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Achievement Emotions in Paper-Based Exams vs. Computer-Based Exams:
The Case of a Private Saudi University

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ABSTRACT

This study investigates the emotional experiences of undergraduate students when taking computer-based compared to traditional paper-based exams. The authors surveyed 144 students and conducted in-depth written interviews with 44 of them to gain a comprehensive understanding of their emotions and experiences. The findings revealed that students generally feel more positive emotions, such as enjoyment, hope, and pride during computer-based exams. Conversely, they experienced less anger, anxiety, and hopelessness compared to paper-based exams. However, they observed no significant differences in feelings of relief and shame between the two exam modes. The interview responses provided valuable insights into the reasons behind these emotions. Students found computer-based testing to be more efficient, user-friendly for language editing, and appreciated the auto-grading features. However, technical concerns were identified as a major challenge in this format. On the other hand, paper-based exams allowed students to avoid technical problems, draft their answers, and express ideas more effectively. Despite these advantages, students reported disliking the lengthiness of the written responses, the difficulty of editing, and the pressure of maintaining legible handwriting. Overall, this study sheds light on the emotional experiences of students in different exam formats, helping educators make informed decisions to optimize testing environments.

KEYWORDS

Achievement Emotions, Computer-Based Tests, Paper-Based Exams, Saudi Arabia, University Education

INTRODUCTION

In our current age of digitization, computer-based testing (CBT) has become an integral part of the educational process and, hence, educators must learn more about the use of this type of testing and the impact it has on students' academic progress, emotions, and well-being. In fact, CBT has several advantages and disadvantages. On the plus side, CBT is generally efficient, can provide immediate scoring and feedback in certain types of questions and allows for several types of innovative and

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authentic assessment, including the use of video clips, slide shows and simulations (Boevé et al., 2015; Öz & Özturan, 2018). On the minus side, however, CBT requires adequate facilities, special procedures for test security and the provision of back-up procedures. Additionally, students/teachers may not easily adapt to CBT because they lack familiarity with and/or competence in using relevant tools (Ebimgbo et al., 2021; Odo, 2019). Considering the advantages of CBT and the fact that it is increasing in popularity with the current trends of digitization, several scholars attempted to explore a variety of relevant issues, such as how CBT could affect students' performance (Jalo et al., 2021; Jeong, 2014; Rodríguez et al., 2021) and/or their perceptions (Alnasser, 2022; Bloom et al., 2018; Debuse & Lawley, 2016). However, fewer studies have attempted to explore how transitioning to CBT could affect students' achievement emotions and well-being.

Achievement emotions are a certain emotion directly linked to learning activities or learning outcomes (Pekrun et al., 2011). This type of emotions greatly influences learning and achievement in academic settings (Pekrun, 2006). Cognitively, achievement emotions influence storage, processing, memory, attention, and retrieval of information, among others (Pekrun, 2011, Phelps, 2006). Additionally, achievement emotions significantly influence intrinsic and extrinsic motivation (Pekrun, 1992). Due to this importance, several studies have examined the influence of achievement emotions in relation to learning in the classroom (Behrens et al., 2019; El-Dakhs et al., 2022; Stephan et al., 2019), studying (Karimi et al., 2022; Pekrun et al., 2011; Peterson et al., 2015) and taking exams (Daniels & Gierl, 2017; Dermitzaki et al., 2016; Harley et al., 2020). These studies, however, have rarely compared students' achievement emotions in computer-based versus paper-based exams. This gap has motivated the current study which compares the achievement emotions in computer-based versus paper-based exams among undergraduate students in a private Saudi university. More specifically, the current study aims to identify the differences in students' emotions during paper-based versus computer-based exams and to explore what factors influence students' emotions in these modes of testing. We must note that CBT in the current study does not mean online exams. CBT in the present study refers to tests held in computer labs using computers and/or learning management systems under regular human proctoring.

The current study is significant for three reasons. First, the present study helps fill a gap in the literature. Only a few studies have compared students' achievement emotions under different modes of testing, including CBT. Second, the results of the present study will contribute to the smooth transition into CBT in higher education. Third, the present study is conducted in Saudi Arabia, part of the Arab World. This adds to the value of the study since the Arab World is greatly under-represented in achievement emotions research.

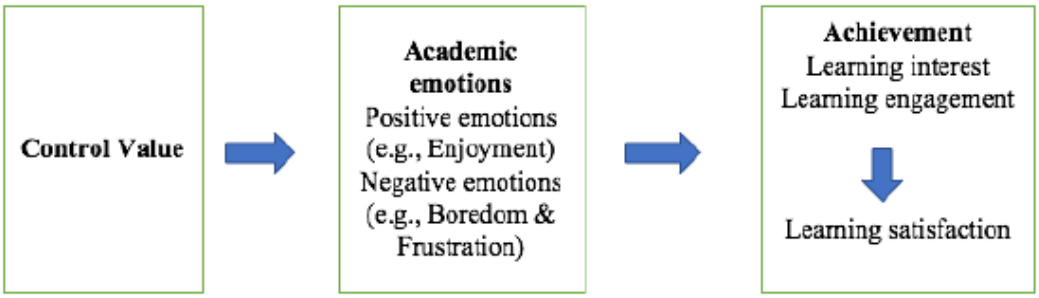
The following two sections will survey the relevant theoretical model and the existing literature to situate the current study. This will be followed by listing the research questions and describing the methodology. Then, the results will be explained and interpreted. Finally, the conclusion will be drawn, including pedagogical implications and suggestions for future research.

