Factors Affecting the e-Book Adoption amongst Mathematics and Statistics Students at Universities in Libya: A Structural Equation Modelling Approach

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Abstract: This paper investigates the factors affecting the acceptance of e-book amongst Mathematics and Statistics students at universities in Libya. Technology Acceptance Model (TAM) was used and extended by using five factors that may affect the acceptance of e-book among Mathematics and Statistics students. Three of these factors belong to external variables, which are related with infrastructure of universities and the characteristics of e-book such as accessibility, technical support and cost; the other two factors are classified from intrinsic variables which are related with users or potential users such as self-efficacy and social influence. A quantitative evaluation was utilized in this research leveraging subjective methods, such as survey where a distributed sample of 392 Mathematics and Statistics students at universities in Libya. The Statistical Package for the Social Sciences (SPSS) and Structural Equation Modelling (SEM) were used to measure the model and to examine the hypotheses. The research hypotheses were examined by path analysis using the standardised coefficient, probability value and Critical Ratio. Based on the result, perceived usefulness, perceived ease of use and attitude are the strongest factors at all. Moreover, the intrinsic variables were important factors for predicting students' behavioural intention adoption e-book among Mathematics and Statistics students at universities in Libya.

Key words: External variables, internal variables, mathematics, statistics, students, TAM.

1. Introduction

The educational application of computers has evolved from being basic standalone data processing machines in computer labs, to being able to access the internet to where computers are being used in a number of integrated web services that have applications in learning and teaching [1]. The use of ICT in online teaching and learning has quickly grown to become an essential method used in the general delivery of education. According to [2], e-learning can be defined as being the creation of a learning environment using a variety of modern tools afforded by Information Technology (IT). E-learning is found to have a number of different educational and interactive applications that are be able to support a wide variety of different types of applications such as using electronic books (e-book).

E-book is a generic term that refers to the digital representation of printed material delivered through mediums such as personal computer, net book, e-book reader, PDA, smart phone, and iPad [3]. The content of e-book primarily includes books, research, journals, report, and magazines. Most e-books have features that can be provided in an electronic environment, like within-book or within a collection of note taking,

searching, highlighting, bookmarking, and annotating [3]. Lately, most educational institutions are working to transform their learning paradigm from the use of printed materials such as textbooks to the use of electronic sources such as e-books, electronic reports and e-lectures [4], [5]. This technology allows universities to widen their educational territories outside of time and place, and the promotion of traditional learning [5]. Most teachers and modern librarians advocate for the use of e-books for study; citing many of the benefits that are derived from the method of learning [6]. There are however, several challenges to the integration of educational technology into the higher education institutions, especially in developing countries such as Libya, for example technological problems, cost of technology, technology acceptance, technical support, resistance to change, etc. [7]. Therefore, many studies appeared recently to investigate the effect of these factors upon students' acceptance of IT application in higher education, few researchers used the Technology Acceptance Model (TAM) to investigate the effect of extrinsic variables and intrinsic variables toward students' behavioural intention [7]. However, they have been non-existent in the case of e-book. This paper seeks to cover this shortcoming and looking at the impact of external factors in general on Mathematics and Statistics students' behavioural intention. It also investigates which group of variables has a strong impact on the acceptance of e-book (intrinsic or extrinsic variables).

2. Theoretical Background

2.1. Technology Acceptance Model

The Technology Acceptance Model (TAM) was developed by Davis in 1986, which deals more particularly with the calculation of the suitability of an information system [8]. The focus of TAM is on the end users acceptance behaviour of a number of different IT applications. The intention of this model is to forecast the suitability of a tool in order to identify the adaptations which must be brought to the system to make it satisfactory and acceptable to users [9]. Two types of beliefs can use to determine the individual's Behavioural Intention (BI) to adopt a technology, Perceived Ease of Use (PEOU) and Perceived Usefulness [10], [11].

TAM is used in this research for three particular reasons. Firstly, it has a strong base in speculation [12]. Secondly, it could be utilised as a guideline to improve effective IT applications, because the model has become well recognized as a strong, powerful and economical model for predicting user recognition [12]. Finally, in accordance with [13], for the past ten years a research stream supported the strength of TAM in a number of populations, settings and an extensive range of IT applications [5], [7].

