Effect of 'Bring Your Own Device' (BYOD) on Student Behavior, Well-Being, and Learning Economic Disciplines

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***Abstract*—Digital technologies are becoming an integral part of education. This study aims to quantify the effect of Bring Your Own Device (BYOD) on student behaviour, welfare and learning using a sample of Jordanian learners engaged in the study of economic disciplines. Data from the questionnaires were analyzed using Student's t-test. According to the results of the study, participants in the educational process generally recognize the positive effect of BYOD initiatives on learning and support their implementation. Female students reported negative effects of BYOD on their behaviour more often than male students. Combining BYOD with a traditional learning approach was more effective than implementing the BYOD mode alone. Teachers with prior BYOD experience generally rated higher on the learning scale than those using BYOD for the first time. The present findings might be helpful for university teachers and administrators who want to implement a BYOD program; the learning discipline does not matter.**

***Index Terms*—Digital economy, Bring Your Own Device (BYOD), higher education, economist education, Nearpod**

I. Introduction

The ubiquity of mobile devices and their use as a mandatory accessory in daily life led to the emergence of BYOD (Bring Your Own Device). The first companies to encourage their employees to use their mobile devices and other gadgets were those whose leaders noticed its positive effect on employee productivity. According to a market research report by MarketsandMarkets, nearly 50% of U.S. companies adopted BYOD in 2018. Meantime, Sapho workplace productivity experts report that the average worker saves 81 minutes per week in productivity by using a personal device at work [1].

Higher education institutions followed in the footsteps of business organizations and began to successfully integrate BYOD. The new strategy has its advantages. Firstly, it boosts productivity and intensifies learning. One can associate this effect with the habitual use of familiar tech that is usually better than whatever the company or university can offer. Secondly, it allows companies and universities to save on the purchase and maintenance of devices. But there are drawbacks too, mostly related to cybersecurity. Educational institutions and business entities tend to approach cybersecurity differently. For example, the largest private university in Long Island (USA) provides 16,000 students who paid for their tuition on time with an iPad to work with confidential data, such as the university's research. Such information is stored on a private cloud server that can be accessed by users on verified devices [2].

Mobile technologies play an increasingly important role in the academic life of students. Mobile devices, such as smartphones, tablets, e-readers and other gadgets, connect users to the world, providing instant access to vast amounts of information and activities. Apps running on these devices allow users to search for, digest and generate new content. The reasons why mobile technologies have become an integral part of modern higher education go beyond the universities' efforts to save financial recourses. The initial intention of introducing mobile tech was to make education more effective. The advancement of mobile technologies and BYOD adoption in higher education has opened up many opportunities for both students who need to handle a complex and rapidly changing array of information and teachers who seek to activate the learning process and increase student motivation.

Currently, many universities optimize their websites for mobile devices, complement them with stand-alone apps, and use mobile technologies to send information and educational materials to students, check assignments, monitor student progress, and provide learners with rapid feedback. The duty of a modern university is to instil general and special competencies in its graduates to make them competitive in the national and global labour market. Mobile device proficiency is one such competency. Economic specialists like financial and marketing managers may find these competencies especially relevant, for these jobs usually require the use of mobile technology in a BYOD environment.

The skills of using mobile devices for work (including remote work) became of particular relevance under the threat of the COVID-19 pandemic in 2020. Office work moved online, while personal gadgets replaced corporate equipment. Education, including higher education, faced similar transformations. A modern specialist in the field of economics is expected to manage production and communicate with partners and customers from anywhere at any time using a personal mobile device. Figuratively speaking, an office is now inside a smartphone, so that employees can work remotely using apps (e.g., Trello, Telegram, or Mopria Print Service). Hence, it is best to instil these skills in the university. BYOD, in this case, is a kind of testing ground for competence formation. Thanks to it, the social and technological substance of professional activity is consistently modelled into the learning process, resulting in the gradual transformation of academic activity into quasi-professional and later professional economic activity.

II. Literature Review

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BYOD plays an important role in the digital economy, as it contributes to a more efficient organization of labour and business management [3]. It implies radical changes to didactics, methodology, content, and education infrastructure.

The BYOD model is becoming more common at all levels of education, but its effectiveness versus traditional pedagogy remains a controversial issue. Despite many reports saying about the successful integration of BYOD strategies in higher education around the world, the extent of BYOD adoption varies widely. Siani [4] argues that the introduction of BYOD may prevent some demographic groups of students from receiving education, particularly those that cannot afford to bring their own devices or do not have the necessary skills.