THEORETICAL BACKGROUND

The Control-Value Theory of Achievement Emotions is an integrative framework that describes the antecedents and effects of achievement emotions (Figure 1). In this framework, achievement emotions rely on two important factors. The first factor, known as "subjective control over learning," refers to the perceived controllability of achievement emotions. The second factor, which is called "subjective value for learning," refers to the subjective importance attached to achievement activities and outcomes (Pekrun & Stephens, 2010).

The Control-Value Theory classifies achievement emotions based on the dimensions of valence and activation. The valence dimension distinguishes between positive and negative emotions, whereas the activation dimension differentiates between activating and deactivating emotions (Pekrun et al., 2011). Positive, activating motions, such as enjoyment, hope, and pride, trigger interest and enhance

Figure 1.
Control-value theory (Pekrun, 2006). A solid arrow shows the prediction direction



intrinsic motivation, while positive deactivating emotions, such as relaxation and relief, trigger positive attitudes toward learning (Pekrun et al., 2017). Conversely, negative, activating emotions, such as shame and anxiety, trigger negative attitudes towards learning whereas negative deactivating emotions, including boredom, undermine motivation and information processing (Pekrun et al., 2017).

In accordance with this theory, the Achievement Emotions Questionnaire (AEQ) was designed to assess the achievement emotions of university students. The current study used the AEQ to compare students' emotions in paper-based exams versus computer-based exams. The results will help us better understand students' feelings toward each mode of testing. Further details about the AEQ will be discussed in the methodology section.

LITERATURE REVIEW

Several studies compared paper-based testing (PBT) and CBT in the last decade. For example, Boevé et al. (2015) compared the performance of 401 German students of psychology in computer-based versus paper-based exams. The results showed no differences in total scores across the two modes. However, when the students' acceptance of computer-based examination was addressed, the findings showed that 50% preferred paper-based over computer-based exams, while only 25% preferred computer-based exams. Likewise, Karay et al. (2015) found similar results regarding test performance. Comparing the performance of 266 German students of medicine on paper-based versus computer-based tests revealed no differences in test results. The only notable differences were related to the test taking time and guess work. Students using the computer version, particularly the high performers, needed significantly less time to complete the test. Additionally, no performing students guessed significantly more often in computer-based than paper-based tests.

The comparison between the two modes of testing triggered increasing attention in other parts of the world as well. Khoshsima and Toroujeni (2017) investigated the score equivalency of a test taken by 228 Iranian undergraduate students to see whether the scores of two administrations of testing mode (computer-based versus paper-based) were equivalent. A paper-based and a computer-based version of a test were administered to two groups of students in a counterbalanced administration sequence. This pattern was repeated on four testing occasions with four weeks interval. The findings revealed that test takers' results were comparable in both modes. Similarly, Öz and Özturan (2018) assigned 97 Turkish English majors into an experimental group that took the computer-based achievement test and a controlled group that took the test in a paper-based format. The results showed no significant differences in the test's reliability and validity either way. Additionally, no significant differences were found in test scores between the participants of the experimental and the controlled groups. Likewise, Yu and Iwashita (2021) randomly assigned 92 Chinese undergraduate students to an experimental group using CBT, and a controlled group using PBT. The test scores were compared, and semi-structured interviews

were conducted with the participants. The quantitative results showed that test scores were comparable in the two modes. As for the semi-structured interviews, the results revealed that most test takers prefer computer-based testing because they believed that this mode enhanced their efficiency in listening and writing, offered them an innovative test experience, and created a comfortable test environment. However, those test takers who did not prefer computer-based testing believed that this mode lowered their speed at analyzing text, increased their test anxiety, and distracted them due to others' typing sounds.

These studies such as Öz and Özturan (2018) and Yu and Iwashita (2021) showed that computer-based testing can be integrated into university education without fears regarding test validity, reliability, or scores. However, the area that still needs further exploration is students' acceptance of this mode of testing (Zheng & Bender, 2019). This area started to draw scholars' attention recently and represents a major motivation for the current study. In terms of students' perceptions, several studies have been conducted using a variety of quantitative and qualitative measures. For example, Holchlehnert et al. (2011) examined the satisfaction of 98 German medical students with CBT versus PBT. Out of 98 students, 36 were in favor of computer-based exams, while 62 students showed a preference for paper-based exams. The students who preferred computer-based exams appreciated the clear exam format, while those who were not satisfied with the computer format complained about the lack of outlines and written notices, the additional noise from the keyboards and missing several other habits related to paper-based exams. Likewise, Adanir et al. (2020) investigated the perceptions of 370 Turkish and Kyrgyz undergraduates of computer-based exams using a survey and a written interview. The results showed a high acceptance of computer-based testing among Turkish learners. However, the Kyrgyz undergraduates found CBT less reliable and fair than PBT. Similarly, Odo (2019) examined the perception of 300 Nigerian university students of education regarding CBT. The survey results revealed that most respondents had positive views of CBT. However, they acknowledged several relevant challenges, including inadequate supplies of computers at their university and a lack of sufficient orientation to this mode of testing.