2.2. Developed Model

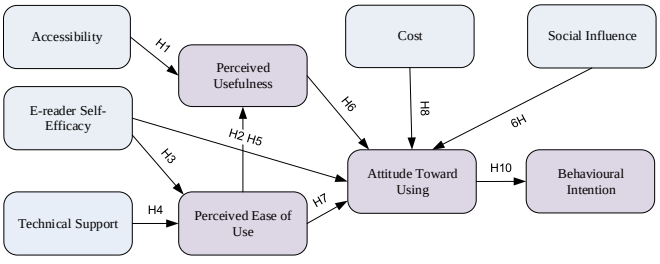

Fig. 1. The initial model.

According to previous research of the acceptance of technology, researchers selected the factors that were be used to determine the acceptance of e-book. Reference [12] believed that the best method to determine the external variables is the review of the literature, because it will provide a theoretical framework that will explain the relations between the variables of the model, and which will lead to the formulation of hypotheses. The selection process underwent two conditions. First, the external factors should address unique context for the e-book. Secondly, the external factors must be having the ability to foresee and

explain the acceptance of e-book. The selected factors in this research came after a thorough study of a number of experimental evidence and previous forecasts derived from the existing literature. (Fig. 1) shows the developed model. The relationships between variables represent the hypotheses of this study that subjected to measurement.

2.2.1. Extrinsic variables

2.2.1.1. Accessibility (AC)

Accessibility is the degree to which e-book is available to as many students and teachers as possible [14]. Also, it can be viewed as "the degree of convenience with which an individual accesses an information system" [15]. The results obtained by [16] confirms that accessibility was one of the most influential factors on PEOU, while the factor was insignificant toward perceived usefulness. However, [17] pointed out that accessibility have a strong impact on PEOU, whereas it is not statistically significant toward PU and BI for the student to use e-learning system in South Korea.

2.2.1.2. Technical support (TS)

Technical support is one of the most significant factors in determining the approval of acceptance of technology for learning [18] where availability of support of internet services have increased an opportunity for easy access to e-texts and digital resources on the web [19]. A good example of this can be seen in study of [18] in Bahrain. They used technical support as independent factor to extend TAM to investigate users' acceptance of e-learning system. The outcomes confirmed that technical support has a significant direct influence upon perceived ease of use and perceived usefulness of students using e-learning system. However, ref [20] tested the impact of technical support on adoption e-learning in Jordan, and it has insignificant impact on PEOU, and it also has a weak indirect effect upon the intention to use an e-learning system. Otherwise, it was significant influence toward PU.

2.2.1.3. Cost(C)

Cost can be defined as the amount of currency to be paid by users in order to purchase an e-book; it also includes the purchase of e-reader devices, such as handheld devices, electronic publications and software used[9]. In this research, cost is being studied as a significant factor that can impact on the adoption of e-book. According to Compeau and Higgins [21], cost played an important factors to the adoption of e-learning in many developed countries. Reference [22] suggested that cost is one of the key factors that have an important influence on the behaviour of users regarding the use of e-book. However, reference [23] investigated users' acceptance of mobile internet in Australia using TAM. The result of this study confirmed that there is no clear impact of cost on the users' attitude and behavioural intention.

2.2.2. Intrinsic variables

2.2.2.1. Self-efficacy (SE)

Reference [24] highlighted that "computer self-efficacy is described as the perception of an individual on his or her ability to make use of computers in the completion of a task". Similarly, self-efficacy of e-reader devices is interpreted by student's self confidence in his/her ability to make use of e-reader software and devices, such as personal computers, tablets and smart phones. Reference [25] found that self-efficacy has a statistically significant effect upon perceived ease of use of e-learning, while it was insignificant toward perceived usefulness of e-learning system. Due to the importance of this factor, we felt that it was necessary to test its effect on the acceptance of e-book.

2.2.2.2. Social influence (SI)

The term social influence or subjective norm was introduced in social psychology research dating back to the mid of the 20th century. According to [26], this term was used to refer to the influence of communication that takes place between individuals, which leads to a change of emotion or mood or view of a person or an individual associated with a particular behaviour [26]. Reference [13] view that public or

subjective norm can significantly influence behaviour intention of individuals to comply with the views presented to them. Furthermore, it was suggested that individuals act or exhibit a particular behaviour despite their non-acceptance of the positive outcome of the behaviour enforced through influence of another person or an individual. The individual behaviour is motivated by the views presented by one or more referents and his or her behaviour is simply to comply with their views.

