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IT education: impact assessment of a multi-fold approach

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ABSTRACT

This study addresses the benefits and challenges of implementing a multi-faceted hybrid approach to delivering an introductory information technology (IT) course at Jordan University of Science and Technology, Jordan. We conducted a questionnaire survey with 251 participants, utilizing Google Forms for data collection and Microsoft Excel 2016 for coding. Data analysis was performed using SPSS statistics 17.0. Most participants were male students aged 21-23, pursuing bachelor's degrees across various departments, with network engineering and security (NES) being the most represented. The survey items exhibited good internal consistency (Cronbach's alpha=0.778), and significant associations were found among variables (p-value<0.05). Strengths of the hybrid approach include flexibility, instructor responsiveness, and engaging online resources. However, areas for improvement were identified in online discussion forums, such as technology tool usability, workload management, communication clarity, and assessment transparency. Despite challenges, the study underscores the successful implementation of the hybrid approach in IT course delivery, supported by positive student perceptions and recommendations for future adoption.

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1. INTRODUCTION

The rapid progress of technology and its impact on society's everyday routines have generated an urgent requirement to modernize education in line with the demands of the 21st century [1]. Countries have recognized the importance of enhancing their educational systems to keep pace with the evolving world. Evaluating the schools and teaching methods is crucial to ensure their alignment with the modern era. Despite significant technological progress, the traditional classroom model has predominantly remained unchanged. Students still find themselves seated in rows, armed with pens and paper, attempting to absorb information from lectures and notes before exams. To create an engaging learning environment, however, educators must actively embrace technology and integrate it into their teaching techniques [2]. Administrators, teachers, and students were significantly impacted in different ways by the coronavirus pandemic in 2019. Some of the challenges teachers reported were fear of technology, inexperience with software, poor time management, and a general sense of isolation. The aftermath of the pandemic on the economy resulted in lower enrollment and more constrained finances, which exacerbated the challenges faced by faculty members [3]. In light of these circumstances, researching and implementing state-of-the-art

technology-driven course delivery solutions must come first. This focus aims to help faculty and students overcome similar challenges in the future.

The field of education is constantly developing and evolving. With institutions in developed countries using technology-based education, this change has been particularly expedited by the development of technology. The idea of "smart schools" and virtual and online learning options are the products of a dramatic change in how education is approached in the twenty-first century [2], [4]. A course on discrimination and diversity in society that employs various instructional techniques to convey the material and actively involve students in interactive learning illustrates this trend [5]. Tseng and Walsh [6] examined students' perceptions and experiences of regular English literacy classes in a mixed environment. Participants in the combined course reported increased motivation to study and a desire for further blended learning. However, the two versions had no significant differences in learning outcomes or final grades [6].

Hybrid learning, a pedagogical technique integrating in-person instruction with online learning, has favored modern education [5], [7]. This architecture, the synchronous hybrid or the blended learning environments, allows on-site and remote students to partake in instructional actions simultaneously [8], [9]. According to Graham [10], blended learning combines traditional in-person instruction with online learning. This instructional technique blends in-person interactions between students in the same course and teachers with synchronous and asynchronous online components [10], [11]. With hybrid learning, educators and administrators have a flexible approach to providing learning materials outside traditional classroom environments. The technique fosters active participation, cooperation, and student discussion by mixing in-person and online elements. This results in a more engaging and enhanced learning experience with the course content [3].

In October 2022 (first semester of 2022-23), an introductory course on information technology (IT) designed along with the course learning outcomes (CLOs) was delivered to students enrolled in several undergraduate IT programs at Jordan University of Science and Technology (JUST) using a multi-faceted hybrid approach [12]. These undergraduate IT programs include software engineering (SE), computer engineering (CE), network engineering and security (NES), computer science (CS), computer information systems (CIS), data sciences (DS), cybersecurity (CyS), and artificial intelligence (AI). Eight courses covering a wide range of subjects, including AI and its impact on IT, computer organization and architecture, numbering systems, data storage, C programming, software engineering, networking, and security, made up the course-several instructional components were included in the course delivery technique, which was complex. Synchronous in-class lectures were required of the students to promote learning and real-time interaction. They also had to do mandatory asynchronous self-reading assignments outside of class, encouraging individual study and understanding of the course topics. The assessment structure required synchronous or asynchronous online and offline tests and quizzes to evaluate students' understanding comprehensively. To further enhance their learning experience, students could participate in optional, asynchronous, off-class self-watching activities. This allowed them to engage with the course material more flexibly. They could participate in synchronous online discussion sessions, which gave them a forum for group discussions and in-depth research on certain topics [12]–[14].