Several other studies have reflected scholars' increasing interests in students' perceptions. For example, Zheng and Bender (2019) examined the acceptance of dental students in computer-based exams. Survey and focus group data revealed that most students accepted CBT and were aware of its potential to support learning. The results also found that CBT's perceived ease of use and usefulness significantly influenced students' acceptance. Likewise, Ebimgbo et al. (2021) distributed 151 questionnaires and conducted in-depth interviews with 12 Nigerian university students. The results showed tests helped reduce stress and some examination malpractices. The results also showed that the course of study and adequate knowledge of computers greatly influenced students' perception. Several challenges, such as power and software failure and insufficient test time similarly influenced the students' perceptions.

Despite the relatively large number of studies examining students' perception of CBT, much fewer studies addressed the students' achievements emotions. One of these rare studies was conducted by Harley et al. (2020), who investigated the emotions of 74 university students during an authentic course-based assessment in a CBT environment. The results showed that students reported lower negative emotions in computer-based tests than in their typical paper-based tests. The results also showed that female students reported higher retrospective negative emotions than male students. Additionally, female students reported lower anxiety in computer-based than paper-based environments. Similarly, Riegel and Evans (2021) compared the achievement emotions of 91 undergraduate students when taking an online quiz versus a paper-based quiz. Data were collected using an adaptation of the Achievement Emotions Questionnaire (Pekrun et al., 2005). The results revealed higher levels of positive emotions and lower levels of negative emotions in online quizzes. Another relevant study was conducted by Daniels and Gierl (2017) regarding the impact of CBT and immediate score reporting on students' achievement emotions. The findings showed students endorsed more positive than negative emotions at the end of computer-based exams. The findings also showed that exam scores presented immediately positively affected the feelings of relief, pride, and hope, while they significantly negatively affected feelings of anxiety and shame.

Considering the paucity of research on achievement emotions in the comparison of computer-based versus-paper based exams, the current study is designed to address this gap in the literature

by comparing the emotions of Arab undergraduates that are enrolled in a private Saudi university in computer-based versus paper-based exams. In addition, the study aims to reveal how well-accepted CBT is in this context of higher education and how it affects students' emotions and well-being.

Research Questions

The current study addresses these two research questions:

1. Are students' emotions different during paper-based versus computer-based exams?
2. What factors influence students' emotions in paper-based versus computer-based exams?

METHODOLOGY

Participants

A total of 144 female Saudi undergraduate students participated in the study. Their ages ranged between 18 and 24. They studied at four colleges: the College of Computer and Information Sciences, the College of Business Administration, the College of Law, and the College of Architecture and Design. They were students in the first and second years of university education and had all experienced paper-based exams and exams in computer-based environments. As explained earlier, computer-based exams here are not online exams. They are rather exams that are conducted in computer labs with the use of computers and/or the learning management system (e.g., Moodle). That is, the students had their exams at the university campus. The students were enrolled in a Saudi private university where English is the medium of instruction. In this university, students join their majors only after attaining 5.5 on IELTS or equivalents on other tests. Hence, we administered the study instruments in English because the students' proficiency level would allow them to understand the instruments' sentences and express their perceptions freely. All the students participated voluntarily in the study and submitted their consent forms as part of the emotions questionnaire. Tables 1 and 2 below show the demographics of the students who took part in the survey and in the written interview.

Table 1.
Surveyed students' demographics

Age Group		
18 -20 Years old	70.5%	
21-23 Years old	29.5%	
School Year		
Freshmen	53%	
Sophomore	28.5%	
Junior	8%	
Senior	10.5%	
College		
Computer & Information Sciences	48%	
Business Administration	29.5%	
Architecture & Design	8.5%	
Law	5%	
Humanities & Sciences	9%	

Table 2.
Interviewed students' demographics

Age Group	
18 -20 Years old	78.5%
21-23 Years old	21.5%
College	
Computer & Information Sciences	87%
Business Administration	13%

INSTRUMENTS

The study employed two instruments: the third part of the Achievement Emotions Questionnaire (Pekrun et al., 2005), which is concerned with "test-related emotions scales," and a written interview. Further details about these instruments are provided in the following sections.

The Achievement Emotions Questionnaire

The achievement emotions questionnaire (AEQ) is based on the control-value theory of emotions (Pekrun, 2006). The questionnaire aims to assess the emotions of university students in several academic situations, which are categorized under "attending class," "studying" and "taking tests." The questionnaire provides around 80 statements under each category to examine the students' emotions at three points in time, namely, before, during, and after the primary category. In our case, the statements aimed to assess students' emotions before, during, and after having paper-based versus computer-based exams. The students were asked to rate their agreement with these statements on a 5-point Likert scale ranging from 1 strongly disagree to 5 strongly agree. The statements targeted eight emotions: enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom. We must note that the students completed the surveys right after taking their mid-term exams, including paper-based and computer-based exams.

To meet the purpose of our study, the questionnaire was adapted to allow the comparison of the modes of testing. Each statement was written once with computer-based exams and the other with paper-based exams as illustrated in this example:

After the paper-based exam, I feel ten feet taller because I'm so proud.
After the computer-based exam, I feel ten feet taller because I'm so proud.

