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RESEARCH ARTICLE

Understanding the Effects of Digital Transformation During Covid-19 on Teachers' Practice and Beliefs

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Abstract

Objective: To study university teachers' practices and beliefs using technology in a digitally transformed environment during the COVID-19 event. **Methods:** Quantitative data collection methods were used (surveys) and were supported by qualitative data (interviews). The study period spanned May 2020 to November 2020 at a small rural Saudi Arabian institution faculty (n=100), where the sample size used was n=37. The sample was all practising teachers of both genders and different academic positions in the faculty. Interview data were analysed qualitatively, and the survey data were analysed statistically using the SPSS package. **Findings:** The study provides insights into an approach that allows for richness in investigative studies in the social sciences. Many studies relating to Covid-19 do not fully address the WHY question regarding technology adoption and use. As such, this study drew on theories of change, social cognitive theories, policy implementation theories and Technological Pedagogical and Content Knowledge (TPACK). This paper found that behaviour is changeable and predicated on personal as well as social and professional environmental factors (primarily linked to Covid-19 institutional policy pressures). Teachers' beliefs about the perceived value (P-value = 0.015; 0.007 & 0.047) of using technology alongside their self-efficacy beliefs (P-value = 0.025) correlate positively with practice. There were no significant differences in knowledge, use, and attitudes across gender, age, or position. The data highlighted an increased use of constructivist, connectivist and instructivist methodologies (P-value = 0.024; 0.040 & 0.035) during COVID-19, which could be attributed to the affordances of technologies in online engagements and teachers' evolving pedagogical beliefs. **Novelty:** The limitations of techno-centric approaches to engagement with technology deny the human factor. This article uses a theoretically grounded approach to show how digitally transformed practices influence teachers' attitudes/behaviours.

The research outcome shows that although research suggests that behaviours and attitudes/beliefs are difficult to change, events and policies dynamically challenge and alter behaviours.

Keywords: Policy; Covid19; Technology; Pedagogy; Belief; Attitude

1 Introduction

The industrial revolution, major global wars, the silicon revolution, the era of steam, electricity, sea, air, road, and train travel, and health-related disasters like the bubonic plague (14^{th} century), Spanish flu (1918-1920), bird flu (H5N1) (1959–1991), and COVID-19 (2019) all change the social order. These events change society, institutions, and people [(1)].

Early in the year 2020, COVID-19 began to devastate humanity. On March 2, 2020, a Saudi royal order banned face-to-face education and relocated it online within three days of the decree. The decree established online distance education as a valid option for lockdown schooling. Despite university teachers' digital pedagogical background, they had to adapt to online education instantaneously. Teachers and students were traumatised by the decree.

Many teachers are unprepared for online learning (technology-based teaching and learning approaches) [(2)]. This unexpected shift challenges teachers' practises and beliefs, and teachers may doubt online education's potential to enhance learning [(3)]. According to [(4)],"a majority of faculty continue to hold sceptical attitudes towards the newer teaching modality, with many expressing that online classes are less rigorous and effective than traditional classes in engaging students". Furthermore, [(5)] contend that a "psychological climate support[s] various positive behavioural changes". Such behaviours can include the impacts of both teaching efficiency and the relative productivity of the teacher.

This paper's focus on teachers' beliefs and practices was primarily on how they responded to having to teach subjects that traditionally were practical in nature. These include, among others: anxiety about success, extreme difficulties due to diverse learning attitudes, technological difficulties with physical technology and online-learning methodologies, and remote learning methods not perceived as applicable [(6)].

1.1 Research Gap

Personal and contextual factors encompass a teacher's social structure. Social and professional contexts and individual factors shape teacher identity as social agents [(7)]. Discourses in digitally transformed education often include ambiguities and inconsistencies of polar opposites such as age, gender, access, context, etc. Research has shown that results are usually inconclusive [(8)]. For example, while some studies found males more inclined to ICT use, other studies found no difference; some studies speak of an inverse relationship between age and interest in ICT, but other studies do not come to the same conclusion and; while some studies return positive relationships between experience and use, others report negative relationship, and some are finding no relationship at all.

Many studies on ICT use focus on learning from a techno-centric point, and some on management, physical access, and processes. Yet fewer studies are focused on the policy impacts of Covid-19 and its relationship to teachers and their feelings, attitudes, behaviours and coping mechanisms. Exploring socio-cognitive and psychological factors as one of the prominent determinants of technology adoption and use is relatively unexplored during Covid-19. To address this gap and understand the socio-psychological milieu, this article examines how digital change affects beliefs and behaviours in the context of COVID-19.

Aligned with social theories, which suggest understanding social behaviour and, in particular, how human societies develop and respond in the face of adversity, this paper attempts to understand teachers' responses to digital transformation resulting from the COVID-19 pandemic. It does this by examining the various circumstantial factors at play during the Covid-19 period. Teachers' responses to events assume rational decisions based on personal and contextual factors. Our assumptions are predisposed to and grounded in cause and effect. We hypothesised that personal and contextual variables might influence instructors' use of technology for online instruction. The results of this study thus increase our understanding of how teachers coped and contribute valuable insights into what determines and is necessary to enable technology adoption and use in challenging times.

Our rationale for undertaking this inquiry is the policy decisions resulting from the COVID-19 decree. This article presents statistics on teachers' responses to the COVID-19 digital transformation agenda. The Saudi royal decree was enacted on Monday, March 2, 2020. All schools had to "suspend face-to-face teaching" and "offer educational activities online with a quality equivalent to that supplied via conventional face-to-face interactions" within three days[(1)]. Saudi universities, including this research site, held emergency meetings to address this Royal decree[(9)].