BYOD integration in higher education is an urgent problem. Many researchers show interest in the potential of using mobile technologies in the university [5, 6] and seek ways to improve technology accessibility [7, 8]. Others investigate the attitude towards BYOD among participants in the teaching and learning process [4, 9], adaptation issues [10], and challenges to security [11, 12]. In the context of the present research, studies about BYOD in economist education are of particular importance [13].

According to previous research, mobile devices have several undeniable advantages. Among them, scholars highlight better communication [14, 15], active learning [16], rapid feedback [17], optimized knowledge control [18], and increased academic integrity [19]. Mobile devices also allow for creating an interactive learning environment where students can learn without time, location, and device constraints, thereby supporting student-centred learning.

Exploring mobile learning in higher education, Albastroiu and Felea [17] found that only 7.5% of students used their own mobile devices at the university. At the same time, the percentage of mobile users was 86.1%. According to those researchers, the biggest obstacles to BYOD implementation were the lack of electronic learning materials, regulatory framework, and connectivity. While 57.7% of students participating in that study described mobile learning as an alternative to traditional learning, 37.9% stated that their university was not ready to adopt the BYOD model [17].

Siani [4] analyzed the positive and negative aspects of implementing BYOD in education. Livas and Katsanakis *et al.* [20] examined university teachers' perceptions of BYOD's impact on student learning, behaviour and well-being. Both studies reported a predominance of positive over negative influences [4, 20]. Livas and Katsanakis *et al.* [20] also highlighted the role of individual characteristics, such as gender, prior knowledge of technology, and teaching experience, on the perceived impact of BYOD. With these insights at hand, it is of particular interest to compare BYOD effects from teacher and student perspectives, but there is little information on this matter in the literature so far.

Developing countries and Jordan in particular have limited possibilities of using technological innovations in the educational process, accompanied by environmental and social difficulties. On the other hand, training competent professionals can become the key to the higher well-being of the population [21]. BYOD offers significant environmental and economic benefits [4], which are relevant for countries with limited natural resources, such as Jordan. The Jordanian educational system is undergoing significant changes in terms of technology use [22], which needs to be investigated to enrich the international experience.

Today's learners are increasingly gaining access to Internet-connected mobile devices. In Jordan, for example, educational institutions can even implement a BYOD policy, for the state government supports this initiative [21]. The main research questions stated in this regard are as follows:

RQ1: How does BYOD impact economics education in Jordan?

RQ2: Is there interdependence between the effectiveness of the BYOD program in Jordan and the teacher's personal qualities?

RQ3: To what extent is BYOD complementary to traditional learning?

The study thus aims to quantify the effect of BYOD in higher economic education by analyzing its effect on the learning behaviour and well-being of Jordanian university students. The secondary objective of the study is to identify differences in respondents' perceptions and experiences with BYOD between gender and age groups.

III. Methods and Materials

The population of the study was business students (n = 188) and instructors (n = 36) from the University of Jordan, Amman. The demographic information about these study populations is presented in Table I.

TABLE I: Demographics of Study Participants

	Total	Gender		Prior experience with BYOD		Integration of BYOD and conventional learning	
		Female	Male	Yes	No	Yes	No
Instructors	36	16	20	17	19	-	-
Learners	188	86	102	98	90	94	94

A forum entitled "*Economic Transformations in the Digital Age*" was held at the University. Students were required to attend conferences (*theoretical block*, no active participation needed) and then engage in thematic round tables (*practical block*) on the following topics: Educational Policy of Jordan: The Path to the Top; Business of the New Era; Smart City: Prospects and Challenges; The Road Towards Environmental Sustainability.

In the practical block, half of the participants (n = 94) used Nearpod, a mobile learning app, and other digital tools to communicate with the lecturer and other students. Other participants (n = 94) had no such limitations and could also use conventional tools, such as lecture screens, pens, notepads, printed books and journals. All students went through a practical block after completing a theoretical one and knew the topic of the lesson and issues to be discussed in advance; thus, they all had time to prepare. The participants were randomly divided into groups of 10–12 people. Each group had two instructors assigned to it. Those were people participating in the forum (n = 18) and teachers employed in the University (n = 18).

During group discussions, open-ended and multiple-choice questions were asked. Students were also given a drawing task where they had to provide a graphic representation of a specific scheme or structure. For example, learners engaged in a discussion over the Road towards Environmental Sustainability were asked to draw a diagram depicting an increased environmental social responsibility. Graphic images were then displayed and discussed within a group.