To obviate any potential effect for the order of items, the AEQ was administered in two counterbalanced versions. While half the participants read about "paper-based exams" first, the other half read the statement about "computer-based exams" first.

We used the AEQ to assess students' achievement emotions for two reasons. First, the questionnaire has been widely used and validated (e.g., (Frenzel, et al., 2007; Peixotoet al., 2015; Pekrun et al., 2009; Raker et al., 2019), which adds to the credibility of our results. Second, the questionnaire allows students to self-report several significant emotions related to various academic situations students regularly experience at university.

The Written Interview

Besides the AEQ, we used a written interview to provide an in-depth understanding of students' emotions and to clarify their responses to the AEQ. In the written interview, which was administered in a google form, the students were asked 16 questions, two per emotion as follows:

Emotion: enjoyment
What do you enjoy in paper-based exams?
What do you enjoy in computer-based exams?

Again, to obviate any potential effect of the order of the items, the questions were counterbalanced. Half the participants saw the questions about "paper-based exams" first whereas the other half read the questions about "computer-based exams" first.

The students' responses were downloaded and added to an excel sheet and were thematically coded following Creswell's (2013) approach to analyze qualitative data. The first researcher organized the material and prepared the data for analysis. Then, the two researchers analyzed the data independently. This involved looking thoroughly at the data to understand the information and reflect on its overall meaning. This was followed by organizing the collected data in categories and labelling these categories with appropriate terms. Then, the terms were inserted into an excel sheet. Every achievement emotion was assigned a separate tab in the excel file and the categories that emerged were added to each tab along with the number of students that mentioned this category. For example, six students mentioned that they enjoyed computer-based exams due to the convenience of editing, six students stated that they felt relieved with computer-based exams because they avoided problematic issues with handwriting and three students mentioned they felt hopeful with computer-based exams because they could easily avoid spelling errors.

The two researchers completed the coding of the written interview data independently. Then, the codes were compared across the two excel sheets. Since the agreement level was above 90%, the variance in results was discussed between the two researchers, and the agreed-on results are reported here. The variance was mainly related to some categories that could be merged (e.g., "getting high grades" and "passing exams with high scores").

Procedure

The AEQ was shared with the participants through a Google form in weeks 5, 6 and 7 of the semester which consists of 15 weeks. The Google form was shared with the students via the university email. At the end of the Google form, the participants were requested to share their email addresses if they were willing to complete a follow-up written interview. The students who volunteered to participate in the interview (n=44) were contacted in week 9 and were requested to complete the written interviews in another Google form. The students completed a consent form before completing the questionnaires/interviews.

RESULTS

Multiple analyses, including descriptive statistics, paired samples t-tests, and qualitative assessment, were undertaken on the data to provide answers to the proposed research questions. The answers to the research questions are detailed below.

RQ1: Are there differences in students' achievement emotions in paper-based exams versus computer-based exams?

The researchers applied descriptive statistics and paired samples t-test analyses to answer the first research question. The test-related emotion questionnaire consists of eight categories: enjoyment, hope, pride, relief, anger, anxiety, shame, and hopelessness. Analyzing the data for each category, researchers determined how students feel about PBT versus CBT and if there is a difference between the two modes of testing.

Test-Related Enjoyment

The results of t-samples test in Table 3 show that the following statements were statistically significant in favor of CBT:

I look forward to the exam.
I enjoy taking the exam.
I look forward to demonstrating my knowledge.
I'm motivated to do more than is necessary.
This result indicates that CBT is more enjoyable for students to some extent.

Test-Related Hope

As shown in Table 4, five statements led to statistically significant differences in achievement emotions between the two testing modes as follows:

I am optimistic that everything will work out fine.
I have great hope that my abilities will be sufficient.
I'm quite confident that my preparation is sufficient.
I think about my exam optimistically.
I start studying for the exam with great hope and anticipation.

Table 3.
Descriptive statistics of test enjoyment in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
1	156	I look forward to the exam	B	3.76	1.18	2.89	1.38	4.786*	<0.001*
26	181	I enjoy taking the exam	D	3.50	1.28	2.96	1.31	3.340*	0.001*
18	173	I look forward to demonstrating my knowledge	B	3.50	1.06	3.28	1.10	2.027*	0.045*
45	200	I am happy that I can cope with the test	D	3.60	1.12	3.43	1.15	1.483	0.140
49	204	For me the test is a challenge that is enjoyable.	D	3.27	1.20	3.16	1.16	0.885	0.378
8	163	Because I enjoy preparing for the test, I'm motivated to do more than is necessary.	B	3.41	1.14	2.91	1.23	3.487*	0.001*
22	177	Because I look forward to being successful, I study hard.	B	3.93	1.05	3.85	1.17	0.808	0.421
14	169	Before taking the exam, I sense a feeling of eagerness	B	3.20	1.15	3.10	1.18	0.807	0.421
58	213	My heart beats faster with joy	A	3.10	1.15	3.06	1.16	0.459	0.647
75	230	I glow all over	A	3.27	1.07	3.10	1.17	1.639	0.093

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

Table 4.
Descriptive statistics of test hope in computer-based exam vs. paper-based exams