Of importance in this discussion is that at this research site, online teaching was not obligatory. The royal decree meant an immediate switch to online teaching, regardless of their digital pedagogy experience[(9)]. Teaching online demands a different attitude and significant pedagogical adjustment[(1)]. Thus, this report examined teachers' technology usage before and during Covid-19 and their attitudes and beliefs. Furthermore, this paper sought to look for any statistical variance in teachers' use of technologies before and during Covid-19 and looked for variances in attitudes and beliefs based on age and position at a university.

1.2 Theoretical underpinning

The theoretical framing of this paper draws from theories of change and social cognitive theory. Change theories were influenced by Auguste Comte (1798–1857), Herbert Spencer (1820–1903), Emile Durkheim (1858–1917), Karl Marx (1818–1883), Kurt Lewin (1890–1947), and Talcott Parsons (1902–1979). Five change factors are identified by[(10)]: discursive, procedural, content-based, attitudinal, and behavioural. Attitudinal means "change in the way actors think about a concern", and behavioural means "change in the way actors behave vis-à-vis a concern". Attitudes and beliefs influence teaching and learning, which impacts changes[(11)]. We believe psychological self-attitudes and beliefs are interconnected.

We employed social cognitive and policy implementation theories to understand rational decision-making in response to personal and environmental circumstances. According to[(12)], "Self-efficacy is the most significant aspect of both the theory of planned behaviour and social cognitive theory…self-efficacy must be present for the theory of planned behaviour and social cognitive theory to be applied, resulting in effective change".

Emergency Remote Teaching (ERT) was a reaction to Covid-19, suggesting online and remote teaching using technology. There is an understanding that emergency remote education is obligatory, whereas distant education is optional[(13)], and in the case of any policy directive, the royal 'decree' is mandatory. Given that teachers were confronted with a fundamental drive to survive during the crisis, the connotation of the policy implementation directive's obligatory character is significant.

Policy implementation and evaluation are the final stages in a public policymaking (PPM) process. There are three crucial participants in the public policymaking process: the end-beneficiaries [university students], the target group [university faculty], and the policy creators [university/state][(14)]. The policy aims to modify the target group behaviour of the end beneficiaries. In the context of our research, the desired change in behaviour is the pedagogical use of technology for online instruction. We place this inside the underlying tensions and contradictions of the policy implementation process, including the idealised policy, the implementation organisation, the target group, and environmental factors. The target group, which is the focus of this study, addresses mechanisms that change target group behaviour (individuals/organisations), including policy attainment barriers and non-compliance mitigation.

The difficulty of integrating information and communication technologies (ICT) is attributable primarily to human and technological issues. Digitally transformed education changes the roles of teachers, and innovation in education transforms the character of the teaching/learning process, creating variations in face-to-face teaching techniques and new learning contexts other than physical halls[(15)]. Teachers' opinions and attitudes towards integrating ICTs into classrooms have long been considered vital to effectively deploying new technology[(16)]. Educators' opinion of their understanding of ICTs for curriculum delivery and their ability to incorporate them into the classroom influences self-efficacy beliefs[(17)].

Thus, for successful digital integration into the curriculum, educators must understand technology, pedagogy, and content and how they relate to one another[(18)]. Technological Pedagogical and Content Knowledge (TPACK) is a framework for understanding and describing the knowledge a teacher needs to effectively teach in a technology-enhanced learning environment[(19)]. It is reviewed briefly to support this study's data analysis and survey:

- Content Knowledge (CK) - Teachers' subject area expertise.
- Pedagogical Knowledge (PK) - Teachers' deep knowledge about the processes and methods of teaching and learning.
- Technology Knowledge (TK) - Knowledge about particular methods of thinking about and working with technology, tools, and resources applies to all technology tools and resources.
- Pedagogical Content Knowledge (PCK) - Knowledge of pedagogy that is relevant to the teaching of particular content.
- Technological Content Knowledge (TCK) - Awareness of how technology and content impact and restrict each other.
- Technological Pedagogical Knowledge (TPK) - Awareness of how teaching and learning might change when certain technologies are applied in a specific manner.

This study's survey instrument focused on three combinations: TK; PK and TPK.

In the new digital context, teachers' self-efficacy, pedagogical beliefs and technology adoption, motivation, value/benefits and attitudes impact behaviour, and teachers' practises [20]. Intentions are the motivating variables that manifest behaviour [21]. In a digitally transformed environment, a teacher's understanding of the affordances and strategies of using technology is equally critical. As mandated by self-regulation theory, change from a teacher-centred to a student-centred teaching method is a difficult process requiring modifications to epistemic beliefs and pedagogical practices [22]. Conventional teaching beliefs, with tools centring on the instructor and where the student is viewed as the recipient of the information, are commonly observed among university professors [23]. Thus, for a change in teachers' beliefs about teaching, a transformation from a behavioural to a constructivist view is required [24]. This is noted by [24], who contends that a change has to occur in teachers' beliefs about teaching to transform from a behavioural view to a constructivist view.

Changing the beliefs of teachers often takes time. It is linked to "personal factors as well as the professional context in which teachers work" [1]. Beliefs influence a person's creation of thoughts, judgments, aptitudes and attitudes [23]. "Beliefs are formed early, and they tend to self-perpetuate despite the contradictions caused by time, reason, education or experience, and due to their own nature and origin, some beliefs are more irrefutable and harder to change than others" [23]. While there is an understanding that beliefs are hard to change, it does not imply that they cannot be modified. Self-efficacy is defined as [25] "people's beliefs about their capabilities…that impact on what people choose to do and the amount of effort they are willing to invest". The theory of planned behaviour (TPB) suggests that perceived behavioural control (PCB) is a direct predictor of intentions, which impact behaviour [26]. Perceived behavioural control [21] is defined as one's perception of a behaviour's difficulty, competence, or ease. As such, "people will choose among alternatives so as to optimise outcomes for them personally" [27]. This implies that teachers will act if the action provides them with what they desire or, in the context of Covid-19, for accountability.