Several research have documented the impact of social influence on attitudes and behavioural intention [27]. According to [27] and [28], the finding indicated that subjective norms was important impact on students' behavioural intention to use e-learning in developing countries. It deeply influenced on users' behaviour [29]. On other hand, reference [30] posited that social influence was only an indirect effect on behavioural intention adoption e-learning system at the Bahrain university.

3. Research Methodology

3.1. Research Design

Both qualitative and quantitative research methods are used in this research; however this research fundamentally adopted a quantitative survey process. Information from the participants are collected using a self-administered survey which includes close ended types of questions on five-point Likert scale to measure students' level of agreement or disagreement. 63 items aiming are used to gather information and they are divided into the six sections: section (a) Demographics; (b) Current use of e-book; (c) The acceptance of e-book; (d) The factors related with users or potential users; (e) The factors related to the infrastructure of universities; and (f) The factors related with the characteristics of e-book.

3.2. Population and Sample

The research population included Mathematics and Statistics students and teachers at three different public universities in Libya totaling 392 participants who participated in this survey. The three universities are Tripoli University, Al-Jabal Al-Gharbi University and Al- Zawia University and they are all accredited by the Ministry of Higher Education in Libya. The three universities differ geographically where Tripoli University is located at the heart of the capital city Tripoli in the far north, the Al-Jabal Al-Gharbi University is located in the far west and represent the rural community, and Al- Zawia University is located in the north-west, a homogeneous mixture of the two former. These universities are the largest and oldest universities in Libya where they enroll students from all across Libya.

Table 1. Demographic of the Participants

Variable	Category		Percent
	MALE	FEMALE	
Al-Zawia University	97	84	45.6
Tripoli University	69	73	36.2
Al-Jabal Al-Gharbi University	33	35	18.2
Total	199	192	100

The percentage of participants from each university is not important, as long as the sample size required was achieved [31] . The missing data is data as a result of participants leaving some questions without answers [32]. Once data has been sorted, out of 392 participants, there are only three incomplete responses. There are two responses that suffer from the 1% of missing data, whereas the third response failed to answer 60% of the questionnaire. Reference [32] recommends dispensing any respondents who did not answer 50% of the survey questions. Thus, the two incomplete responses are replaced by median [33], and the third response is cancelled (see Table 1).

4. Analysis and Results

In this section, explanations of the data analysis process, measurement of model and development and proposed hypothesis are described. The Statistical Package for the Social Sciences (SPSS) version 21 and Structural Equation Modelling (SEM) version 22 are used to analyse the data and examine the research hypotheses. SEM has been widely used to measure the acceptance of IT by users [34]. In SEM the measurement model includes the statistical relationship among the observed and latent variables [20].

The statistical analyses can be divided to four main steps. Data screening is the first process to make sure the collected data are clean, useful, and valid for testing. In this step, many issues such as missing data, outliers and normality are tested. Second, the Exploratory Factor Analysis (EFA) is used to check the validity of the variables proposed and compare the initial reliability of the scales. It used maximum likelihood with Premix rotation to check whether the observed variables loaded together as intended. Third, the Confirmatory Factor Analysis (CFA) is used to measure the model validity. Goodness of fit and constructs' validity was used to measure variables. The last step is to check the developed model hypotheses through using path analysis.

4.1. Exploratory Factor Analysis

Table 2. The Factors Loading for the Measured Variables

Factors	PU	TS	C	SI	PEOU	BI	SE	AC	AU
PU1	597								
PU2	.735								
PU3	.800								
PU4	.728								
TS2		916							
TS4		.928							
C3			.746						
C1			.882						
C2			.712						
SI3				928					
SI4				.792					
SI1				.632					
SI2				.545					
PEOU3					.860				
PEOU4					.743				
PEOU1					.488				
PEOU2					.518				
BI3						.766			
BI1						.782			
BI4						.736			
SE4							. 828		
SE3							.727		
SE2							.745		
SE1							.599		
AC2								.924	
AC1								.940	
AC3								.924	
AU4									.669
AU5									.666
AU2									.721
AU1									.571
composite Reliability (α)	0.82	0.93	0.85	0.83	0.80	0.80	0.81	0.95	0.77

