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AN EXAMINATION OF THE PERCEIVED EFFECTIVENESS OF COMPUTEE SIMULATION IN A CLASSROOM SETTING AS AFFECTED BY GAME, ENVIRONMENTAL AND RESPONDENT CHARACTERISTICS

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ABSTRACT

This paper is an empirical study to determine if the perceptions of students involved in a classroom computer based simulation game are affected by other than internal reactions. The purpose of the study is to generate some data which can be used by those interested in the simulation approach for whatever purposes they wish. In this study eleven tables representing those statistically significant responses of 131 undergraduate students involved in a classroom computer based simulation exercise to a number of statements relating to simulation techniques are tabulated with several demographic and game characteristics and then briefly analyzed. The authors sincerely hope this preliminary investigation will encourage, perhaps even professionally compel, others to conduct similar research.

INTRODUCTION

The Primary goal of schools of business administration is to develop executives capable of functioning effectively and efficiently within an organization. To achieve this objective, the basic tools of analysis and decision making are imparted to the student through various courses covering the traditional business disciplines. In recent years some different pedagogical tools such as the case method and simulations have been increasingly utilized to achieve the goal of improved decision making skills. While the case approach has certain merits, its principal shortcoming is that it lacks a dynamic environment in which the students can test their decisions.

An examination of recent literature in the area of current educational techniques used in the production of the future leaders of the organizational world indicates a steadily increasing degree of interest in simulation and computer gaming. The techniques surrounding simulation, it is generally agreed, involve an extension of statistical theory, logic and mathematics into the domain of choice and decision. The result is a unique educational tool designed to increase a student's decision making skill. Management decision making simulations are considered to be very effective in that:

"They teach by showing the result of good or bad decisions very quickly. They allow mistakes to be made without the actual cost which results when mistakes are made in real life. They allow for experimentation that cannot be tolerated in real life situations. They generate a great deal of personal involvement that the participants feel that they are working at a very serious business making important decisions. This involvement helps make the activity a far more effective teaching method than a lecture, seminar or case study." (6)

Despite the preceding quotation which tends to somewhat idealize simulation game methodology there are conflicting opinions concerning the true effectiveness of computer simulations as viable educational tools. Several studies have taken the position, based on their respective research, that simulation is not a superior tool in

the educational process. (1), (7), (13). There are a number of studies which, again based on completed research, maintain that simulation games have no significant advantage over either the traditional lecture or the case method in terms of increasing the mastery of the subject by the student. (8), (11). An excellent review of several simulation effectiveness studies was conducted by Pierfy. (10) Based on the results of his research he believes simulation games are not superior to the more traditional teaching methods. However Pierfy has conceded that simulations have certain merits in terms of increased student interest and better retention of learned material, certainly a somewhat conflicting conclusion. A review of the literature relating to the analysis of the effectiveness of business simulations reveals a number of studies which support the usefulness of the techniques and methods of simulation. One example of this positive attitude is the very interesting study of Joseph Wolfe. (14) Wolfe arrives at the conclusion that some games have a definitely positive impact in a learning situation. Nixon and Yantis present the idea that simulation: "May be a vehicle whereby the student not only learns the functional principles but also is enabled to make a better transition from academia to business". (9)

More specifically related to the direction of this paper are those studies which seek to evaluate simulations from the viewpoint of student perceptions. (2), (3), (12) In general the conclusion reached by such studies presents the use of computer simulation in the classroom setting in a favorable light. Frazer shares this point of view when he observed: "Taking the literature as a whole one would probably come to the conclusion that simulation is as good or slightly better than other methods of presenting material." (5) Further Frazer in his thought provoking article relates several instances where as he sees it: "Learning unrelated to the material in the game has taken place". He further points out that there is no real counterpart to this in any other traditional teaching methodology.

A recent paper by Faria and Nulsen develops an entirely different approach to research into the efficacy of the simulation method. They suggest research efforts should be oriented to: "Examine the motives and attitudes underlying simulation usage by faculty members and business men."

