in decreases in acceptance.

Table 10. Perceptions of student S2 before the EndNote experiment

	PS2,B	PS2,A
US	5	7
ES	4	5
AS	3	6
UT	5	7
ET	4	5
AT	3	6

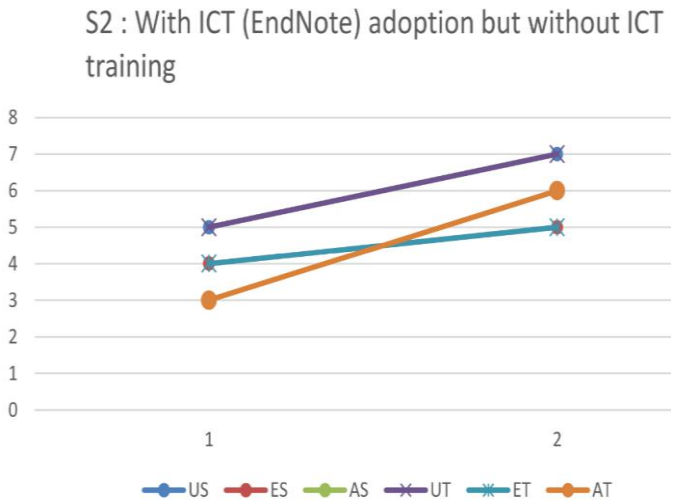

Figure 10. Graphical representation of the perceptions of student S2 before the EndNote experiment

Figure 10 shows that the training experiment did increase the perceptions of student S2 for all of the TAM constructs. It also shows that increases in perceived usefulness and in perceived ease of use for S2 also translate in increases in acceptance.

Table 11. Perceptions of student S3 before the EndNote experiment

	PS3,B	PS3,A
US	4	7
ES	4	5
AS	4	6
UT	6	7
ET	5	6
AT	5	7

Figure 10 shows that the training experiment did increase the perceptions of student S3 for all of the TAM constructs. It also shows that increases in perceived usefulness and in perceived ease of use for S3 also translate in increases in acceptance.

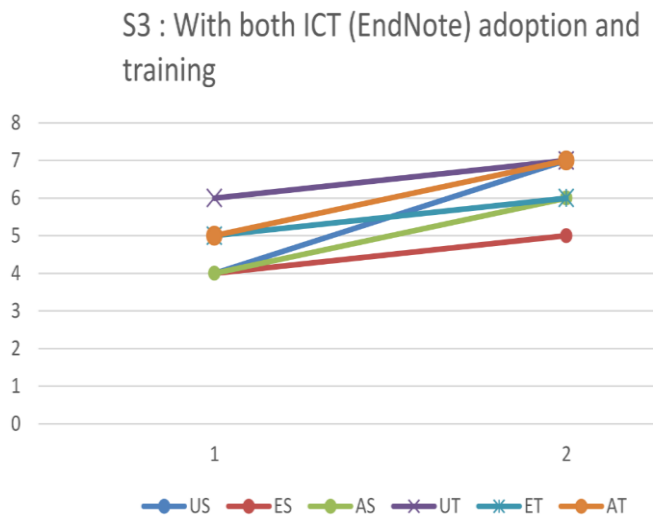

Figure 11. Graphical representation of the perceptions of student S3 before the EndNote experiment

Discussion

The originality of this paper can be attributed to the fact that it is one of the first studies dedicated to the joint effect of ICT adoption and of ICT training on research workload and productivity for universities. There are indeed several existing studies on the joint effect of ICT adoption and of ICT training on workload and productivity for various domains such as banking [17], manufacturing [14], and security [15, 16]; other existing studies [18-22] even use the e-Notes software to exhibit the impact of ICT adoption on research workload and productivity, however existing literature is almost silent on the joint effect of ICT adoption and of ICT training on research workload and productivity for universities.

The results of this study clearly confirm existing results from literature on the joint impact of ICT training and of adoption on research productivity in the sense that increased ICT training and adoption leads to increased research productivity. However, the results of this study do not show a clear pattern between increases in ICT training and reductions in research supervision time or workload, probably because of variations in the numbers of citations and of references during the experiment conducted by this study; and hence the need for further research in that direction.

Conclusion

This paper uses two different methodologies to measure the joint impact of ICT adoption and of ICT training on the improvement of research productivity for universities' academics: an experiment based on a training needs' assessment model, and the analysis of data from a questionnaire designed based on the technology acceptance model. However, the same results could not be reached on the joint impact of ICT training and of ICT adoption on academic workload, as this remains an issue for future research.

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