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A Mixed Method Study on Online Learning Readiness and Situational Motivation among Mathematics Students using Gamified Learning Objects

Kajian Kaedah Gabungan tentang Kesediaan Belajar atas Talian dan Motivasi Berasaskan Situasi dalam kalangan Pelajar Matematik yang Menggunakan Pendekatan Gamifikasi dalam Objek Pembelajaran

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ABSTRACT

The trend of employing game features into non-game contexts or gamification has increased in recent years. Gamification has the potential to be a new paradigm in enhancing online user engagement in the online based education system. As Mathematics subjects is normally associated with a high drop-out rate, especially among students who have encountered low mathematical performance in their past, the implementation of gamification may support more successful online learning for this subject. Three undergraduate classes with at least four months experience in using any gamified learning objects implemented using Kahoot!, Socrative or Quizizz were selected as a case study. This study aimed to examine the association between Situational Motivation with the dimensions of Online Learning Readiness using a mixed-methods-approach. 34 students voluntarily answered an online survey and a total of twelve participants were purposively selected to answer open-ended questions. The results showed that significant positive associations were found between students' online learning readiness in three dimensions (technical competencies, social competencies with classmates, and social competencies with lecturers) with both identified and intrinsic motivation. No such association between students' online learning readiness dimensions and amotivation was found for students who participated. This finding can provide a better understanding of how situational motivation relates to students' online learning readiness among students using gamified learning objects. In addition, Mathematics educators may consider applying the findings into the design of their gamified learning objects to improve the students' online learning readiness.

Keywords: Online learning readiness; situational motivation; mathematics; gamification; learning objects

ABSTRAK

Trend menggunakan ciri-ciri permainan ke dalam konteks bukan permainan atau gamifikasi telah meningkat dalam beberapa tahun kebelakangan ini. Gamification berpotensi menjadi paradigma baru dalam meningkatkan penglibatan pengguna dalam talian dalam sistem pendidikan berasaskan talian. Manakala, Matematik adalah subjek yang biasanya dikaitkan dengan kadar keciciran yang tinggi, terutamanya di kalangan pelajar yang mengalami prestasi matematik yang rendah di masa lalu. Maka penggunaan gamifikasi dipercayai dapat menyokong pembelajaran dalam talian yang berkesan untuk subjek ini. Pelajar sarjana muda dari tiga buah kelas yang mempunyai pengalaman sekurang-kurangnya empat bulan dalam menggunakan apa-apa objek pembelajaran berasaskan Kahoot!, Socrative atau Quizizz dipilih sebagai kajian kes. Kajian ini bertujuan untuk mengkaji korelasi antara dimensi motivasi situasi dengan dimensi kesediaan belajar atas talian menggunakan kaedah campuran-pendekatan. 34 pelajar secara sukarela menjawab kaji selidik dalam talian dan sejumlah dua belas peserta telah dipilih untuk menjawab soalan terbuka. Keputusan menunjukkan bahawa terdapat korelasi positif yang signifikan diantara kesediaan pembelajaran dalam talian pelajar dalam tiga dimensi (kecekapan teknikal, kecekapan sosial dengan rakan sekelas, dan kecekapan sosial dengan pensyarah) dengan identified motivation dan intrinsic motivation. Tiada korelasi antara dimensi kesediaan pembelajaran dalam talian dan amotivation ditemui untuk pelajar yang mengambil bahagian. Dapatan ini dapat memberikan pemahaman yang lebih baik tentang bagaimana motivasi situasi berkaitan dengan kesediaan pembelajaran dalam talian pelajar di kalangan pelajar yang menggunakan objek pembelajaran berasaskan Kahoot!, Socrative atau Quizizz. Di samping itu, pendidik matematik boleh mempertimbangkan untuk menerapkan penemuan ke dalam reka bentuk objek pembelajaran mereka untuk meningkatkan kesediaan pembelajaran dalam talian pelajar.