V4) Following this intellectual path the essence of their research is to pursue the perceptions of the administrators of the simulations rather than those of the participants. While the authors of this paper acknowledge the usefulness of this particular approach they feel the continued examination and evaluation of the perceptions of the participants is the more critical aspect of the entire issue surrounding the effectiveness of computer simulations. Our theoretical assumptions are based on the well known marketing principle that any product must ultimately be measured in terms of the satisfaction of the consumer. Carrying this rationale just a bit further we believe organizations are to a large extent evaluated in terms of survival or nonsurvival by the same criteria. Further it is our belief that the same measurement, namely consumer satisfaction, applies to educational techniques and tools. Those sys-

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terms and techniques which refuse to take into consideration the reactions of the environment will encounter difficulties of an increasingly serious nature. It is for this reason feedback from the participants (our consumers) in simulations is in order. The additional information derived from a source should be the prime material on which to base necessary revisions in order to achieve increasing effectiveness. In time with this reasoning the authors maintain that an emphasis on the analysis of the responses by the participants in a simulation exercise is not only desirable but vitally necessary for the advancement of the effectiveness of computer simulation techniques in the classroom setting.

THE FRAMEWORK FOR THE EVALUATION

A functional relationship of the following form may be formulated to indicate the nature of the measurement problem: $E=f(G,C,E_r)$, where E equals effectiveness of computer simulations, G equals the game characteristics, C equals environmental factors, and E_r equals the characteristics of the respondent. As indicated earlier the effectiveness criteria (E) is always to be generated from the responses of the participants. Game characteristics (G) refer to the nature of the simulation game adopted for the particular classroom purpose. Environmental characteristics (C) could include several of the variables which have found their place in the simulation literature: Instructor personality, group behavior variables, task structure associated with the simulation, administrative variables, weight allotted for the exercise and the nature of the interaction generated by the simulation game. Respondent characteristics (E_r) may include socio-demographic variables such as grade point average, class level, sex, and prior simulation exposure. This study is a preliminary attempt to examine the impact of game characteristics and respondent characteristics upon the perceived effectiveness of the simulation exercise by the participants. Due to space and time limitations no specific attempt is made to develop and test the relationship between environmental characteristics (E) as it relates to the perceived effectiveness. Furthermore the purpose is not to develop an effectiveness index or to build a predictive model with the effectiveness index as a dependent variable. Rather the study is an exploratory investigation of the influence of game characteristics and respondent characteristics on different aspects of the simulation which in their totality may determine the perceived effectiveness of the game.

METHODOLOGY

The research instrument consisted of a questionnaire divided into two sections. The first used a Likert scale format to elicit the respondents' feelings in terms of twenty-four statements. The results of this questionnaire in its entirety were presented by the authors to the fifth ABSEL meeting. (3) The responses were expressed in terms of one of the following categories: (1) Agree Strongly, (2) Agree Moderately, (3) Uncertain, (4) Disagree Moderately, and (5) Disagree Strongly. The twenty-four statements were varied in terms of being stated negatively or positively, and both positive and negative statements were randomly interspersed. The statements were developed by the authors after an extensive amount of preliminary exploration and testing. The scale was chosen because it has been shown in previous studies by both the authors and by others to be effective in terms of both discrimination and reliability. Pretesting was, of course, a part of the construction of the final questionnaire. The second part of the questionnaire was designed to obtain

relevant game and respondent characteristics. These included: Sex, class Level, course number, cumulative grade point average, and the number of times the respondents had prior exposure to simulations. This research instrument was administered to three groups of students. The first group consisted of 60 students enrolled in a Principles of Marketing course. This class used the Quaker Oats Version of the Purdue Supermarket game. The second group of students was enrolled in a Managerial Finance course. These 51 students used Leroy Brooks Financial Management game. The third group of 18 students were enrolled in an advanced marketing course (Marketing Channels) and participated in the IBM/360 Marketing Management game. It is important to note at this point that the game characteristics for each of the three simulations are somewhat divergent. Marketing students in the principles course were formed into teams of four which then proceeded to manage a supermarket making such decisions on a weekly basis as: margins, inventory, specials, trading stamps, advertising, personnel and cash flow. The Leroy Brooks game has as its specific purpose the development of financial analysis skills and was operated on an individual basis. The third group in the advanced marketing course individually managed a company in a constantly changing economic environment with a complexity greater than either of the other simulations. Their decisions involved such variables as: plant size, production levels, production costs, unit prices, marketing expenses, marketing research, inventory, dividends, cash flow, research and development and product differentiation.