2 Methodology

The method employed in this study is theoretically grounded; that is, it drew on a sensible range of theories and frameworks that included theories of change, social cognitive theories, policy implementation theories and the Technological Pedagogical and Content Knowledge (TPACK). This uniquely provided insights into an approach that allows for richness in investigative technology-related studies in the social sciences. This approach is a deviation from traditional techno-centric approaches to studies involving technology adoption and use, which we believe is a limitation as it denies the crucial human factor.

2.1 Methodological approach

This paper is a quantitative exploratory case study. Quantitative data collection methods were used (surveys) and were supported by qualitative data (interviews). This article primarily presents quantitative data collecting and analysis. The study site was a small rural Saudi Arabian institution faculty (n=100), and the sample size used was n=37. The study looked at the actions and beliefs/attitudes (quantities) in a digitally transformed environment brought about by Covid-19 (case) of a sample of practising university teachers representative of both genders and of different academic positions between May 2020 and November 2020. Interview data were analysed qualitatively, and the survey data were analysed statistically using the SPSS package. The following research questions guided the study:

(1) To what extent have teachers complied with the decree to move from traditional f2f teaching to online teaching?

(2) How have teachers' attitudes and beliefs been affected by the move to online teaching?

The research was conducted in phases, each with its own set of instruments and methodologies. After the Royal Decree in March 2020, we conducted a descriptive-analytical literature study to examine practice and beliefs. During the second phase, interconnected theoretical characteristics were found. The third step was data collecting through surveys and interviews. After receiving an IRP (No. 01142) from Taif University, questionnaires were sent out in September 2020, and interviews were held

in November 2020. The questionnaire was created using Survey Monkey, and a link was provided to all faculty members via their university email addresses. The poll allows teachers to indicate their willingness to be interviewed.

Participants used a 4-point scale to answer a modified TPACK questionnaire and a survey on attitudes/beliefs towards technology use developed by the research team. After carefully evaluating the study team's recommendations, the questionnaire was verified. In the last step, we used SPSS to analyse the data's patterns and ambiguities. Teachers' attitudes/beliefs in a digitally transformed environment and practice patterns before and after COVID-19 are documented. The attitudes/beliefs were categorised based on age and academic standing.

The data were inductively analysed under the TPACK components and the practice and attitudes/beliefs themes. For each question, the tables show the sample's percentage of agreement. Data was inferred from the theory of change, policymaking, and socio-cognitive theories.

3 Results and Discussion

Table 1 provides the participants' basic characteristics (N = 37) in frequencies and percentages. The sample is 62% male and 37% female. Most participants are under 50 years of age, that is, 31- 39 (37%); 40- 50 (45.5%). The teaching experience of the respondents varies, with the majority (29.7%) having 11- 15 years of experience. Most respondents hold doctorates. The majority of faculty (56.8%) are assistant professors. A professorship at this university requires a PhD and four years as an associate professor with published articles. The advancement to associate professor requires a PhD and four articles. Assistant professors hold a PhD, regardless of their level of experience. Lecturers have Master's degrees regardless of experience.

Table 1. Basic characteristics of participants

Item	Variable	n	%
Gender	Male	23	62.2
	Female	14	37.8
Age	< 40	14	37.3
	40-50	15	40.5
	>50	8	22.2
Position/Status	Professor	3	8.1
	Associate professor	5	13.5
	Assistant professor	21	56.8
	Lecturer	8	20.8

3.1 Technological Practice/Use

Table 2 consists eleven prompts about technology-integrated teaching and learning strategies before and after COVID-19. This section answers a "HOW" question about teachers' usage of technologies, systems, and services before and during COVID-19. Responses were grouped by TPACK categories: technological pedagogical knowledge (TPK - 4 items), technological knowledge (TK - 4 items), and pedagogical knowledge (PK - 3 items). Percentage agreement and scale mean responses are shown in Table 2.

The data in Table 2 revealed an increase in agreement with technology use practices during COVID-19 and a high scale mean. Mechanical aspects of technology utilisation are prominently featured (statements 4, 5, 9 & 10). Pedagogical use patterns showed an increase (statements 6, 7, & 11). Statements 4, 5, 7, 9, and 11 showed significant differences. Statements 2, 3, 1, and 8 show that professors, professor assistants, and lecturers changed significantly during COVID-19. Teachers' responses in their practices during the pandemic are supported by a selection in the qualitative data, which shows that "teachers' beliefs and attitudes about online education appeared to show varying levels of change" [9].

"At first, it was very traditional in presenting…now I tell them to write on the chat and then discuss the answers with them… also received the activities on Blackboard… I also varied in the assessment, not only exams… presentations, group discussions, individual participation, and short tests."

"I cannot do [lab/practical work] …has become a simulation…and we work on YouTube in some lab experiments".

"using technology online to use audio clips."

"watch the video, and we will discuss it in the next lecture…through info-graphic programs, Prezi and questions… they answer it via a barcode".

"created a WhatsApp group for each division, and students uploaded their work."