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
11	166	I am optimistic that everything will work out fine.	B	3.52	1.09	3.20	1.15	2.511*	0.013*
38	193	I am very confident.	D	3.43	1.12	3.22	1.13	1.783	0.077
16	171	I have great hope that my abilities will be sufficient.	B	3.70	0.99	3.38	1.16	2.535*	0.012*
20	175	I'm quite confident that my preparation is sufficient.	B	3.60	1.03	3.33	1.14	2.305*	0.023*
21	176	I think about my exam optimistically.	B	3.58	1.02	3.22	1.20	2.811*	0.006*
3	158	I start studying for the exam with great hope and anticipation	B	3.82	1.01	3.17	1.24	4.909*	<0.001*
25	180	My confidence motivates me to prepare well.	B	3.77	1.01	3.58	1.12	1.831	0.069
28	183	Hoping for success, I'm motivated to invest a lot of effort.	D	3.69	1.13	3.57	1.17	0.952	0.343

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

The results showed these statements are statistically significant in favor of computer-based exams, which reveals that students feel more hopeful with this testing mode.

Test-Related Pride

As shown in Table 5, the T-samples test reveals a statistically significant difference in favor of CBT regarding the following statement:

I'm so proud of my preparation that I want to start the exam now.
This result indicates that computer-based testing may increase students' feeling of pride.

Test-Related Relief

Table 6 shows that no statistical difference emerged regarding any statements related to the emotion of relief. It thus seems that students experience a similar level of relief in the two modes of testing.

Test-Related Anger

In relation to anger, Table 7 shows that the following statements show statistically significant differences in favor of paper-based tests over computer-based tests:

I get angry about the amount of material I need to know.
I get so angry, I start feeling hot and flushed.

Table 5.
Descriptive statistics of test pride in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
69	224	I am very satisfied with myself.	A	3.50	0.98	3.34	1.08	1.413	0.160
77	232	I am proud of myself.	A	3.63	1.05	3.48	1.20	1.351	0.179
32	187	I think that I can be proud of my knowledge.	D	3.62	1.01	3.57	1.15	0.422	0.673
60	215	To think about my success makes me feel proud.	D	3.63	1.07	3.59	1.13	0.324	0.747
57	212	I'm proud of how well I mastered the exam.	D	3.61	1.05	3.45	1.12	1.353	0.178
5	160	I'm so proud of my preparation that I want to start the exam now.	B	3.43	1.26	3.06	1.27	2.741*	0.007*
41	196	Pride in my knowledge fuels my efforts in doing the test.	D	3.42	1.06	3.42	1.07	0.000	1.000
54	209	When I get the test results back, my heart beats with pride.	A	3.43	1.11	3.56	1.14	1.158	0.249
65	220	After the exam I feel ten feet taller because I'm so proud.	A	3.24	1.11	3.11	1.18	1.194	0.235
72	227	I walk out of the exam with the look of a winner on my face.	A	3.43	1.08	3.24	1.13	1.873	0.063

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

Table 6.
Descriptive statistics of test relief in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
66	221	I feel relief.	A	3.63	1.05	3.53	1.18	0.935	0.351
73	228	I feel freed.	A	3.50	1.06	3.60	1.10	1.122	0.264
63	218	I feel very relieved.	A	3.62	1.05	3.63	1.16	0.118	0.906
55	210	The tension in my stomach is dissipated.	A	3.41	1.15	3.52	1.10	1.080	0.282
61	216	I finally can breathe easy again.	A	3.42	1.10	3.46	1.17	0.405	0.686
70	225	I can finally laugh again.	A	3.57	1.07	3.40	1.13	1.966	0.051

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

Table 7.
Descriptive statistics of test anger in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
31	186	I get angry.	D	2.97	1.36	3.08	1.36	0.744	0.458
59	214	I am fairly annoyed.	A	3.06	1.22	3.13	1.22	0.580	0.563
4	159	I get angry over time pressures which don't leave enough time to prepare.	B	3.43	1.28	3.62	1.22	1.477	0.142
12	167	I get angry about the amount of material I need to know.	B	3.37	1.18	3.68	1.16	2.839*	0.005*
39	194	I think the questions are unfair.	D	3.10	1.27	3.15	1.19	0.429	0.669
53	208	I get angry about the teacher's grading standards.	A	3.15	1.28	3.15	1.19	0.000	1.000
64	219	I wish I could tell the teacher off.	A	2.86	1.20	3.02	1.25	1.816	0.071
71	226	I wish I could freely express my anger.	A	3.06	1.23	3.17	1.24	1.207	0.229
68	223	My anger makes the blood rush to my head.	A	2.76	1.31	2.87	1.29	1.065	0.289
76	231	I get so angry, I start feeling hot and flushed.	A	2.68	1.26	2.92	1.33	2.328*	0.021*

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

Test-Related Anxiety

Table 8 relates to the second negative emotion to be examined, anxiety. Eight statements were rated significantly higher for paper-based tests than computer-based tests as follows:

Before the exam, I feel nervous and uneasy.
I am very nervous.
I worry whether I have studied enough.
I worry whether the test will be too difficult.
I get so nervous I wish I could just skip the exam.
I am so anxious that I'd rather be anywhere else.
I feel sick to my stomach.
My hands get shaky.

Test-Related Shame

As for the negative emotion of shame, Table 9 shows no statistically significant differences between the two modes of testing.