ANALYSIS

Ideally a study such as this should examine the impact of environmental, game and respondent characteristics as they affect the perceived effectiveness of the use of simulations in a classroom setting. However, due to time and space limitations, the analysis presented in this paper will be limited to the effect of game and respondent characteristics on how the simulation was perceived by the participants.

A preliminary analysis of the data using Chi Square as a test statistic indicates several variables have an influence on the perceived effectiveness of simulation exercises. These variables include: sex, grade point average, the particular game used, respondent exposure to prior simulations, and the class level of the respondents. This paper will present only those situation in which Chi Square has indicated an acceptable level of significance, (.05).

The answers to the statement "The simulation helped me to better understand the basic principles of the course" are presented in Table I. Here 76% of the male respondents and 64% of the female respondents agree with the statement. On the negative side 12% of the males and 36% of the females did agree with the statement. In the uncertain category are 12% of the males and none of the female respondents. From this it appears that female respondents feel they have some difficulty using simulation as a learning device. The authors suggest this is an area which could benefit from additional in depth research. Is there something in the simulation technique that is, at least not a significant part of the female population, not meeting their educational needs? When the statement is analyzed in terms of the academic achievement of the respondents 74% of the upper level students (those with a 3.0 grade point average or over) agree with the statement. In the next lower academic level (those with a 2.5 to 2.99 grade point average) 81% agree with the statement. At the lowest of the three categories (those below a 2.149) the acceptance

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rate for the statement dropped to 65%. This is an interesting situation. The middle group in terms of academic achievement reacted more positively to the simulation than did the extremes. Of further interest might be a determination for the reasons why the statement met with a 22% undecided response rate by the lowest of the academic groups. Could this fairly high degree of uncertainty be a sign that the simulation techniques are not fully meeting the

TABLE I						
The simulation helped me to better understand the basic principles of the course						
	Sex					
	Male		Female		Total	
	n.	%	n.	%	n.	%
Agree Strongly	23	21	3	14	26	20
Agree Moderately	60	55	11	50	71	54
Uncertain	13	12	0	0	13	10
Disagree Moderately	10	9	6	27	16	12
Disagree Strongly	3	3	2	9	5	4
	109	100	22	100	131	100
$\chi^2 = 10.05989$, significance at .05 level						

needs of the lower ranked student?

TABLE II						
The simulation helped me to better understand the basic principles of the course						
	Grade Point Average					
	3.0 to 4.0		2.5 to 2.99		2.49 and below	
	n.	%	n.	%	n.	%
Agree Strongly	5	17	14	25	7	15
Agree Moderately	17	57	31	56	23	50
Uncertain	2	7	1	2	10	22
Disagree Moderately	4	13	7	13	5	11
Disagree Strongly	2	6	2	4	1	2
	30	100	55	100	46	100
$\chi^2 = 37.14015$, significance at .0020 level						

In all research it is important to determine, when three different entries as in this survey and analysis are used, whether the respondents have different perceptions or feeling toward each particular simulation. Such preferences can possibly bias the results arrived at in terms of more general questions. Ideally the responses to the statement "Most of the students I know liked the simulation" should be about equal in terms of like or dislike across the entire sample.

From Table III there is evidence of a disparity in terms of individual popularity of each simulation. The most liked exercise was the Purdue Supermarket game with a 68% affirmative rating. Next came the Marketing-Management game, the most complex of the three, with a 50% favorable rating. Lastly came the Financial Management game with a

32% student approval rating. Thus the popularity of each of the three simulations differed rather widely. The low acceptability of the Finance game may have been due to certain classroom environmental factors. For example; heavier grade emphasis, complex or unclear directions, a greater work load for the entire class are a few of a number of possibilities. However, the uncovering of this variation is notification to other researchers in this area that respondent reaction to anyone particular simulation exercise is unique for that one only and can vary widely for other simulations. This, of course, leads to the consideration of: "What makes a simulation more or Less acceptable to the respondents?" At that point the potential research takes us far beyond the scope of this study. It is the authors feel a relevant topic which deserves considerable additional thoughtful research and analysis. One final concern of the authors is the rather large uncertain response rate. Either the respondents don't care how their fellow students feel about the simulation or there is a rather small amount of interpersonal communication concerning the likes or dislikes of the simulation. More discouraging to contemplate is the possibility the students look at the simulation as one more academic obstacle and as such it doesn't much matter to them whether anyone likes the exercise or not as it was just something to "go through" to reach the end of the course. Thus no one bothered to find out the likes or dislikes of