The introductory course on IT was the first course at JUST to be delivered using a multi-faceted hybrid approach that incorporates synchronous in-class lectures to promote learning and real-time interaction with the students; mandatory asynchronous self-reading assignments, activities, and individual studies to expand their knowledge and understanding of the various IT topics; synchronous and asynchronous online and offline tests and quizzes to assess their understanding comprehensively; and optional, asynchronous, and off-class self-watching activities to enhance their learning experience. Thus, it became essential that we evaluate the advantages and challenges of implementing such a multi-faceted hybrid approach in delivering courses at JUST, focusing on students' perceptions and overall satisfaction with the course delivery method.

As explained, we focused on 880 students registered in the above-referenced introductory course on IT. We approached them to complete a questionnaire designed specifically for this study. The questionnaire sections focused on students' demographic information, views, satisfaction, agreement, and rating of the multi-faceted hybrid learning, and recommendations. Then, the 251 received responses were analyzed, discussed, and concluded. We utilized Google Forms for data collection and Microsoft Excel 2016 for coding and performed data analysis using SPSS statistics 17.0.

This paper explains our analysis of the 251 received responses. This comes from different perspectives, including their descriptive analysis; their reliability statistics; their factor analysis; their inferential statistics of the association among the questionnaire variables that were responded to by students; and the challenges faced by students. Furthermore, we highlight the strengths and weaknesses of the multi-faceted approach used to deliver the above-referenced introductory course on IT. Overall, the results were reasonable and can help the JUST mission enrich its portfolio of course delivery approaches.

2. METHOD

2.1. Participants

The current study focused on a group of 880 students who were enrolled in the IT course at Jordan University of Science and Technology. This course adopted a multimodal hybrid structure in the first semester of the 2022–2023 academic year. A survey using Google Forms was used to gather important information on the benefits and drawbacks of this innovative course delivery method from the student's perspective. Enrolled individuals were asked to share their opinions using a Likert scale-based questionnaire with various possible answers. A computerized survey containing 251 replies was made available to the students [15], [16]. The questionnaire design was influenced by prior research on students' perspectives on blended learning. All along the way, participants were reassured that their data would be treated with the utmost confidentiality and utilized exclusively for research.

2.2. Questionnaire sections

The questionnaire was composed of nine sections. The demographic information section included five questions to gather basic participant data including department, year of study, age, gender, and level of education. The student methodology (StApp) section included four well-thought-out questions to gauge participants' thoughts on the multi-faceted hybrid approach to IT education. Respondents endorsed replacements such as Yes/No, using a simplistic approach to convey their views. The student satisfaction (StSat) section included four questions to determine participants' satisfaction with the complex hybrid method. Participants were requested to grade their satisfaction on a five-point Likert scale, ranging from "Very dissatisfied" to "Very satisfied". The student's agreement (StAgr) section involved four questions to evaluate how well the students agreed with certain claims considering the multi-faceted hybrid approach. Participants were requested to grade their agreement on a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree". The student's rating (StRt) section involved four questions to assess different aspects of the multi-faceted hybrid method. Participants assessed each other using a five-point Likert scale ranging from "Very poor" to "Very good". The students' challenges section involved four questions to determine students' obstacles when utilizing the multi-faceted hybrid system. Respondents were given a similar scale with alternatives such as Yes/No to share their observations. The course flaws section permitted respondents to select two course flaws from a list of choices during the weaknesses portion. The course strengths section allowed participants to select two questions in the strengths section using a given list of alternatives to determine the course's strengths. The student's recommendation (StRcmn) section was the students' recommendation section that included two questions to gather participants' recommendations regarding the multi-faceted hybrid approach.