Test-Related Hopelessness

As for the eighth and last emotion examined in the survey, which is hopelessness, Table 10 shows that paper-based exams showed a significantly higher level of hopelessness in relation to the following three statements:

Table 8.
Descriptive statistics of test anxiety in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
15	170	Before the exam I feel nervous and uneasy.	B	3.43	1.20	3.83	1.10	3.288*	0.001*
33	188	I am very nervous.	D	3.36	1.17	3.63	1.14	2.321*	0.022*
42	197	I feel panicky when writing the exam.	D	3.09	1.24	3.31	1.22	1.797	0.074
2	157	I worry whether I have studied enough.	B	3.35	1.22	3.63	1.17	1.986*	0.049*
24	179	I worry whether the test will be too difficult.	B	3.52	1.19	3.80	1.10	2.314*	0.022*
27	182	I worry whether I will pass the exam.	D	3.34	1.18	3.52	1.24	1.580	0.116
19	174	I get so nervous I wish I could just skip the exam.	B	2.90	1.32	3.29	1.42	2.898*	0.004*
37	192	I get so nervous I can't wait for the exam to be over.	D	3.24	1.28	3.39	1.31	1.444	0.151
46	201	I am so anxious that I'd rather be anywhere else.	D	3.03	1.25	3.31	1.30	2.362*	0.020*
10	165	I feel sick to my stomach.	B	3.08	1.39	3.59	1.24	3.721*	<0.001*
29	184	At the beginning of the test, my heart starts pounding.	B	3.46	1.17	3.63	1.17	1.354	0.178
35	190	My hands get shaky.	D	2.84	1.40	3.36	1.31	4.001*	<0.001*

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

I feel so resigned about the exam that I can't start doing anything.
I'd rather not write the test because I have lost all hope.
My hopelessness robs me of all my energy.

Factors Influencing Students' Achievement Emotions When Comparing Exam Modes

We answered the second research question, "What factors influence students' achievement emotions in computer-based exams versus paper-based exams?" by analyzing the data collected from the written interview questions. In their responses to the interview questions, some students reported positive emotions towards paper-based exams because they did not have to worry about technical issues, such as a computer logging out unexpectedly or a slow internet connection. Some students also preferred PBT to CBT because the former allowed them to explain their responses and convey their ideas more clearly. Some justified their positive emotions toward paper-based testing with the ability to scribble on the sides of the paper to create mind-maps or organize their ideas, which assisted them in recalling information and drafting their answers.

As for their negative emotions, some students expressed anxiety and anger during paper-based tests because they had to write lengthy answers, which left them exhausted. Time management was

Table 9.
Descriptive statistics of test shame in computer-based exams vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
44	199	I feel humiliated.	D	2.69	1.42	2.85	1.39	1.217	0.226
56	211	I feel ashamed.	A	2.76	1.29	2.84	1.29	0.716	0.475
7	162	I can't even think about how embarrassing it would be to fail the exam.	B	3.45	1.33	3.27	1.35	1.554	0.122
36	191	I am ashamed of my poor preparation.	D	2.85	1.36	2.85	1.35	0.000	1.000
52	207	I get embarrassed because I can't answer the questions correctly.	D	2.78	1.32	2.91	1.30	1.104	0.271
62	217	My marks embarrass me.	A	2.78	1.28	2.81	1.31	0.311	0.756
48	203	I get so embarrassed I want to run and hide.	D	2.56	1.33	2.73	1.41	1.833	0.069
67	222	When I get a bad mark I would prefer not to face my teacher again.	A	2.98	1.25	3.01	1.19	0.302	0.763
51	206	Because I am ashamed my pulse races.	D	2.59	1.31	2.73	1.34	1.331	0.185
74	229	When others find out about my poor marks I start to blush.	A	3.03	1.29	3.08	1.35	0.550	0.583

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

another factor that caused students anxiety in paper-based exams and made them feel hopeless. Student participants seemed to be concerned with their handwriting as well. While some of them explained they felt anxious that their handwriting might not be legible to their teachers, causing them to lose points, others noted they felt embarrassed and ashamed by their poor handwriting. In paper-based exams, students also struggled with spelling, which made them feel ashamed. Several students complained about the restricted space on the exam paper for writing lengthy responses. They also appeared angry about creating a mess when editing or changing an answer on their paper. In addition, a few students voiced their concern over teachers' assessment errors on paper-based exams.

The following excerpts are selected participants' responses to the written interview questions.

Enjoyment

Question: What do you enjoy in paper-based exams?
Answer: "I am able to brainstorm and organize my ideas on the paper quickly and effectively, it helps me get my thoughts organized and helps me be more efficient when completing the exam"
Question: What do you enjoy in computer-based exams?
Answer: Most computer-based exams are multiple choice so that makes it easier than usual.