TABLE III						
Most of the students I know liked the simulation						
	Type of Game					
	Finance		Super-market		Marketing Management	
	n.	%	n.	%	n.	%
Agree Strongly	3	6	13	22	1	6
Agree Moderately	17	33	28	46	8	44
Uncertain	19	36	15	25	8	44
Disagree Moderately	10	19	3	5	1	6
Disagree Strongly	3	6	1	2	0	0
	52	100	60	100	18	100
$\chi^2 = 17.72418$, significance at .05 level.						

fellow students.

Turning now to Tables IV and V an attempt was made to determine the respondents' attitudes in terms of the perceived value derived from the simulation exercise in relation to the time it took to complete the required assignments in the simulation. In Table IV the purpose was to determine if the respondents' attitudes in this area changed as the number of simulation exposures increased. Of those respondents who had been exposed to one other simulation, 70% disagreed that "The simulation took more time than it was worth." Those respondents with two or more simulation exposures disagreed by 82% with the statement. The much smaller group with three simulation exposures as agreed by 70%. All in all there seems to be a positive attitude on the part of the respondents in terms of how they feel about the usefulness of the simulation and the time it took to perform the mechanics or the operation.

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TABLE IV						
The simulation took more time than it was worth						
	Number of Exposures					
	One n. %	Two n. %	Three n. %	Total n. %		
Agree Strongly	1 1	2 9	1 10	4	4	
Agree Moderately	13 18	1 4	1 10	15	14	
Uncertain	8 11	1 4	1 10	10	9	
Disagree Moderately	25 34	15 68	5 50	50	45	
Disagree Strongly	26 36	3 14	2 20	31	28	
	73 100	22 100	10 100	110	100	
$\chi^2 = 16.85487$, significance at .05 level						

TABLE V						
The simulation took more time than it was worth						
	Type of game					
	Finance n. %	Super- market n. %	Marketing Management n. %	Total n. %		
Agree Strongly	4 8	1 2	1 6	6	5	
Agree Moderately	13 25	6 10	3 17	22	16	
Uncertain	5 10	6 10	1 6	12	10	
Disagree Moderately	23 44	21 36	10 54	54	42	
Disagree Strongly	7 13	25 42	3 17	35	29	
	52 100	59 100	18 100	129	100	
$\chi^2 = 23.94902$, with significance of .0207						

In a somewhat different direction but closely related to the findings presented in Table IV is the material presented in Table V. Here the researchers were interested in determining the degree of variance among the perceptions of the respondents as these perceptions were affected by the individual simulations. In other words to what extent did the games themselves affect the students' perceptions of the value of the time spent accomplishing the exercises. From Table V it can be seen that the relative value of the simulations as a function of the time required for participation as perceived by the respondents varied quite widely among the three games. The most time consuming game, the Finance game, has a 33% agree rate and a 58% negative reaction. The Management-Marketing game, possibly the most complex of the three games, shows a 22% agree and a 72% disagree rating. The simplest of the three simulation, the Supermarket game, has a 12% agree and a 78% disagree response rate. Overall the three games when combined show that 21% of the total respondents agree with the statement and 71% disagree. In general according to the results of this survey most of the students think the time spent on the simulation was time well spent. However there is a definite tendency for students to think of simulation in a very cost-benefit frame of mind. As such those interested in simulation should have a better grasp of the time benefit

trade-off which quite clearly exists in the minds of the students.