Table 2. Technology use before and during COVID-19

	Item N = 37	**Scale mean**	**% agreement**	**Scale mean**	**% agreement**	**Δ % agreement**	**P value**
		PRE COVID-19		**DURING COVID-19**			
TK	Statement 1. I use technologies to distribute/share information, materials, assignments, assessments, reminders of tasks to be done to the students	4.00	80.70	4.67	93.33	12.63	0.101
TK	Statement 2. I use technologies to support students remotely, to provide feedback, respond to question and share information.	3.90	78.00	4.53	90.67	12.67	0.158
TK	Statement 3. I always plan activities for students to use technologies to complete their normal work (e.g., do a presentation, type a document, complete a worksheet, designing, creating content, applying and publishing work).	4.20	84.00	4.63	92.67	8.67	0.289
TPK	Statement 4. I get students to use technologies to submit work on Blackboard and/or through WhatsApp	3.30	66.70	4.83	96.67	29.97	0.001*
TPK	Statement 5. I get students to use technologies to submit work	3.10	62.00	4.80	96.00	34.00	0.001*
PK	Statement 6. I teach students by telling them the content and telling them what to do in my lessons when I use technologies (Instructivist methodology)	4.10	81.30	4.63	92.67	11.37	0.167
PK	Statement 7. I teach students by getting them to learn by doing, experimenting, collaborating, practicing during my lessons when I use technologies (Constructivist methodology)	3.60	72.70	4.57	91.33	18.63	0.035*
TK	Statement 8. I use technology to manage learning with high extent to enable students' self-learning	3.60	71.30	4.17	83.33	12.03	0.218
TPK	Statement 9. I use student-centred approaches leading to students using technologies for designing, creating content, applying and publishing work	3.20	63.30	4.20	84.00	20.70	0.040*
TPK	Statement 10. I get students to use technologies by using simulations for experiments	3.40	68.70	4.30	86.0	17.30	0.065
PK	Statement 11. I teach students by getting them to collaborate and communicating among themselves for their learning during my lessons when I use technologies (Connectivist methodology)	3.30	66.70	4.43	88.67	21.97	0.024*

"I worry about if students will understand through remote education in the same way they do in traditional sessions."

The large-scale mean for general use was expected since it reflected essential modifications, which [10] states "are often a result of events and developments". This could be attributed to the decree, which is similar to a "policy" in that it is mandatory and aims to alter behaviour [28]. Qualitative research showed that "the teachers seemed to show renewed awareness of their own needs, shortcomings, and strengths" [9]. The qualitative data in this study yielded insights into how some participants responded to the decree.

"It was very great suffering; I was wondering when we will learn to deal with the use of this technology…felt the limitations of my preparation for this situation."

"there were barriers, fears of failure to perform, but gradually…we have overcome this obstacle."

As a result, we situate this within the intrinsic tensions and contradictions of policy implementation processes. "Agree" to "Strongly Agree" may have implied compliance rather than personal choice. The author [20] explained the necessity to comply by asserting that "use" is based on human dispositions and that even if a teacher has an unfavourable disposition or attitude toward online teaching, they "may still engage on account of it being made mandatory." This is supported by qualitative research, where teachers noted that the technological and technical challenges affected them greatly [9]. In our qualitative data, teachers noted:

"I can't work despite all that I have and [what] was asked from us [university expectations]."

"Before Corona, it was not required by the university; the blackboard was present, but not at the same level as it is now in terms of quality and uses."

Tables 3 and 4 provide insights into nuances across age and position of participants towards clarifying the data in Table 2.

Table 3. Ways of technology use

1. I use technologies to distribute/share information, materials, assignments, assessments, reminders of tasks to be done to the students.											
		Before COVID-19 %					During COVID-19 %				
	n=	Strongly Agree	Agree	Disagree	Strongly Disagree	Not applicable	Strongly Agree	Agree	Disagree	Strongly Disagree	Not applicable
< 40	14	14.30	35.70	14.30	7.10	28.60	77.80	22.20	0.00	0.00	0.00
40-50	15	46.70	26.70	0.00	6.70	20.00	66.70	25.00	8.30	0.00	0.00
>50	8	37.50	62.50	0.00	0.00	0.00	75.00	25.00	0.00	0.00	0.00
Assistant Professor	21	38.10	38.10	9.50	4.80	9.50	78.90	21.10	0.00	0.00	0.00
Lecturer	8	14.30	28.60	0.00	14.30	42.90	50.00	25.00	25.00	0.00	0.00
Professor	3	66.70	0.00	0.00	0.00	33.30	100.00	0.00	0.00	0.00	0.00
3. I always plan activities for students to use technologies to complete their normal work (e.g. do a presentation, type a document, complete a worksheet, designing, creating content, applying and publishing work).											
< 40	14	20.00	70.00	10.00	0.00	0.00	60.00	40.00	0.00	0.00	0.00
40-50	15	41.7.	50.00	8.30	0.00	0.00	75.00	16.70	0.00	8.30	0.00
>50	8	25.00	75.00	0.00	0.00	0.00	87.50	12.50	0.00	0.00	0.00
Assistant Professor	21	21.1.	68.40	10.50	0.00	0.00	73.70	26.30	0.00	0.00	0.00
Lecturer	8	50.00	50.00	0.00	0.00	0.00	75.00	0.00	0.00	25.00	0.00
Professor	3	50.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00

Table 3 shows a positive shift during COVID-19 in all age categories in the two ways of using technology in their practice. The 40 - 50 age group registered the most adaptations to ways of using technology during COVID-19.

The fact that the < 50 age groups are more at the cold face of teaching than some older faculty members might explain their shifts during Covid-19. The mandatory setting may have stimulated and suppressed prior attitudes to online teaching, but it could have also afforded opportunities to re-examine and modify viewpoints [7]. The qualitative data suggested that "teachers demonstrated personal efforts and reflexivity in overcoming such institutional challenges" [9]. The way in which teachers coped is supported by our qualitative data.

"I look for technology and tools that help students learn more."

"I have a series of foreign university websites that I have submitted to students". "I teach them with links… I do translation tasks with students, and I go to Team Viewer and explain."