2.3. Statistical analysis

Microsoft Excel 2016 was used for data coding, and statistical package for the social sciences (SPSS statistics 17.0) was used for analysis. To assess the presence of collinearity and correlations between questions (variables), the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were employed on the complete dataset. The internal consistency and reliability of the data were examined using Cronbach's alpha. The Chi-square test was applied in this study to examine whether any significant associations exist between the variables.

3. RESULTS AND DISCUSSION

3.1. Descriptive analysis

The study sample consisted of 251 participants who completed the questionnaire. All the participants were affiliated with JUST. The sample encompassed a diverse mix of male and female students, with male students (65.7%) outnumbering females (34.3%). Regarding age, most participants (55%) fell within the 21-23 age range, followed by (40.6%) students who fell within the 18-20 age range, indicating a predominant presence of the typical undergraduate age group. When analyzing the study year distribution, it was observed that the highest representation was from the third year (44.6%), followed by the fourth year (26.7%), indicating that these two study years had the largest number of respondents. First-year students constituted 21.9%, while the lowest representation came from second-year students (6.8%).

Regarding academic pursuits, around 94% of respondents were pursuing a bachelor's degree. The study encompassed a diverse range of departments, including CE, NES, SE, CS, CIS, DS, CyS, and AI. Among these departments, the highest representation was from NES (31.1%), followed by CE (27.5%) and SE (22.3%). Furthermore, a 5.2%, 5.2%, 4%, 3.2%, and 1.6% distribution was observed for CyS, CIS, AI, CS, and DS, respectively. Table 1 summarizes the study sample's demographic characteristics, including age, gender, educational level, study year, and department.

3.2. Reliability statistics

In this study, Cronbach's alpha coefficient is 0.778, which rounds off to 0.8, suggesting good internal consistency among the questions with several items or questions included in the analysis 37. The KMO measure in this study was 0.772, which suggested that the data is adequate for factor analysis. Generally, a value above 0.6 is considered acceptable. Bartlett's sphericity was significant, with a significance level (Sig.) of 0.000, suggesting significant correlations among the variables. This supported the use of factor analysis. Table 2 represents the KMO and Bartlett's test results.

3.3. Factor analysis

Table 3 displays the commonalities of the variables used in the study and their extraction values. The extraction values ranged from 0.47 to 0.94, signifying the extent to which the identified factors explain the variables' variance. Notably, the range of extracted values suggests the significance of all factors, and none of the variables exhibited a communication value below 0.5, reaffirming the decision not to exclude any variables.

3.4. Association among variables

Inferential statistics provided valuable insights into the relationships among the questionnaire variables that students responded to, encompassing students' approach, satisfaction, agreement, rating, challenges they faced, and recommendations of the multi-faceted hybrid approach to IT education as shown in Table 4. MeanStApp * MeanStSat" referred to the association between the mean scores of the student approach and student satisfaction of the multi-faceted hybrid approach with a p-value of 0.028. Similar significant results were seen between all the variables except for "MeanStApp * MeanChallenges," "MeanStAgr * MeanChallenges," "MeanStRt * MeanChallenges," and "MeanChallenges * MeanStRcmn" with p-values of 0.534, 0.057, 0.098, and 0.198 respectively. The insignificant results indicated a weaker relationship between these variables.

Table 1. Demographic data of the study participants

Variables	Findings	Frequency (N)	Percentage (%)	Variables	Findings	Frequency (N)	Percentage (%)
Age	18-20	102	40.6	Study year	1st year	55	21.9
	21-23	138	55.0		2nd year	17	6.8
	24-26	8	3.2		3rd year	112	44.6
	>27	3	1.2		4th year	67	26.7
Gender	Male	165	65.7	Department	CE	69	27.5
	Female	86	34.3		NEWS	78	31.1
Educational level	Bachelor's	236	94.0		SE	56	22.3
	Diploma	5	2.0		CS	8	3.2
	Other	10	4.0		CIS	13	5.2
					DS	4	1.6
					CyS	13	5.2
					AI	10	4.0

Table 2. KMO and Bartlett's test results

KMO measure of sampling adequacy		0.772
Bartlett's test of sphericity	Approx. Chi-square	5128.045
	df	666
	Sig.	0.000