One of the advantages given for simulation exercises is that they can and do enhance the student's ability to integrate or pull together knowledge acquired in other courses to resolve the simulation problems. To test this concept the questionnaire contained this statement: "The simulation brought together material I had learned in several other business courses". The purpose for this statement is to determine if this integration of the learning process is really

TABLE VI						
The simulation brought together material I had learned in several other business courses						
	Type of game					
	Finance n. %	Super- market n. %	Marketing Management n. %			
Agree Strongly	10 19	6 10	7 38			
Agree Moderately	30 58	38 63	4 22			
Uncertain	3 6	7 12	1 6			
Disagree Moderately	5 10	7 12	5 28			
Disagree Strongly	4 8	2 3	1 6			
	52 100	60 100	18 100			
$\chi^2 = 16.83612$, significance at .05 level						

being perceived by the students.

In Table VI 77% of the Finance game participants agreed with the statement posed. In the Marketing- Management game 60% of the respondents agreed with the statement. In the Supermarket game 73% agreed with the statement. Surprising was the rather high 34% negative reaction achieved by the Marketing-Management game since this particular simulation is considered to be the most likely are of the three to include material drawn from other courses in

TABLE VII						
The simulation brought together material I had learned in several other business courses						
	Number of exposures					
	one n. %	two n. %	three n. %			
Agree Strongly	10 14	3 14	4 40			
Agree Moderately	41 55	12 55	3 30			
Uncertain	7 9	3 14	0 0			
Disagree Moderately	10 14	4 18	3 30			
Disagree Strongly	6 8	0 0	0 0			
	74 100	22 100	10 100			
$\chi^2 = 21.12578$, significant at .05 level						

a business curriculum.

To give the research into this general topic of the "integrative" nature of simulations the same statement was analyzed in terms of the number of simulation

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exposures experienced by the respondents. in Table VII 69% of those respondents experiencing one other simulation agreed with the statement. At the same time 69% of those respondents with two simulation exposures agreed with the statement. In the smallest group of those experiencing three or more simulations the agree rate is 70%. From this analysis it can be concluded that in all of the individual simulations the respondents perceived the "integrative" nature of the simulation exercise.

A number of writers in the field of the uses of simulation techniques in the classroom maintain that the exercise adds a certain degree of realism which is unobtainable by using any other pedagogical method. To test this particular belief the research instrument asked the respondents to react to the following statement: "The simulation added a lot of realism to the class. Table VIII presents the respondents' reply to that statement.

TABLE VIII					
The simulation added a lot of realism to the class					
	Class level				TOTAL
	JUNIOR		SENIOR		
	n.	%	n.	%	n. %
Agree Strongly	15	25	6	9	23 18
Agree Moderately	35	57	37	58	72 55
Uncertain	8	13	11	17	23 17
Disagree Moderately	3	5	7	11	10 8
Disagree Strongly	0	0	3	5	3 2
	61	100	64	100	131 100
$\chi^2 = 22.50209$, significant at the .05 level.					

The respondents were divided into two class levels, junior or senior. In the entire sample only 6 respondents fell outside these two categories. An interesting result is while an 82% of the juniors in the sample agreed the simulation added realism to the class only 61% of the seniors felt the same way. This somewhat unexpected result might be due to an undiscovered variable in one of the simulations. The authors suspect it lies somewhere in the Finance game, because a large number of seniors were enrolled in that game. In any case the degree of realism perceived by the students is quite likely very dependent on the nature of the game, how it is administered, and its relationship to class objectives.

Table IX is designed to explore the reactions of the students to the idea that the simulation used in class was more entertaining than it was educational. This charge is frequently raised by those who erroneously see the use of simulations as something of a lesser educational tool than the more traditional pedagogical approaches. As one test of the validity of such a charge the respondents were divided into three groups according to their previous exposure to other simulation exercises. Table IX shows without question that the respondents in this survey do not perceive their simulations, both past and present, as being more entertaining than educational. It is worth noting that there is a slight tendency for those respondents with two exposures to simulation to be somewhat more uncertain of the educational value of simulations.