"I brought my laptop and my internet card, and I provided the students with internet"- "I download [virtual lab]

In Table 4, the pedagogical use of the three teaching methodologies indicated an increase during COVID-19 across all age groups. The shift in pedagogical usage raises questions about how age, experience, and teaching position affect technology adoption. The 40 - 50 age group showed the most significant change. Item 7 focuses on student learning by constructing meaning as individuals, or independent learning, through practical activities like experimenting and testing. The nuanced distinction in Item 9 is that student learning in Item 7 was centred on collaboration rather than independent learning. The Assistant Professor and Lecturer indicated substantial pedagogical modifications across all three items (items 6, 7, & 11). According to the data, Professors' pedagogical use was not constant. In items 6 and 11, Professors agreed less with an instructivist approach during COVID-19.

The slight changes in senior positions are consistent with [29], who contend that institutionalised teaching using traditional face-to-face methods makes it difficult for senior teachers to adjust and change. The authors [1] note that "shifting mindsets" is challenging when expected to flip to online teaching. Beliefs about teaching and learning held by teachers are essential for understanding the techniques and methodologies they employ in their classes and online education since they reflect the

Table 4. Pedagogical use of technology

		Before COVID-19					During COVID-19				
	n=	Strongly Agree	Agree	Disagree	Strongly Disagree	Not applicable	Strongly Agree	Agree	Disagree	Strongly Disagree	Not applicable
6. I teach students by telling them the content and telling them what to do in my lessons when I use technologies (Instructivist methodology).											
< 40	14	30.00	50.00	20.00	0.00	0.00	80.00	10.00	10.00	0.00	0.00
40-50	15	50.00	25.00	25.00	0.00	0.00	75.00	16.70	8.30	0.00	0.00
>50	8	37.50	62.50	0.00	0.00	0.00	75.00	25.00	0.00	0.00	0.00
Assistant Professor	21	31.60	52.60	15.80	0.00	0.00	84.20	10.50	5.30	0.00	0.00
Lecturer	8	25.00	25.00	50.00	0.00	0.00	75.00	0.00	25.00	0.00	0.00
Professor	3	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00
7. I teach students by getting them to learn by doing, experimenting, collaborating, practicing during my lessons when I use technologies (Constructivist methodology).											
< 40	14	10.00	50.00	40.00	0.00	0.00	80.00	0.00	20.00	0.00	0.00
40-50	15	16.70	50.00	33.30	0.00	0.00	83.30	8.30	0.00	8.30	0.00
>50	8	25.00	75.00	0.00	0.00	0.00	75.00	25.00	0.00	0.00	0.00
Assistant Professor	21	10.50	63.20	26.30	0.00	0.00	84.20	5.30	10.50	0.00	0.00
Lecturer	8	0.00	25.00	75.00	0.00	0.00	75.00	0.00	0.00	25.00	0.00
Professor	3	50.00	50.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00
11. I teach students by getting them to collaborate and communicating among themselves for their learning during my lessons when I use technologies (Connectivist methodology).											
< 40	14	0.00	30.00	60.00	10.00	0.00	60.00	30.00	10.00	0.00	0.00
40-50	15	8.30	66.70	25.00	0.00	0.00	75.00	16.70	0.00	8.30	0.00
>50	8	0.00	100.00	0.00	0.00	0.00	37.50	62.50	0.00	0.00	0.00
Assistant Professor	21	0.00	68.40	26.30	5.30	0.00	63.20	31.60	5.30	0.00	0.00
Lecturer	8	0.00	25.00	75.00	0.00	0.00	50.00	25.00	0.00	25.00	0.00
Professor	3	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00

teachers' epistemological beliefs about teaching and learning and the conceptualisation of their responsibilities[30]. In our opinion, the rising usage of different methodologies is a result of what technology can do and how teachers employ it in an online context.

3.2 Attitudes/Beliefs informing technological practice/Use

Thirty-one items concerning attitudes, beliefs, and experiences were categorised by how individuals use technology for personal reasons, their beliefs and opinions in a digitally transformed environment, the perceived benefit or value of utilising technology, their belief in their ability to use technology, and institutional support (see Table 5). This section answers the "WHY" issue by outlining why technologies, systems, and services should be employed. Personal, digital transformation, experiences, benefits/value, self-efficacy, and support were classified by type of technology usage. The participant responses were calculated as P values in Table 5.

There were significant disparities between university professor positions (item 2) and ages (items 19, 21, 22, & 28). The significant difference calculated from item 2 is regarding faculty position participants' beliefs about whether the COVID-19 pandemic required them to utilise technology. Table 6 explains item 2 in more detail.

Items 21 and 28 reveal a significant association between participants' beliefs about subject-related benefits of using technology and their influence on students. Item 28, concerning self-efficacy, also differed significantly by faculty position and age. Item 21 is detailed in Table 8, while Item 28 is detailed in Table 9.