Table 3. Communalities for variables in the study (extraction method: principal component analysis)

S.No	Variables	Extraction	S.No	Variables	Extraction
1	StApp1	0.47	17	StRt2	0.64
2	StApp2	0.56	18	StRt3	0.63
3	StApp3	0.61	19	StRt4	0.52
4	StApp4	0.70	20	MeanStRt	0.87
5	MeanStApp	0.85	21	Challenge1	0.61
6	StSat1	0.67	22	Challenge2	0.53
7	StSat2	0.49	23	Challenge3	0.58
8	StSat3	0.62	24	Challenge4	0.59
9	StSat4	0.66	25	MeanChallenges	0.85
10	MeanStSat	0.93	26	Weakness1	0.56
11	StAgr1	0.57	27	Weakness2	0.67
12	StAgr2	0.58	28	Strength1	0.66
13	StAgr3	0.62	29	Strength1	0.68
14	StAgr4	0.60	30	StRcmn1	0.78
15	MeanStAgr	0.88	31	StRcmn2	0.81
16	StRt1	0.65	32	MeanStRcmn	0.94

Table 4. Association analysis among the mean of variables (*Significant association)

Variables	Tests	p-value	Variables	Tests	p-value
MeanStApp * MeanStSat	Chi-square	0.028*	MeanStSat * MeanStRcmn	Chi-square	0.000*
MeanStApp * MeanStAgr		0.001*	MeanStAgr * MeanStRt		0.000*
MeanStApp * MeanStRt		0.000*	MeanStAgr * MeanChallenges		0.057
MeanStApp * MeanChallenges		0.534	MeanStAgr * MeanStRcmn		0.000*
MeanStApp * MeanStRcmn		0.008*	MeanStRt * MeanChallenges		0.098
MeanStSat * MeanStAgr		0.000*	MeanStRt * MeanStRcmn		0.000*
MeanStSat * MeanStRt		0.000*	MeanChallenges * MeanStRcmn		0.198
MeanStSat * MeanChallenges		0.009*			

3.5. Challenges faced by students

Table 5 presents the percentages of students who experienced various challenges in hybrid learning. The data reflects the responses of students to questionnaire items regarding these challenges. The challenges included technical difficulties with online platforms or tools, difficulty staying focused during online lectures or discussions, difficulty in online communication or collaboration, and difficulty understanding course material due to the lack of in-person interaction. The 57% of students reported experiencing technical difficulties with online platforms or tools during the course, while the other 43% did not experience this challenge. Moreover, 64.1% expressed difficulties maintaining focus during online lectures or discussions, while 35.9% did not consider this a challenge. About 52.6% of the respondents reported difficulties effectively interacting with peers and instructors online, unlike 47.4% who did not experience such challenges. 48.6% of the students acknowledged experiencing difficulties comprehending the course material due to the absence of in-person interaction, whereas the other 51.4% did not experience such difficulty.

Table 5. Challenges faced by students during hybrid course delivery

Challenges	Yes (%)	No (%)
Have you experienced technical difficulties with online platforms or tools during the course?	57	43
Have you needed help staying focused during online lectures or discussions?	64.1	35.9
Have you experienced difficulty communicating or collaborating with peers or instructors online?	52.6	47.4
Have you experienced difficulty understanding the course material due to a lack of in-person interaction?	48.6	51.4

3.6. Strengths and weaknesses of the multi-faceted hybrid approach

Students were surveyed regarding the course assessments and activities they found particularly helpful or challenging. These activities included lectures, quizzes, self-reading/watching, group projects, discussions, and exams. The outcomes of the student responses are detailed in Table 6. Lectures were identified as particularly helpful by 28.7% of students. However, a small % of students (9.6%) found lectures challenging. Quizzes, as a form of assessment and formative learning, were seen as helpful by 27.9% of students. Nonetheless, a sizable portion (33.9%) thought that quizzes were difficult. 17.9% of students thought self-directed learning activities like watching and reading were beneficial.