Kata kunci: pembelajaran atas talian; motivasi berasaskan situasi; matematik; gamifikasi;objek pembelajaran

INTRODUCTION

The world of the 21st century is changing exponentially. Individuals in the 21st century need to be able to anticipate and adapt to these changes to assure their continued success and to remain competitive. However, Goodman, Sands, and Coley (2015) argued that these individuals have less competence when dealing with numbers as well as less capacity to solve problems in rich technological environments. Similar problem is also observable in Malaysia. For these individuals, mathematics is known as a challenging subject. The evidence comes from the Trends in International Mathematics and Science Study (TIMMS) report. Malaysia's ranked fell from 16th (1999) to 10th (2003), 20th (2007) and 26th (2011) and slightly increases to 22th place in 2015.

Generally, mathematics is a subject which is vital for scientific and technological development. A research conducted by Stanford University indicates that brain regions that help a person do maths are also used in decision-making and attentional processes (Evans, Kochalka, Ngoon, Wu, Qin, Battista, & Menon 2015). Therefore, mathematics is the means of improving the individual's mind by shaping his reasoning ability and developing his personality. For this reason, mathematics is of high significance in the Malaysian education system.

Originally, the Malaysian science and mathematics education has been carefully shaped and guided by a strategic five-year development masterplan. The significance increased when the Prime Minister announced Vision 2020 (Mahathir 1991) which encourages mathematics educators to make a quantum leap from 'Meeting Today's Challenges' to 'Fulfilling Tomorrow's Dreams' (Esther & Idris 2007). In addition, a current interview with the Prime Minister stressed a need to focus the education system toward science and mathematics (Tan 2019). Thus, mathematics is a vital of part of life that needs extra attention.

Although technology has already been integrated in the teaching and learning of mathematics, however, its implementation seems slow and is met with divergent results (De Witte & Rogge 2014). Mainly, the problem emerged because the individuals in the 21st century do not feel that they are as good in real life situations as they are in games. This encourages them to feel depressed, devastated, discouraged or even cynical when they encounter difficulties in real life situation. However, the same feelings are not present in the gaming environment and at the same time the gaming environment also allows them to obtain direct pleasure that keep them engaged and motivated.

In addition, prior research mentioned that students' level of interest were high when they were given performance awards (Lepper, Greene & Nisbett 1973) or other rewards (Harackiewicz 1979). Likewise, the level of interest was lost or plummeted when the students stopped receiving rewards. The same situation also happens when using gamified learning objects in the process of learning of mathematics. This is because motivation plays an important role in digital system (Jung, Schneider & Valacich 2010).

LEARNING OBJECTS

The concept of Learning Objects is grounded in the object-oriented paradigm of computer science (Freeman 2004). The principle of Learning Objects is the creation of instructional components that can be reused numerous times in different learning contexts. Gallenson, Heins & Heins (2002) defined a Learning Object as a unit of instructionally sound content centred on a learning objective or outcome intended to teach a focused concept. It is the basic building block composed of all the instructionally necessary components to comprise a self-contained instructional unit. These learning objects can be delivered over the Internet and can be accessed by a number of individuals simultaneously, with minimal effort, reducing the need for instructors to develop their own instructional components. They allow for increased speed and efficiency of instructional development and decrease faculty preparation time (Freeman, 2004). According to Wiley (2000), the fundamental idea behind learning objects is that instructional designers can build small instructional components that can be reused a number of times in different learning contexts. Additionally, learning objects are generally understood to be digital entities deliverable over the Internet, meaning that any number of people can access and use them simultaneously.

IMPLEMENTING THE LEARNING OBJECT

The online gamified learning object that was used for the study is a mixture of Kahoot! (https://

kahoot.com/), Socrative (https://socrative.com/) and Quizizz (https://quizizz.com/). These are all online application that is free and accessible for the lecturers and can be used at various levels. Lecturers can create their own questions adapting them to the level of knowledge and skills of their students. These online applications are user-friendly as well as containing the basic game elements: points, a leader board, instant feedback and a reward.