In this research, nine factors are tested for validity and reliability. Data at this stage is analysed using SPSS. The results indicate that after moving some of the items, the Cronbach's alpha for each factor is higher than the normally accepted standard level of 0.7 as proposed by [35]. Therefore, two types of construct validities are examined to assess Construct Validity [36]. Convergent validity of a variable implies that the variables around a single factor are greatly correlated [36]. The first assessment of Construct Validity is to check for convergent validity of a scale. The eight constructs used in this research show convergent validity, high factors loadings among factors of similar element. The loading recorded by the variables are also above the proposed standard of 0.30 for a sample size of 350 or more [37] (see Table 2). The Discriminant Validity measures how distinct or uncorrelated a variable is to another. The Discriminant Validity can be determined by checking whether cross-correlations between the indicators measuring the different factors are not excessively high. Thus, the result confirms that the correlation coefficients are less than 0.567 which indicate that no correlations above 0.700 as the correlation matrix recommended by[32], and has no cross-loading problem.

4.2. Measurement and Development Model

The developed model has been examined by using goodness of fit and constructs validity and reliability.

As indicated earlier discriminate validity help to check the degree in which a variable is very distinctive from other variables[32]. Dividing the total of all squared standardized factors loading on the number of measured variables gives the average variance extracted value (AVE). To examine the measured variables discriminate validity, the average variance extracted (AVE) values will be compared to the maximum square variance (MSV). Average variance extracted value must be 0.5 or more to confirm convergent validity. Also, the average variance extracted has to be higher than the maximum square variance to ensure discriminate validity [38]-[40]. However, reference [41] proposes this value to be 0.7 or higher for good reliability. Based on the results obtained, the convergent validity for each variable in the developed model was achieved. Moreover, the outcomes confirmed that all of the variables in the developed model have been achieved a good reliability.

4.3. Test of the Structural Equation Model (SEM)

Five measures have been chosen to evaluate the validity of the developed model, Chi Square Test, Goodness of fit (GFI) and Adjusted Goodness of Fit Index (AGFI), Root mean square error of approximation (RMSEA), Standardized root mean residual (SRMR), Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI). All of the results obtained were satisfactory and can be used to assess the results for the structural model, and they were within the recommended value, except for GFI which was very close to the recommended value suggesting that the research model provided a good fit to the data [29] (see Table 3).

The research hypotheses were examined by using Path analysis via standardised path coefficients, significance of the estimated coefficients (Critical ratio) and probability value (p-value). To accept the hypothesis, the probability value must be $(-0.05 \leq p - value \leq 0.05)$. The critical ratio (t-values) was obtained by dividing values of path by their standard errors [18]. It has been used for testing whether the path values are significantly different from zero [18]. The path values are significantly different from zero if the critical ratio is more than +1.96, or less than -1.96 (two tails), and therefore the significance level is $(-0.05 \leq p - value \leq 0.05)$ [18].

Based on the result of causal relationship with estimated path coefficients and Critical Raito (t-test), the outcomes showed that all of the acceptance of e-book hypotheses (TAM constrains) were accepted with $(-0.05 \leq p - value \leq 0.05, -1.96 \geq t \geq +1.96)$(see Table 4 and Fig. 2). PEOU (H7) had a positive impact on attitude toward using e-book and also had a direct positive impact on PU of e-book (H5) with $(\beta = 0.45, p - value \leq 0.001, t = 4.28)$ and $(\beta = 0.60, p - value \leq 0.001, t = 6.27)$ respectively. Moreover, PU

(H6) had a direct positive impact on attitude toward using e-book with ($\beta = 0.45, p - value \leq 0.001, t = 5.75$). Finally, attitude toward using e-book (H10) had a strongest determinate on BI to adopt e-book ($\beta = 0.53\text{p}, p - \text{value} \leq 0.001, t = 7.65$). Second, the hypotheses that related with intrinsic variables hypotheses were accepted. SI (H9) and e-reader self-efficacy (H2, H3) were accepted. SI was hypothesized to have a direct positive impact on attitude ($\beta = 0.20, p - value \leq 0.001$). Moreover, e-reader self-efficacy had a direct impact on PU of e-book (H2) and attitude (H3) with ($\beta = 0.24, \text{p-value} \leq 0.001, \text{t} = 4.84$) and ($\beta = 0.20, \text{p-value} \leq 0.001, \text{t} = 3.03$). However, two hypotheses related with extrinsic variables were rejected. Accessibility (H1) and cost (H8) were had $p -$ value higher than the recommended value ($-0.05 \leq p - value \leq 0.05$). Whereas, the results showed that the hypothesis (H4) that tested the impact of technical support on perceived ease of use of e-book was accepted ($\beta = 0.07, \text{p-value} \leq 0.001, \text{t} = 3.26$).