Nonetheless, a marginally greater proportion (19.1%) perceived these tasks as difficult. This shows that while some students value the independence of these activities, others may require assistance in efficiently managing their self-paced learning. To develop collaborative skills, 14.3% of students found group projects useful. Nevertheless, a small portion (1.9%) thought they were difficult. This suggests that group projects might be well welcomed overall, with very few people having trouble with them. The 68% of students said discussions were beneficial because they encourage active participation and peer interaction. The small proportion of participants (3.2%) who felt that conversations were difficult suggests that this activity may be somewhat doable. Exams were perceived as difficult by 9.6% of students, while 4.4% thought they were helpful.

Table 6. Students' perceptions of helpful and challenging course activities

Activities	Helpful (%)	Challenging (%)
Lectures	28.7	9.6
Quizzes	27.9	33.9
Self-reading/watching activities	17.9	19.1
Group projects	14.3	19.9
Discussions	6.8	3.2
Exams	4.4	9.6
Total	100	100

Table 7 provides insights into students' perceptions regarding the strengths of the multi-faceted, hybrid course delivery approach to IT education. Most students (27.5%) identified the flexibility offered by the course design as a strength of the course delivery approach. Additionally, 26.3% of the students appreciated the instructor's responsiveness in addressing their questions, and 25.1% found the course content easy to follow. The 12.7% of students recognized the effectiveness of online resources like lecture videos and interactive modules, whereas only 8.4% found the combination of in-person and online instruction engaging.

Table 8 highlights several weaknesses acknowledged by the students. The most prominent concern was related to the online discussion forums, with 31.9% of students indicating that they could be more active and engaging. The 21.9% of students found certain technology tools used in the course challenging to navigate and understand. Furthermore, 21.5% of students expressed that the workload could sometimes become overwhelming. The 13.9% of students believed that the grading rubrics and assessment criteria could be clearer and more transparent, and only 10.8% of students highlighted the need for improved communication regarding expectations and deadlines, reflecting a relatively limited concern in this aspect.

Table 7. Strengths of the hybrid course delivery approach

Items (strengths)	Number of respondents (N)	Percentage (%)
The course design allows for much flexibility, which has helped me manage my other commitments	69	27.5
The course content is easy to follow	63	25.1
The instructor is very responsive in answering questions	66	26.3
The hybrid delivery format allows for a combination of in-person and online instruction, which helps keep things interesting	21	8.4
The online resources, such as lecture videos and interactive modules, are engaging and effective	32	12.7

Table 8. Weaknesses of the hybrid course delivery approach

Items	Number of respondents (N)	Percentage (%)
The online discussion forums could be more active and engaging	80	31.9
Some of the technology tools used in the course can be difficult to navigate and understand	55	21.9
The workload can be overwhelming at times, particularly with other commitments.	54	21.5
The grading rubrics and assessment criteria could be more transparent and consistent	35	13.9
The course could benefit from clearer communication regarding expectations and deadlines	27	10.8

3.7. Discussion

A multi-faceted hybrid approach was introduced to deliver an introduction to IT course at JUST. The authors collected input from enrolled students through a survey, with 251 responses received. The survey covered demographics like age, gender, education level, study year, and department. Most participants were aged 21-23, with more male than female students. The majority pursued a bachelor's degree, with the highest representation in the third year. The factors in this study were labeled as mean students' methodology (approach), satisfaction, agreement, rating, challenges, weaknesses, strengths, and recommendations regarding the multi-faceted hybrid approach. The results indicated that these factors explain a significant portion of the variation within each aspect we studied. This finding is consistent with previous study by Tahar *et al.* [17]. Similarly, Bouilheres *et al.* [18] studied the benefits of blended learning on an offshore campus of an Australian university in Vietnam.

The study showed a significant relationship (p-values<0.05) between the hybrid approach's recommendation, overall rating, satisfaction, and student approach. This shows that students who adopted the hybrid approach were satisfied and found it more advantageous. In line with this conclusion, Bendania [19] discovered that Saudi students had a very good attitude regarding e-learning. A strong relationship exists between students' satisfaction and degree of agreement, overall rating, and course delivery technique recommendation. This implies that if students felt the hybrid approach worked well, they were likelier to be happy with how the course was taught. These findings support past research emphasizing the importance of students' satisfaction with hybrid learning environments and their adoption of hybrid e-learning [20], [21].