Table 10.
Descriptive statistics of test hopelessness in computer-based exam vs. paper-based exams (n = 143)

No.	Items	Statement	Condition	Computer-Based Exams		Paper-Based Exams		t	p
				Mean	*SD*	*Mean*	*SD*		
23	178	I get depressed because I feel I don't have much hope for the exam.	B	2.87	1.27	3.01	1.31	0.985	0.326
50	205	I feel hopeless.	D	2.65	1.31	2.71	1.28	0.532	0.596
9	164	I have lost all hope that I have the ability to do well on the exam.	B	2.65	1.27	2.77	1.29	0.952	0.343
47	202	I have given up believing that I can answer the questions correctly.	D	2.79	1.30	2.93	1.34	1.252	0.212
30	185	I start to think that no matter how hard I try I won't succeed on the test.	D	2.74	1.34	2.92	1.37	1.609	0.110
40	195	I start to realize that the questions are much too difficult for me.	D	3.03	1.27	3.17	1.25	0.976	0.331
13	168	I feel so resigned about the exam that I can't start doing anything.	B	2.90	1.12	3.15	1.21	2.083*	0.039*
17	172	I'd rather not write the test because I have lost all hope.	B	2.44	1.28	2.73	1.40	2.238*	0.027*
34	189	I feel like giving up.	D	2.77	1.26	2.82	1.32	0.412	0.681
6	161	My hopelessness robs me of all my energy.	B	2.92	1.19	3.27	1.20	3.027*	0.003*
43	198	I feel so resigned that I have no energy.		2.92	1.24	3.10	1.22	1.402	0.163

Note. SD: Standard deviation t: Paired t-test
p: p value for comparing between computer-based exams and paper-based exams
*: Statistically significant at $p \leq 0.05$
B = before taking the exam; D = during taking the exam; A = after taking the exam

Hope

Question: What makes you feel hopeful in paper-based exam?
Answer: That the instructor can give me marks for the steps of the question even if I didn't write the right final answer.
Question: What makes you feel hopeful in computer-based exams?
Answer: Calculating the grades correctly

Pride

Question: What makes you feel proud in paper-based exams?
Answer: When I get a high grade because I usually struggle with paper based exams.
Question: What makes you feel proud in computer-based exams?
Answer: Submitting my exam before the time ends.

Relief

Question: What makes you feel relieved in paper-based exams?
Answer: Not afraid to lose your work.
Question: What makes you feel relieved in computer-based exams?
Answer: That my handwriting will be clear.

Anger

Question: What makes you feel angry in paper-based exams?
Answer: That it is time consuming.
Question: What makes you feel angry in computer-based exams?
Answer: The technical problems

Anxiety

Question: What makes you feel anxious in paper-based exams?
Answer: Lack of time.
Question: What makes you feel anxious in computer-based exams?
Answer: If the devices are faulty or not working efficiently, it makes me anxious.

Shame

Question: What makes you feel ashamed in paper-based exams?
Answer: Maybe bad handwriting when I have to write quickly
Question: What makes you feel ashamed in computer-based exams?
Answer: I would feel ashamed if I did not know how to navigate through the exam and use several applications.

Hopeless

Question: What makes you feel hopeless in paper-based exams?
Answer: When I have to write a lot of things and don't have enough time to think correctly.
Question: What makes you feel hopeless in computer-based exams?
Answer: When the internet isn't working.

As for students' positive feelings during computer-based exams, on the one hand, several students reported that they have sufficient time to complete the exam because typing is easier and faster. Another advantage of computer-based examinations for some students is the ability to edit responses effortlessly. Most students also stated that they enjoyed computer-based tests because they are typically less difficult, considering that they consist primarily of multiple-choice questions, making them feel hopeful. Further, a few noted they felt proud of the renovation of educational assessment tools, which is critical in this digitized world. An interesting reason noted by a few students for feeling hopeful and relieved is the possibility of avoiding human error with automated grading. On the other hand, students' negative emotions towards computer-based exams were primarily caused by technical issues. They felt angry at the possibility of encountering technical issues during their exam that would cause them to waste valuable time. Some even reported feeling hopeless when confronted with technical issues throughout the exam. Furthermore, the lack of computer skills was one reason why some students felt ashamed when taking computer-based tests.

DISCUSSION

The current study compared students' achievement emotions in computer-based versus paper-based exams. To this end, we collected data using the test-related part of the AEQ besides a written interview about the eight emotions targeted in the questionnaire. The questionnaire results revealed that students generally developed more positive emotions (i.e., enjoyment, hope, and pride) and fewer negative emotions (i.e., anger, anxiety, and hopelessness) in computer-based versus paper-based exams. Not all the statements in the questionnaire indeed followed this pattern. However, the statements that did

Table 11.
Factors influencing students' emotions in paper-based exams

Emotion	Factors (Number of Participants)
Enjoyment	Ability to express and explain ideas (19)
	None (13)
	No technical issues (10)
	Ability to create mind-maps and draft (organize) answers
Hope	Receiving extra marks for drafting answers (7)
	None (9)
	Explaining answers (5
	Avoiding technical issues (3)
Pride	Nothing (19)
	Completing and submitting exam on time (7)
	Showing students' understanding (4)
	Getting high grades (3)
Relief	Nothing (10)
	Not facing technical issues (5)
	Expressing ideas better (4)
	The ability to scribble on paper and draft answers (2)
Anger	Nothing (8)
	Limited space to provide long answers (5)
	Exhausted from writing long responses (4)
	Limited time to answer long questions (4)
	Poor quality of printing (3)
	Difficulty of editing answers/ causing a mess on paper (3)
Anxiety	Time management (12)
	None (9)
	Lengthy answers (6)
Shame	Nothing (21)
	Legible or poor hand-writing (6)
	Not completing all questions (5)
	Receiving bad/low grades
Hopelessness	Nothing (21)
	Time management (7)
	Difficulty of questions (4)

not follow this pattern did not reveal significant differences from the opposite pattern. Interestingly, hopefulness was the strongest positive emotion in favor of computer-based exams, with five statements reaching statistical significance. As for negative emotions, the strongest was anxiety which was stated in eight statistically significant differences. This result comes in line with recent studies that showed that higher education students tend to prefer CBT over PBT (Adanir et al., 2020; Ebimgbo et al., 2021; Odo, 2019; Riegel & Evans, 2021; Yu & Iwashita, 2021; Zheng & Bender, 2019). The result is also aligned with the study by Harley et al (2020) that showed how achievement emotions are more positive in CBT.