Table 3. The Research Model Fit Outcomes

Model fit indices	x^2/df	GFI	AGFI	CFI	TLI	SRMR	RMSEA
Recommended value by [41], [42]	<3	>0.9	>0.8	>0.9	>0.8	<0.08	<0.08
Obtained	1.7	0.88	0.85	0.95	0.95	0.05	0.04

Table 4. Results of Path Tests

Hypothesis	Path			C.R	*p*-value	Hypothesis Result
H1	AC	→	PU	1.00	0.32	Not Sig.
H2	SE	→	AU	3.03	***	Sig
H3	SE	→	PEOU	4.84	***	Sig
H4	TS	→	PEOU	3.26	***	Sig
H5	PEOU	→	PU	6.27	***	Sig
H7	PEOU	→	AU	4.34	***	Sig
H6	PU	→	AU	5.13	***	Sig
H8	C	→	AU	0.05	0.96	Not Sig.
H9	SI	→	AU	3.14	***	Sig
H10	AU	→	BI	7.01	***	Sig

Notes: (***=*p*-value, 0.001, **=*p*-value, 0.01;*=*p*-value, 0.05)

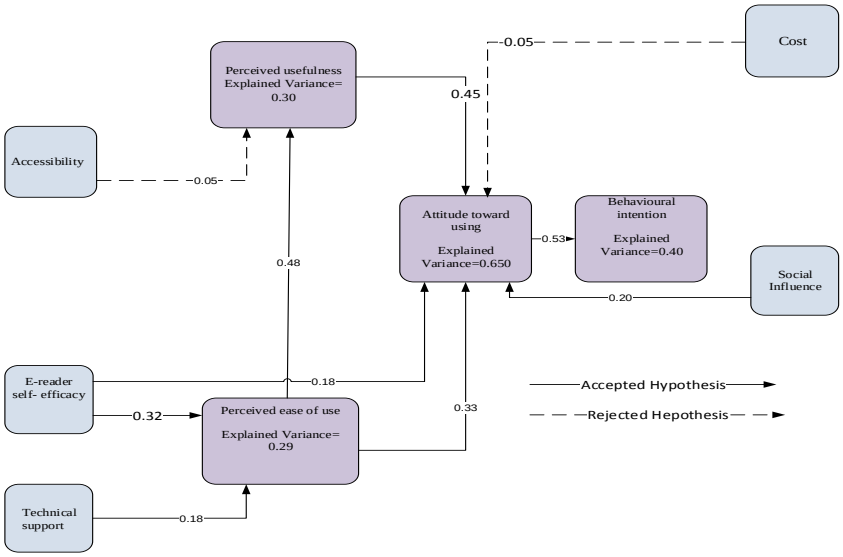

Fig. 2. The developed model outcomes.

4.4. Total Effect Analysis and the Explanation Power of Model

The direct effects are that any change in the results of the variable x directly affects the outcome of the variable y ($x \rightarrow y$).Whereas indirect impact occurs when there is an intermediary factor, where variable x effects on the variable y is through variable z ($x \rightarrow z \rightarrow y$).

The total effect represents the summation of the direct and indirect effects, as well as it is the correlation among the two variables. According to [43], we can classify the total effects into three major parts:

- The greater effect is more than 0.50 that has a strong strength, such as (AU →BI).
- Any total affects located between 0.2 and 0.5 is moderate strength, such most of these results that shown in bold.
- The total effects that less than 0.20 is weak strength.

The coefficient of determination R^2 was important to underline the explanatory power of PEOU, PU, attitude AU and BI, with R^2= 29%, 30%, 60%, 40%, respectively (see Table 5).