This study was focused on students who were given an IT course designed as a multi-faceted hybrid course with required lectures, online and offline quizzes, and assignments that required them to study and view material outside of class, online discussion forums, and assessments. When questioned about the most helpful activities, most students highlighted lectures as the most helpful, followed by quizzes. This result aligns with the findings of Ealy [22], where students in a hybrid organic chemistry course also regarded lectures as helpful. At the same time, most of them marked quizzes as the most challenging fold, followed by group projects and self-reading/watching activities. This study found that quizzes enhanced the interactivity of lectures and were

perceived as useful by students, with all participants having a positive experience with quizzes. This study found that about two-thirds of the respondents considered sustaining focus during online lectures or discussions challenging. In contrast, about one-third of them did not consider this a challenge. Another study found similar results, indicating that in synchronous hybrid courses, students exhibited decreased attentiveness [23].

This study also found that more than half of the students who participated in the survey encountered technical difficulties with online platforms or tools during the course. This finding contrasts with the results of another study by Birbal *et al.* [24] which suggested a connection between students' comfort with online tools and effective online communication and learning. This study also found that more than half of the participating students reported difficulties communicating with peers or instructors online. This is coherent with another research that indicated the inability to connect with peers and teachers as one of the disadvantages of hybrid-virtual learning environments [23], [25], [26]. Thus, about half of the participating students indicated the need for help understanding the course material. Other studies also highlight the significance of direct face-to-face communication for improved understanding [27], [28].

This study found that a significant fraction of the participating students mentioned that one of the course's main shortcomings was the inadequate level of interaction offered by online discussion boards. Another significant fraction of them identified navigating technological tools as a weakness of the hybrid course delivery approach. At the same time, some of them felt overwhelmed due to their workload. Previous studies have also highlighted these weaknesses [3], [29]–[31]. A significant percentage of the participating students identified enhanced flexibility of course design as a strength of the multi-faceted hybrid course delivery approach. This aligns with the study of Birbal *et al.* [24], where they similarly observed that learning flexibility held the utmost significance in blended learning [6]. Easy-to-follow course content, the responsiveness of the course instructor, a combination of in-person and online instructions, and engaging lecture videos and interactive modules were other characteristic benefits of hybrid learning recognized by the students. These favorable attributes of the hybrid course delivery approach are consistent with findings from other research studies [24], [26], [32]–[34]. Recognizing the merits proves how well the course's multi-faceted hybrid approach was implemented. In summary, this study's findings were as well received by the authors, the other instructors who participated in delivering the said course, and the course-participating students. Thus, the study encouraged others to consider a multi-faceted hybrid approach, and even students are spreading supportive messages about our approach among their colleagues at JUST and probably at other universities in Jordan.

4. CONCLUSION

Although the concept of hybrid learning is not new, there has yet to be much investigation into its many facets. This project is intended to introduce a multi-faceted hybrid approach to a JUST introductory IT course. The results demonstrated high student satisfaction by showing a good link between the students' approach, satisfaction, agreement, overall rating, and recommendation of the hybrid model. Acknowledging one's strengths highlights the successful implementation of this complex hybrid approach in teaching IT courses. Although the students faced barriers during the course, they retained a promising outlook on the hybrid model and were enthusiastic about extending such a model to others. In this article, we underlined the future insightful knowledge attained from experiencing such difficulties. Educators must cautiously deliberate these concerns to ensure the appropriateness and usefulness of hybrid learning approaches. Besides, one of the major drawbacks of this research is the deprivation of a longitudinal model, which produces issues that can be partially captured by a single semester. Also, the small sample size is another limitation of this study, which may affect the ability to accurately represent the students' experiences. Indeed, students' experiences and dedication to the course may have been impacted by other factors such as current affairs, prior obligations, or personal circumstances. Also, it is possible that students answered questions in ways they thought were appropriate or expected, which may have uncovered their actual opinions. Finally, the distinctions in how teachers utilize the complex hybrid technique may be a factor in the discrepancies in student experiences that have been noted.

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