Table 12.
Factors influencing students' emotions in computer-based exams

Emotion	Factors (Number*)
Enjoyment	Efficient time (18)
	Less difficult (17)
	Convenience in editing answers (6)
	Faster writing/typing (6)
	Types of questions (5)
Hope	Easier types of questions (14)
	Clearer (4)
	Auto-grading (4)
	Avoiding spelling errors (3)
	High grades (3)
Pride	None (10)
	Answering all questions and finishing on time (5)
	Educational development on assessment tools (3)
	Submitting early (2)
Relief	Easier questions (7)
	Avoiding hand-writing issues (6)
	Nothing (5)
	Time management (4)
	Auto-grading (3)
Anger	Technical issues (23)
	Nothing (8)
	Auto-correction (1)
	Word limit (1)
Anxiety	Technical issues (17)
	Nothing/None (10)
	Limited time (8)
Shame	Nothing (26)
	Technical issues (4)
	Many mistakes/ low grade (4)
	Poor computer skills (2)
Hopelessness	Nothing (17)
	Technical issues (11)
	Lack of time (2)

The results of the written interviews further confirmed the quantitative findings as both showed stronger positive emotions for CBT over PBT. Overall, students preferred CBT because it was more efficient, allowed sufficient time to answer, relied on typing, allowed editing, and facilitated automatic grading. The only concerns they had regarding CBT were facing some technical issues and possibly losing more grades with wrong answers. As for PBT, which triggered less positive and more negative emotions, the criticism was harsher. The students criticized the lengthy responses, the use of handwriting, the restricted space, the poor quality of printing, the challenge of editing, and the difficulty of managing time effectively. On the plus side, only three main reasons emerged, which

were (1) lack of technical difficulties, (2) the ability to draw graphic organizers and write drafts, and (3) the ability to communicate ideas more clearly.

The results of the current study strongly indicate that we are ready to transition to CBT in higher education to a great extent. Students seem to welcome the use of CBT despite minor reservations. However, before the transition is fully implemented, it is important to accommodate students' worry about facing technical issues. Implementing CBT without having an efficient platform and tools could have dire consequences. Additionally, it might be wise to postpone the implementation of computerized adaptive testing because students expressed concerns they might be losing additional marks in this type of test. Allowing space for writing drafts in different forms in CBT is also recommended. Students seemed to prefer to draw graphic organizers and take notes before answering tests. It is essential to ensure students' readiness to use computers during tests. We can incorporate the needed training in school years before joining university. It is widely acknowledged that a lack of adequate familiarity with computers increases resistance to CBT (Ebimgbo et al. 2021).

It is important to note that the results of the current study need to be considered with some caution. First, the study sample is relatively small, covers only female participants, and belongs to only one private university. Doing further research with a larger and more representative sample that includes all genders is advisable. Second, it is important to examine the achievement emotions of higher education students in different parts of the world. Currently, there is a paucity of research in this area. Third, we recommend incorporating oral interviews and focus groups to learn about students' perceptions since these tools allow ethnography integration, which often yields a more in-depth understanding of the situation. Finally, examining the different CBTs and comparing their effects will be important. Students may be ready to accept having tests in computer-based environments but may not be ready yet for other forms of CBT, including computerized adaptive testing or online testing.

CONCLUSION

The current study was designed to compare the achievement emotions of undergraduate students in paper-based versus computer-based exams. 144 undergraduates completed a validated questionnaire based on the Control-Value Theory of Achievement Emotions, and 44 of the participants completed written interviews about eight basic emotions in relation to both testing modes. The emotions were enjoyment, hope, pride, relief, anger, anxiety, hopelessness, and shame. The results revealed that students had more positive emotions such as enjoyment, hope, and pride, during computer-based. Additionally, computer-based exams triggered less feelings of anger, anxiety, and hopelessness. The interviewees explained these differences based on aspects of computer-based exams, and how they liked that they were faster, they could easily make changes, and they did not need to worry about messy handwriting, helping them edit their work.

Thus, the current study supports the transition to CBT in higher education institutions because the participants generally had more positive and less negative emotions towards CBT than PBT. However, the transition must be implemented cautiously since students had several relevant concerns. First, there is a pressing need to have an adequate platform and tools to ensure the system's efficiency and avoid any technical issues with the tests. Second, it is important to accommodate students' need for space for drafting and note-taking. Third, students' readiness for the tests needs to be addressed. Students who lack adequate familiarity with computers and/or are slow typists should not be penalized. Finally, students must be trained on the type of test they will sit for prior to taking the exams.

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