Table 5. Attitudes / Beliefs towards technology use

Item	Prof	Assoc Prof	Assist Prof	Lecturer	P value	< 40	40-50	>50	P value
1. Personal	3.50	4.50	4.93	5.00	0.069	4.72	4.90	4.75	0.796
2. Digital transformation	5.00	3.50	4.87	3.50	0.039*	4.54	4.54	4.00	0.679
3. Personal	4.50	4.50	4.87	4.33	0.465	4.63	4.81	4.50	0.790
4. Digital transformation	2.50	1.50	3.12	3.17	0.457	3.00	3.36	1.75	0.202
5. Digital transformation	4.50	4.00	4.81	3.83	0.165	4.27	4.72	4.50	0.579
6. Experiences	3.50	3.00	2.75	2.50	0.805	2.18	3.18	3.25	0.228
7. Experiences	4.00	4.50	4.00	2.83	0.569	3.18	4.36	3.75	0.163
8. Experiences	4.00	4.50	3.75	3.33	0.485	3.36	4.18	3.50	0.211
9. Experiences	4.50	4.50	4.93	4.17	0.194	4.50	4.90	4.75	0.458
10. Experiences	3.00	3.00	3.75	3.67	0.694	3.27	4.09	3.25	0.191
11. Digital transformation	4.00	4.00	4.43	3.83	0.468	4.00	4.45	4.25	0.442
12. Digital transformation	5.00	4.00	3.87	3.33	0.425	4.18	3.36	4.25	0.288
13. Digital transformation	5.00	3.50	4.31	3.50	0.371	4.18	4.09	4.00	0.962
14. Benefits / Value	4.00	4.50	4.56	4.17	0.557	4.18	4.72	4.25	0.310
15. Benefits / Value	4.50	4.00	4.43	4.00	0.655	4.00	4.54	4.50	0.398
16. Benefits / Value	4.00	4.50	4.56	4.17	0.557	4.18	4.72	4.25	0.310
17. Benefits / Value	4.50	4.50	4.68	4.17	0.926	4.72	4.81	4.50	0.342
18. Benefits / Value	4.50	4.00	4.18	3.50	0.697	3.63	4.45	4.00	0.232
19. Benefits / Value	2.00	2.00	3.75	3.83	0.169	2.90	4.36	2.75	0.015*
20. Benefits / Value	4.50	3.00	4.18	3.50	0.572	3.36	4.45	4.25	0.118
21. Benefits / Value	4.50	3.00	4.00	3.17	0.367	2.90	4.36	4.50	0.007*
22. Benefits / Value	3.00	4.00	4.25	3.50	0.400	4.45	4.54	3.70	0.047*
23. Benefits / Value	4.00	4.00	3.87	3.00	0.850	3.27	3.90	4.25	0.303
24. Benefits / Value	3.00	3.00	3.37	3.50	0.907	3.00	3.90	2.75	0.172
25. Self-efficacy	4.50	4.00	4.18	3.50	0.719	3.63	4.27	4.50	0.116
26. Self-efficacy	4.50	4.50	4.43	4.17	0.958	4.09	4.63	4.50	0.323
27. Self-efficacy	4.50	4.50	4.25	3.33	0.354	4.63	4.36	4.50	0.090
28. Self-efficacy	4.50	5.00	4.31	3.83	0.623	4.63	4.63	5.00	0.025*
29. Self-efficacy	4.00	5.00	4.37	3.67	0.335	3.72	4.54	4.75	0.058
30. Support	4.50	3.00	4.12	4.00	0.530	3.90	4.00	4.50	0.672
31. Support	4.50	4.00	4.37	3.66	0.798	3.81	4.36	4.75	0.174

In Item 19, personal benefits of how participants regard themselves in the teaching-learning hierarchy demonstrated a significant variation between ages. The value and acknowledgement participants believe they get from adopting technologies are related to social norms in Item 31 (no significant difference is noted). The data demonstrate a link between the use of technology for personal and professional reasons. Such conscious decisions to employ technologies are ultimately shaped by internal processes that are independently and jointly driven by needs and circumstances. We notice that this usage was primarily used for personal rather than student learning.

Item 23, which asked participants whether their subject had digital resources, revealed no significant differences. A significant P value was observed at item 22, where participants were asked whether their subject was suitable for ICT integration. Four (4) descriptive tables (Tables 6, 7, 8 and 9) focussing on 14 items provide insights into nuances across age and position of participants towards clarifying additional data in Table 5.

Table 6 demonstrates student pressure for technology usage. The negligible force of student pressure as an external factor strengthens our hypothesis of policy imperatives, which demonstrate strong agreement according to age and position. Except for a few lecturers, online significance varied by age and position.However, change is connected jointly to the student, and policy needs to go online. These changes suggest teachers' psychological restructuring of beliefs, perceptions, feelings, and attitudes.

Table 6. Technology use - Digital transformation

		Statement 2. The Covid-19 pandemic has forced me to use technology. (Behaviour)				**Statement 4. There is some pressure from the students for me to use technology in my classes before pandemic. (Behaviour)**				**Statement 5. The university imperative policy to account online teaching during Covid-19 has caused me to think more deeply about how I could adjust my teaching approaches using technologies. (Attitude)**				**Statement 11. Since the Covid-19 pandemic, I have changed my attitude toward using technologies for my work (I have experienced new uses of technologies that I did not consider before). (Attitude)**			
	n=	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree
< 40	14	77.80	22.20	0.00	0.00	11.10	22.20	33.30	33.30	55.60	33.30	11.10	0.00	44.40	55.60	0.00	0.00
40-50	15	66.70	16.70	8.30	8.30	33.30	25.00	25.00	16.70	91.70	0.00	0.00	8.30	50.00	41.70	0.00	8.30
>50	8	71.40	14.30	14.30	0.00	28.60	28.60	42.90	0.00	57.10	42.90	0.00	0.00	14.30	85.70	0.00	0.00
Assistant Professor	21	68.40	21.10	10.50	0.00	15.80	26.30	36.80	21.10	73.70	21.10	5.30	0.00	31.60	68.40	0.00	0.00
Lecturer	3	66.70	0.00	0.00	33.30	33.30	0.00	33.30	33.30	33.30	33.30	0.00	33.30	66.70	0.00	—–	33.30
Professor	2	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Associate Professor	4	75.00	25.00	0.00	0.00	75.00	0.00	25.00	0.00	75.00	25.00	0.00	0.00	50.00	50.00	0.00	0.00