At the end of the practical block, students and instructors completed an anonymous online survey via Google Forms. The questionnaire they received consists of two blocks, Student Behavior & Well-being and Learning, and is derived from the article by Livas and Katsanakis *et al.* [20]. The internal consistency of the questionnaire (Cronbach's α = 0.88) is good [20]. Responses were evaluated on a 5-point Likert scale (5-completely agree, 1-completely disagree). Student's t-test was used to analyze the results.

IV. Results and Discussion

Table II shows the student survey results. While the first column indicates the two domains of the BYOD effect (Behavior & Well-being and Learning), the second column highlights the potential BYOD effects, the third column provides mean (M) values, and the fourth column depicts standard deviations (SD). The fifth and sixth columns indicate the mean values of female and male students, respectively. Columns seven and eight indicate the mean values of participants with and without prior BYOD experience. Finally, columns nine and ten indicate the mean values of groups where BYOD was incorporated into conventional learning and implemented alone.

TABLE II: Student Survey Results

		M	SD	Gender		Prior experience with BYOD		Integration of BYOD and conventional learning	
				Female	Male	Yes	No	Yes	No
Aspects of behaviour	Q1 Technology overuse	2.42	350.17	2.98	1.86	2.12	2.72	2.24	2.60
	Q2 Distraction from learning activities	2.37	236.98	2.71	2.02	2.31	2.43	2.21	2.53
	Q3 Inappropriate behaviour during class	1.96	312.20	1.76	2.16	2.95	2.06	2.02	1.90
	Q4 Diminished quality of life	2.27	241.74	2.56	1.97	2.32	2.22	2.25	2.29
	Q5 Excessive dependence on digital devices	2.38	220.36	2.74	2.02	2.40	2.36	2.30	2.46
Behaviour & Well-being, mean		2.28	272.29	2.55	2.01	2.42	2.36	2.20	2.36
Independent samples T-Test				0.025*		0.360		0.105	
Aspects of learning	Q6 Active in-class participation	3.12	312.20	3.14	3.10	3.31	3.13	3.20	3.04
	Q7 Improved in-class interaction among students	3.18	356.14	3.10	3.26	3.40	3.26	3.52	2.84
	Q8 Improved in-class interaction between students and instructors	2.86	296.37	3.01	2.71	3.00	2.74	3.17	2.55
	Q9 Improved understanding of educational content	2.95	256.40	2.99	2.91	2.96	2.94	3.23	2.67
	Q10 Customized learning	2.31	220.39	2.20	2.43	2.33	2.29	2.42	2.20
Learning, mean		2.88	288.30	2.89	2.88	3.00	2.87	3.11	2.66
Independent samples T-Test				0.677		0.849		0.011*	

** Statistically significant at ($p < 0.05$)*

A. Differences between BYOD and Control Groups

There were statistically significant differences in learning effects between groups that used BYOD alone and in combination with conventional learning tools. To be more specific, those who combined these instruments rated their in-class participation, interaction with other students and instructors, and understanding of educational content higher than those who did not combine them. Regarding other aspects of learning, there were no statistically significant differences found between these two groups.

B. Differences between Male and Female Students

In terms of behaviour, female students were more likely to excessively depend on digital devices than male students, and they are more likely to get distracted from learning activities. The inappropriate behaviour during class, on the other hand, was rated slightly higher by male students. However, these differences are not significant. Therefore, they give no grounds for arguing that there are substantial correlations between female and male students.

C. No Statistically Significant Differences Were Found between Students with and without Prior BYOD Experience

Table III shows the instructor survey results. Based on the instructors' responses, BYOD had a positive effect on discipline but exacerbated dependence on digital devices. Inappropriate behaviour during class received the lowest score of 1.86, while Excessive dependence on digital devices and Technology overuse scored the highest scores of 3.20, and 2.97, respectively. Regarding the effect on learning, instructors reported improved interaction among students (3.12) and improved understanding of educational content (2.95). At the same time, they did not notice any significant improvement in the interaction with students (2.09).