Table 5. Standardized Causal Effect

Factor	Determinant	Direct Effect	Indirect Effect	Total Effect
PU (R^2 = 0.30)	PEOU	0.48	-	0.48
	AC	0.05	-	0.05
	SE	-	0.16	0.16
	TS	-	0.09	0.09
POUE (R^2 = 0.29)	SE	0.32	-	0.32
	TS	-0.18	-	-0.18
AU (R^2 = 0.60)	PEOU	0.33	0.20	0. 53
	PU	0.45	-	0.45
	C	-0.05	-	-0.05
	SE	0.18	0.17	0.35
	SI	0.20	-	0.20
	TS	-	0.10	0.03
	AC	-	0.02	0.02
BI (R^2 = 0.40)	AU	0.53	-	0.53
	SE	-	0.20	0.20
	AC	-	0.01	0.01
	SI	-	0.11	0.11
	TS	-	0.05	0.05
	PEOU	-	0.28	0.28
	PU	-	0.22	0.22

5. Conclusion and Discussion

Based on these results, intrinsic variables were more significant than extrinsic variables. However, the outcomes showed that intrinsic variables are better predictors of students' acceptance of e-book after TAM constricts. The research findings regarding the impact of the PU factor upon the attitude was strongly direct effect. PU has also indirect influence on behavioural intention via attitude. Numerous studies have confirmed that perceived ease of use has a strong influence on attitude toward and behavioural intention [31], [44], [45]. Students who benefit from e-book dramatically will have positive attitude toward using e-book. The importance of the PEOU factor was through its direct and indirect effects via PU on students' attitude toward using e-book. This result makes sense for participants who were not from the information technology area; and have poor knowledge about the use of e-books. It also has indirect influence on

students' behavioural intention. This is because most of the participants choose to use e-book if it is easy to handle. The finding were also consistent with reference [46]. Moreover, students' attitude seems to have a strong influence in students' behavioural intention. The positive feelings of the students towards the use of the e-book will be positively reflected on their behaviour.

The outcomes of intrinsic variables showed that self-efficacy is a significant consideration in people's decision to use e-book. The outcomes of our research also showed that, self-efficacy has positive effect on students' attitude toward using e-book. Self-efficacy has a strong positive indirect effect on the behavioural intention to use e-book through PEOU and AU. This is because the user's confidence in their abilities to use electronic reading devices associated with their judgment on the ease of use of these devices. Similarly, [20], [25], and [47] confirmed that self-efficacy has a positive direct effect on PEOU and indirect effect on BI. SI has shown critical towards Mathematics and Statistics students' acceptance. Several of researches have documented the impact of social influence on attitudes and behaviour [48], [49]. This is because the nature of the Libyan students in general influenced by the surrounding community and complies with the terms of reference of the president, parents and teachers, or peer such as friends or colleagues even if one does not favour this behaviour.

Accessibility variable was one of the extrinsic variables that evaluated in this research, where did not find any direct relation with perceived usefulness. This result comes in line with [16], where confirmed that accessibility was not significant towards perceived usefulness. In contrast, the factor has a strongly affecting on students' acceptance in Saudi Arabia [7]. Based on the research results that obtained by [15] in some developing countries, accessibility significance towards perceived usefulness, attitude and behavioural intention was inconsistent, because this depend on the level of availability of e-book in these countries. Moreover, technical support has positive impact on PEOU. The result comes in line with [18] was found to has direct influence on PEOU. The availability of the necessary technical support, whether in terms of providing Internet services or the provision of the necessary computers equipment to increase the rate of using e-book among students. These results were contradictory with research results conducted by [50] to identify the students' perception to use e-learning in Libya. Ref [50] confirmed that technological support factor is the most important obstacles that hinder the adoption of e-learning in Libya. In fact, all the interviews also confirmed the weakness of the technological support within the universities, particularly with regard to the internet services. On the other hand, the researcher believes Al- Zawia University is the best in terms of services offered to students in the field of technology, so the results obtained may be affected by the participants' answers; particularly they represent the largest turnout in the questionnaire. There is no strong evidence in this research that the cost influences students' attitudes to use e-book. In a comparative study conducted by [51], cost was rated as a crucial factor; that has impact on using e-learning in developed countries, whereas the cost was considered less important in developing countries , such as Kuwait.

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