Table 7. Technology use – Experiences

		Statement 7. My experiences of using technology have shown that it was useful for my learning at school/university. (Experiences)				**Statement 9. I have seen the effectiveness of using technologies during the Covid-19 period with my students. (Experiences)**			
	n=	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree
< 40	14	44.40	33.30	0.00	22.20	88.90	11.10	0.00	0.00
40-50	15	50.00	25.00	16.70	8.30	91.70	0.00	0.00	8.30
>50	8	28.60	57.10	0.00	14.30	57.10	42.90	0.00	0.00
Assistant Professor	21	42.10	36.80	10.50	10.50	84.20	15.80	0.00	0.00
Lecturer	8	33.30	33.30	0.00	33.30	66.70	0.00	—–	33.30
Professor	3	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
Associate Professor	5	50.00	50.00	0.00	0.00	75.00	25.00	0.00	0.00

There seems to be a change in opinions based on teachers' experiences as recipients of technology-enhanced learning on a time-based continuum. While many did not seem to like learning with technology themselves, recent experiences reveal a more favourable attitude. Statement 9 showed this trend in conjunction with statement 7 (see Table 7) across age and position, where significant agreement approximately doubled. Responses to challenges are exemplified in the quotation [9].

"How I use the technology correctly…use the application effectively…this application in the right place in the way that affects the students' learning…am I able to employ this technology with large numbers of students?"

"With the cooperation of colleagues, research and question, I was able to overcome this stage."

"If I didn't know, I had to learn… made a great effort to overcome shortcomings in technical skills."

"the first thing I did was ask the female colleagues from the computer department for help."

"I learned through trial and error…also used videos from YouTube."

"I attended a course provided by [anonymised] university and the computer department."

More participants believed using technologies for personal/professional purposes was beneficial. However, no apparent benefits were evidenced when juxtaposed with the perceived value/benefits of use by students (see Table 5 and Table 8). Regarding incorporating technology into teaching and learning, we agree that teachers' beliefs and attitudes have always been crucial [16]. General attitudes towards physical objects and attitudes towards executing particular behaviours are examples of attitudinal outcomes [31]. This suggests that beliefs influence technology use. When examined from a social-ecological standpoint, it is clear that reciprocally teachers influence and are influenced by their professional practices. Supporting [31], we are amenable to the notion that "attitudes based on direct experience are more predictive." However, [20] argued that while attitude is a determinant of intent, it is not a good predictor of what a teacher will do in all situations. The variances in the data regarding benefit/value propositions and experiences are consistent with [11] observation that beliefs are assumed to drive behaviours. Yet, experience and reflection on behaviour may lead to modifications in and/or additions to beliefs.

There was consensus among the teachers regarding their skills and knowledge for technology integration (Table 9). Self-efficacy is often linked to these beliefs, which makes sense since the desire to learn new skills is a constant factor in self-efficacy beliefs. Alongside beliefs of value and benefit, [12] contends that "self-efficacy must be present in order for the theory of planned behaviour and social cognitive theory to be applied, resulting in successful change."

It is plausible that teachers' motivation to act is diminished if they do not believe they can. The transition to online teaching implies shifting the power of learning to students, requiring both instructors and students to be "re-educated" [1]. This reflects a metacognitive aspect, which [32] defines as "understanding of self as agent," that is, teachers' and students' high awareness of their strengths, challenges, and limitations, as well as their competencies and approaches to dealing with situations.

There was no significant variation in attitudes and beliefs based on the age, gender or position of participants. This is contrary to [33], who found gender to be an influential factor. While there were no significant connections to technological skills, the data suggest that participants' current (during COVID-19) experiences have played a significant role in changing beliefs and attitudes based on the benefits/value of technology and concurrent pedagogical use. This can be correlated to a [33] study that maintains that the degree of digital training results in teachers placing "a high value on the pedagogic usefulness of technologies" The pedagogical topography (TK, TPK, and PK) of TPACK evidenced in the data resonates with [8] who found a relationship between experiences in ICT use and more constructive use of technology during the pandemic. The belief of the perceived

Table 8. Technology use - Benefits / Value

		Statement 15. The benefits I get from using technology are really valuable to me for professional use. (Belief/ Opinion)				**Statement 18. Using technology makes my teaching work easier, more exciting and helps me teach better. (Belief/Opinion)**				**Statement 21. Students respond more and better when I use technology because their learning experiences are enhanced. (Experiences)**				**Statement 24. I get to see, do and experience things with technology that I cannot do in the traditional way. (Experience)**			
	n=	Strongly Agree	Agree	Disagree	Strongly Dis-agree	Strongly Agree	Agree	Disagree	Strongly Dis-agree	Strongly Agree	Agree	Disagree	Strongly Dis-agree	Strongly Agree	Agree	Disagree	Strongly Disagree
< 40	14	55.60	33.30	11.10	0.00	44.40	33.30	22.20	0.00	33.30	33.30	22.20	11.10	22.20	22.20	55.60	0.00
40-50	15	58.30	33.30	0.00	8.30	50.00	33.30	8.30	8.30	41.70	41.70	8.30	8.30	41.70	33.30	16.70	8.30
>50	8	42.90	57.10	0.00	0.00	28.60	71.40	0.00	0.00	14.30	71.40	14.30	0.00	0.00	71.40	14.30	14.30
Assistant Professor	21	47.40	47.40	5.30	0.00	42.10	42.10	15.80	0.00	31.60	47.40	15.80	5.30	21.10	42.10	31.60	5.30
Lecturer	8	66.70	0.00	0.00	33.30	33.30	33.30	0.00	33.30	66.70	0.00	0.00	33.30	33.30	0.00	33.30	33.30
Professor	3	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Associate Professor	5	75.00	25.00	0.00	0.00	50.00	50.00	0.00	0.00	25.00	50.00	25.00	0.00	25.00	50.00	25.00	0.00