TABLE III: Instructor Survey Results

		M	SD	Gender		Prior experience with BYOD	
				Female	Male	Yes	No
Aspects of behaviour	Q1 Technology overuse	2.97	334.12	2.89	3.05	2.95	2.99
	Q2 Distraction from learning activities	2.41	280.06	2.44	2.38	2.52	2.30
	Q3 Inappropriate behaviour during class	1.86	245.63	1.90	1.82	1.76	1.96
	Q4 Diminished quality of life	1.98	296.30	2.04	1.92	2.13	1.83
	Q5 Excessive dependence on digital devices	3.20	385.61	3.31	3.09	3.62	2.78
Behaviour & Well-being, mean		2.48	308.34	2.52	2.45	2.60	2.37
Dependent samples T-Test				0.863		0.032*	
Aspects of learning	Q6 Active in-class participation	2.61	264.17	2.49	2.83	2.66	2.56
	Q7 Improved in-class interaction among students	3.12	296.27	3.15	3.09	3.14	3.10
	Q8 Improved in-class interaction between students and instructors	2.09	415.89	2.31	1.87	2.85	1.33
	Q9 Improved understanding of educational content	2.95	263.25	2.88	3.02	2.70	3.20
	Q10 Customized learning	2.78	219.20	2.54	3.02	2.88	2.68
Learning, mean		2.71	291.76	2.67	2.77	2.85	2.57
Dependent samples T-Test				0.644		0.001*	

** Statistically significant at ($p < 0.05$)*

The Student's t-test failed to show any statistically significant differences between male and female instructors on both the Behavior & Well-being and the Learning scales ($p<0.05$), but there were statistically significant differences present between instructors with and without prior BYOD experience. Table IV shows the results of the Student's t-test between students (column 4) and instructors (column 5).

TABLE IV: RESULTS OF THE STUDENT'S T-TEST BETWEEN STUDENTS AND INSTRUCTORS, MEAN VALUES

			Students	Instructors	Independent samples T-Test
Behavior & Well-being	Q1	Technology overuse	2.42	2.97	0.612
	Q2	Distraction from learning activities	2.37	2.41	0.541
	Q3	Inappropriate behaviour during class	1.96	1.96	0.892
	Q4	Diminished quality of life	2.27	1.86	0.34
	Q5	Excessive dependence on digital devices	2.38	3.20	0.010*
Learning	Q6	Active in-class participation	3.12	2.61	0.035*
	Q7	Improved in-class interaction among students	3.18	3.12	0.697
	Q8	Improved in-class interaction between students and instructors	2.86	2.49	0.416
	Q9	Improved understanding of educational content	2.95	2.95	0.926
	Q10	Customized learning	2.31	2.78	0.047*

** Statistically significant at ($p < 0.05$)*

There are significant differences in scores for Q5, Q6, and Q10. Overall, students tend to underestimate their level of dependence on digital devices, overestimate in-class participation, and are less convinced that BYOD enables customized learning compared to instructors.

Empirical data show that Jordanian students have a positive attitude towards mobile learning. Many studies on this matter, especially empirical studies on perception and experience with mobile learning, report a positive attitude towards and readiness for integrating mobile learning in the classroom among students, teachers, university leaders and potential employers [4, 20]. At present, most higher education institutions in Jordan have successfully overcome the main obstacles to digitally-enhanced education, namely poor organization, unreliable network connections, and psychological unpreparedness.

Onyema and Anthonia *et al.* [23] reported a linkage between high academic performance and the use of mobile devices. The researchers believe that mobile apps show good prospects for enhancing the teaching and learning process, including expanding the boundaries of self-directed learning, supporting personalized learning, modernizing the evaluation toolkit, and differentiating the forms and methods of teaching. Hashim [24], on the other hand, highlighted the possible risks for educators and learners that may come with digitalization. Among them are being excluded from the education industry on account of not having a digital competence, information overload; more distractions during learning, lower efficiency in fostering interpersonal communication skills, a deepening digital divide, formalization and dehumanization of education.

The literature reports a positive impact of BYOD on social interaction [20], engagement [25], and knowledge assimilation [26]. These findings are consistent with the present study. According to Livas and Shawabkeh *et al.* [20], educators with prior knowledge of BYOD rate its impact on student learning and behaviour more positively. Similarly in this study instructors with prior BYOD experience rated its impact on student behaviour higher than those without prior experience with BYOD, but the difference was statistically insignificant.

Siani [4] reported a higher preference for BYOD over traditional methods among participants in the learning process. This study did not consider the conventional format; instead, the focus was on BYOD and the combination of BYOD and traditional learning. The results suggest that it is better to combine these two approaches rather than utilize BYOD separately. So far, a complete transition to digital learning does not seem to be possible. Among the shortcomings of BYOD, Siani [4] mentions difficulties in communication between students and teachers. The student perceptions described in this paper suggest an improvement here, but the present study sought to evaluate progress, not the remaining challenges.