In an attempt to determine the relationship between what was going on in the course at the same time the simulation was being conducted in order to determine whether the students were treating the course material and the simulation as mutually exclusive parts of the course the questionnaire asked: "Performance in the simulation is a

good way for a student to tell how well he or she is learning

TABLE IX								
Our computer simulation was more entertaining than it was educational.								
	Number of Exposures							
	One		Two		Three		Total	
	n.	%	n.	%	n.	%	n.	%
Agree Strongly	0	0	0	0	1	10	1	1
Agree Moderately	9	12	2	9	3	30	14	12
Uncertain	13	18	6	27	0	0	19	16
Disagree Moderately	42	57	12	55	4	40	68	59
Disagree Strongly	10	13	2	9	2	20	14	12
	74	100	22	100	10	100	116	100
$\chi^2 = 20.24785$, significance at .05 level								

TABLE X								
Performance in the simulation is a good way for a student to tell how well he or she is learning the subject matter								
	Number of Exposures						Total	
	One		Two		Three			
	n.	%	n.	%	n.	%	n.	%
Agree Strongly	4	5	3	14	0	0	7	7
Agree Moderately	23	31	9	41	0	0	32	30
Uncertain	13	18	3	14	5	50	21	20
Disagree Moderately	24	34	4	18	1	10	30	28
Disagree Strongly	9	12	3	14	4	40	16	15
	74	100	22	100	10	100	106	100
$\chi^2 = 24.77684$, significance at .0159 level								

the subject matter".

Those respondents having one previous simulation are evenly divided on the question. Those respondents having had experience with two other simulations are more confident and see a closer relationship between their work on the simulation and the overall class objectives. Of concern should be the 56% of group one and the 32% of group two who do not see much of a relationship between simulation performance and the learning of the subject matter of the course. Part of the difficulty might well be related to the administration of the simulation and the skill that the instructor has in integrating the simulation into the broader objectives of the course. This is a point worth some careful consideration.

Closely related to the idea of the time spent by the respondents on the simulation and its usefulness in determining progress in learning the course material is the idea of perceived efficiency of the simulation exercise in the classroom. To investigate the extent

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TABLE XI						
Using a simulation is a relatively inefficient way to study a subject.						
	Grade point average					
	3.0 to 4.0		2.5 to 2.99		Below 2.49	
	n.	%	n.	%	n.	%
Agree Strongly	0	0	0	0	1	2
Agree Moderate						
Moderately	3	10	4	7	5	11
Uncertain	7	24	11	20	9	20
Disagree Moderately	14	48	27	49	19	41
Disagree Strongly	6	21	13	24	12	26
	29	100	55	100	46	100
$\chi^2 = 20.24785$, significance at .05 level						

to which the respondents perceived the simulation as an efficient way to learn, the questionnaire presented them with the following statement: "Using a simulation is a relatively inefficient way to study a subject".

When the Table XI is analyzed in terms of the academic standing of the respondents only 8% of those students with the highest academic ranking (3.0 to 4.0) agree with the statement. In the next lower group, those with a grade point average of 2.5 to 2.99, only 7% agree with the statement, in the lowest of the academic categories (2.0 to 2.49) some 12% agreed. All three of the academic ranking categories share an about equal rejection rate (70%) for the statement. Concluding with this significant finding that the respondents, the students, those whom we referred to earlier as "our customers" appear to perceive simulation as an efficient learning device. From this we can be encouraged to pursue the continued improvement of classroom simulation exercises. It is said that education is a slow and painful process but the increasing interest in the use of simulation techniques appears to be perhaps a bit less painful than some other aspects of the learning process.

CONCLUSION

The purpose of this study was to develop a theoretical framework to achieve the evaluation of the effectiveness of computer simulations as used in the classroom setting. The authors suggest the following framework:

$E = f(G, C, R)$; where E equals the effectiveness of computer simulation, G equals game characteristics, C equals environmental characteristics, and R equals respondent characteristics. Due to time and space limitations the study examined the impact of only two of these aforementioned variables: game characteristics and respondent characteristics. It is the conclusion of this study that the chosen variables do have at times an impact upon the different components of the perceived effectiveness of computer simulation. The study concludes that the students represented by this sample in general are responding quite favorably to the use of computer simulation in their classes. Some areas of weakness and uncertainty have been revealed

as have a number of areas which appear to merit additional research by those professionals interested in the utilization of computer simulations in the classroom. Referring back to our opening statement, the results of the research indicate that the customers appear to be reasonably satisfied with the product called computer simulation.

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