Table 9. Technology use - Self-efficacy

		Statement 25. I am comfortable/competent in how to use the technologies. (Opinion/Belief) (Skill - TK)				**Statement 27. I know how to choose technologies that enhance my teaching approaches and that enhance my students' learning experiences for lessons in my subject. (Behaviour) (Skill + Pedagogical - TPK)**				**Statement 28. I am fully aware of different approaches to teaching my subject with and without technologies. (Opinion/Belief) (Pedagogical-PK)**				**Statement 29. I can adapt my teaching to include technologies because I am comfortable using these technologies and am fully capable of deciding when technologies are suitable for use in my subject. (Opinion/Belief) (Pedagogical-PK)**			
	n=	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree	Strongly Agree	Agree	Disagree	Strongly Disagree
< 40	14	33.30	55.60	11.10	0.00	66.70	22.20	11.10	0.00	55.60	22.20	22.20	0.00	44.40	44.40	11.10	0.00
40-50	15	41.70	50.00	0.00	8.30	25.00	66.70	0.00	8.30	75.00	16.70	0.00	8.30	66.70	25.00	0.00	8.30
>50	8	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	28.60	71.40	0.00	0.00	14.30	85.70	0.00	0.00
Assistant Professor	21	26.30	68.40	5.30	0.00	26.30	68.40	5.30	0.00	63.20	26.30	10.50	0.00	52.60	42.10	5.30	0.00
Lecturer	8	33.30	33.30	0.00	33.30	66.70	0.00	0.00	33.30	33.30	33.30	0.00	33.30	33.30	33.30	0.00	33.30
Professor	3	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Associate Professor	5	25.00	75.00	0.00	0.00	25.00	75.00	0.00	0.00	25.00	75.00	0.00	0.00	25.00	75.00	0.00	0.00

usefulness of digital tools according to [34] outweighs all other factors. The data on experience, usefulness and adaptability in this study can be related to [8], who noted that experience is not only related to beliefs but contributes to coping and adaptability for different teaching and learning situations.

The findings evidenced a shift in teachers' self-reported beliefs. Change in this research seems to be strongly influenced by the "decree," as evidenced by the data. We found no overt evidence of any significant value pre/post-Covid-19 of the effect of subjective norms. The results from other studies, which correlate with our findings, are that "there is no influence of subjective norms on utilisation of the technology" [35]. What we did find was a professional commitment to the vocation of education prevailing.

While improvements seem to have occurred, actual practice does not always match beliefs/intentions. Policy imperatives, values/benefits, self-efficacy beliefs, experiences, and support factors might have influenced such a shift in their beliefs. This is aligned with [5], who noted that "factors of psychological climate and employee engagement" are significantly related.

3.3 Limitations of the study

We accept the study's limitations, although it has aided us in our understanding of the factors that explain, to some degree, the impact of digital transformation during COVID-19. Because the data does not qualitatively explain variances in teachers' practices and beliefs/attitudes, the study's findings have limited generalisability. In mitigating these limitations, we highlight that this was a case study at a small rural Saudi Arabian institution with a limited faculty (n=100). Small numbers and non-responses prevented further statistical analyses. The data consisted of self-reported opinions throughout time. In addition, the research was non-experimental, having no degree of variable control. Given that no statistical assessment of everyday practices was done, our statements about "significant changes" and "correlation" support the opinions stated by the sample.

4 Conclusion

The Key takeaway from this study is: Events (such as Covid-19) dynamically challenge and change both beliefs and practices. The nearly "God-like" decree of COVID-19 that required an immediate conversion to an online, digitally transformed environment produced unique and unprecedented impacts on the sample. COVID-19 (the cause) contributed to an increase in teachers' experience of working in a digital environment, and we contend that it has impacted instructors' beliefs and practices.

The practical importance of the p-value noted in this study both correlates with and challenges previous studies. The perceived value of using technology, which could be attributed to the affordances of technologies, P-value = 0.015; 0.007 & 0.047, in online engagements (for both students and teachers) was found to correlate positively with teachers' evolving pedagogical beliefs alongside their self-efficacy P-value = 0.025. Regarding practice, the data highlighted an increased use of constructivist, connectivist and instructivist methodologies during COVID-19, P-value = 0.024; 0.040 & 0.035. There were no significant differences in knowledge, use, and attitudes across gender, age, or position.

We contend that "policy" is the one element affecting technology adoption that is unique to COVID-19 since previous technology adoption studies have supported research on the rationale and usage of technology in education across time, P-value = 0.039. The authors [1] found that "when a firm policy was introduced through a royal decree to encourage technology integration in teachings, a shift to online learning happened." Given the urgency of the royal decree during COVID-19, we feel its policy challenges transcend age, gender, and position. There is no assurance that behavioural change will be maintained because of how it manifests over time or instantly, as in this research.

We believe that instructors' participation in this digitally changed environment is affected by how they think about teaching, their experiences, and their confidence in their abilities. Technology affordances, a diversity of pedagogical techniques, instructors' increased opportunities and technical abilities, and their willingness to try new things throughout time may have led to a transformation.

Lessons obtained from this paper transcend the boundaries of higher education and can be used to inform different frameworks for change in response to policy imperatives. Self-regulated learning (SRL) is essential for many teachers and students in a digitally transformed world. Given that teachers' practices are influenced by personal and environmental factors, we suggest that policies are reviewed early during implementation for effectiveness, challenges and possibilities. Additionally, we recommend instituting the necessary provisioning and support for pedagogical development and technological capability for online education.

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