Barlette and Lokker *et al.* [27] note that it can be challenging to deliver effective learning under a BYOD program to individuals with limited access to technology and the Internet. Therefore, the BYOD approach seems to be effective only if applied to a small group of learners with similar characteristics (age, accessible network, social status). Demanuele and Jaouen *et al.* [28] also highlighted the ambiguous effectiveness of BYOD, especially in medical and healthcare education.

D. Significance of Using BYOD in Teaching Economic Disciplines

Today, individuals engaged in professional economic activity are expected to possess mobile technology competencies [29], such as social networking, proficiency in special apps, platforms, and databases, and communication via instant messengers. Mobile learning can help develop these competencies in future economists, for it allows learners to master the necessary skills and use modern tech to solve communication-related, analytical and research problems.

BYOD reshapes the very essence of mobile learning, which, unlike distance learning, can be regarded as a separate model of delivery, for it has changed the role of a student in the educational process from passive to active. Mobile learners have the opportunity to publish their own materials via a personal gadget, keep economic blogs, etc., thereby helping other students engaged in economic disciplines.

Because BYOD is an independent form of learning that makes earners active, it is necessary to establish administrative and legal regulations that would govern BYOD policies in higher educational institutions. It should regulate the use of personal mobile devices by students (e.g., access to Wi-Fi, software and university materials). With these regulations in place, future economists will develop a culture of personal gadget usage and the skills necessary to handle confidential information. At the same time, it is crucial to make sure that the university staff responsible for IT security will not withhold the benefits of BYOD.

Mobile devices became an integral part of personal and professional life, and education is no exception. Therefore, any strategy for BYOD integration should take into account the interests of all participants in the educational process [30, 31].

Considering how fast mobile technologies are spreading these days, one can expect that every employee will carry their own devices to work soon, especially in the business sphere [3]. Due to its cost-effectiveness and productivity (something that employers would enjoy), this form of labour organization is likely to dominate other organizational approaches, replacing traditional formats and work functions. At the same time, the corporate goals of BYOD — to make work schedules flexible and convenient, to enhance productivity, and to boost employee morale — are in line with the interests of the staff.

Researchers drew attention to some new security and intellectual property issues that come with BYOD due to differences in national legislation [6]. It appears that higher education institutions that are actively integrating mobile technologies into their educational process should first create an appropriate regulatory framework to establish the rules, rights and obligations of the parties engaged in BYOD implementation.

Scholars advise focusing on the following key points when integrating BYOD: Strategy and management, network readiness and security [4]. A well-thought-out strategy of BYOD implementation implies that there are technical resources and effective means to protect information. Note that this approach is not limited to BYOD and can be expanded to ICT. Security, efficiency and business productivity are reported to be the most important organizational issues in the Jordanian IT industry, while networks and communications and management systems are listed among the top technology issues [32]. The introduction of BYOD can thus be seen as a logical step to ensure that economics education is effective.

V. Conclusions

The present study suggests that mobile learning technologies, in particular BYOD, are an important pedagogical innovation adopted in higher education in Jordan. These technologies are of particular relevance in economic education, due to the recent trend among businesses to enhance productivity via BYOD adoption.

In economics education, the use of mobile technologies significantly intensifies profession-oriented learning. Because mobile devices serve as both a teaching tool and a learning subject, the integration of BYOD encourages educators to optimize the course content. In a digital economy, mobile device proficiency is a must-have competence for any economist. An economist is expected to quickly adapt to digital challenges, organize a virtual office from a smartphone, be able to work with various apps and platforms and work remotely. New features, goals and objectives of economic education determine the innovative component of teaching in higher educational institutions.

According to the results of the present study, teachers and students in Jordan believe BYOD to be effective (RQ1). Male and female students evaluate the behavioural and well-being effects of BYOD differently. There are differences in the strength of BYOD effects between scenarios where BYOD is implemented alone and in combination with conventional learning tools. Teachers tend to estimate BYOD effects differently depending on their experience in BYOD — more experienced teachers found these effects to be more prominent (RQ2). It seems that BYOD cannot replace the traditional format completely because students who used their own mobile devices along with traditional tools reported a higher level of in-class participation than those who used mobile devices alone (RQ3).

Future research will focus on evaluating and adjusting the regulatory framework for BYOD adoption. It is necessary to further improve the BYOD program for economics education by adjusting it to the relevant economic changes within society, integrating the latest mobile learning technologies, and modernizing the training process to meet the current market requirements.

Conflict of Interest

The author declares no conflict of interest.

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