Wang (2011) mentioned that games can be integrated in higher education in three ways. The first way is by replacing traditional exercises with games to motivate the students to put extra effort in doing the exercises, and giving the lecturer an opportunity to monitor how the students work with the exercises in realtime (Sindre, Natvig and Jahre 2009). The second way is by integrating games within a traditional classroom lecture to improve the participation and motivation of the students through knowledge-based multiplayer games played by the students and the teacher (Wang, Øfsdahl and Mørch-Storstein 2008). Finally, game development projects can be used in computer science (CS) or software engineering (SE) courses to learn specific CS or SE skills (Wu, Wang, Strøm & Kvamme 2009).

The study approaches gamification using the first way by integrating games to replace traditional exercises in the classroom. The lecturers applied the game with different contents according to their syllabus. Consequently, the students still need to attend the theoretical lectures, in which, at the end each lesson, a Kahoot!, Socrative or Quizizz questionnaires was proposed on the contents addressed as an exercise. All students worked on the exercises but the frequency with which they played the games after the first trial in class depended on them. Each questionnaire consisted of 2 questions and offered four different answers with a single correct option; in all cases, the students had 30 seconds to answer each question. Scores are displayed at the end of each game and lecturers are able to save the information in a digital document. Finally, the lecturers gave a short explanation after each question. It should be noted that the participation in the questionnaires was not mandatory, and that the students played the questionnaires through their smartphones.

MOTIVATION AND GAMIFICATION

Motivation is a learners' internal drive. According to Moos & Marroquin (2010), motivation corresponds to physiological processes that influence the directions and persistence of learners' behaviours. Thus, we can say that motivation is the force that causes the learner to act or to do something and to continue doing it. Motivation plays an important role especially when interacting with a digital system (Jung, Schneider & Valacich 2010). This is especially true since computer or video games are digital activities intended to be fun and learners should want to learn. Learners play games for the experience being created (Lazzaro 2009). Nevertheless, Wyeth, Johnson & Sweetser (2012) claimed that the experience of being entertained through games is not yet well understood especially from a psychological perspective. In addition, an article by Sinha (2012) in Huffington Post also argued that most learners lose their enthusiasm to learn due to the inadequate design of motivation scheme in learning objects.

SITUATIONAL MOTIVATION

Situational motivation denotes a motivation that individuals experience while they engage in an activity **(**Vallerand, Fortier & Guay 1997**)**. In addition, the real world practice has seen motivation producing positive results (Ryan & Deci 2000). According to Pintrich (2003), motivation is the main factor in the learning–teaching process to improve active learning. Situational motivation denotes a motivation that individuals experience while they engage in an activity **(**Vallerand, Fortier & Guay 1997). Although, gamification is often supposed to be an effective tool to foster motivation (Kapp 2012; Werbach & Hunter 2012), investigations about the motivational pull of gamification from a psychological perspective is scarce.

The Situational Motivation Scale (SIMS) is a 16-item self-report inventory. The 16-item SIMS was chosen because it is a measure of situational motivation towards a chosen activity. Participants need to choose a number from 1 to 7 (1= corresponds not all to 7 = corresponds exactly) to say how closely the description provided by the items matches their reasons for participating in the survey. A higher number indicates a better description of their reasons. SIMS measures four types of motivation: intrinsic motivation, identified regulation, external regulation, and amotivation. Each type of motivation contains four items.

Briefly, intrinsic motivation captures participation in a task out of one's own will and interest. Identified regulation applies to a task

performed as a means to an end and not done for itself; thus a type of extrinsic motivation. Another type of extrinsic motivation is external regulation which occurs when behaviour is regulated by rewards or in order to avoid a negative consequence. Amotivation applies to tasks the aim and purpose of which we do not understand.

ONLINE LEARNING READINESS

Readiness is a variable which is often emphasized and measured in researches regarding distance learning and online learning (Zhang & Liu 2019). A research by Dray, Lowenthal, Miszkiewicz, Ruiz-Primo, and Marczynski (2011) stated that readiness for online learning should measure two qualities; technology and student attributes dimension. This study used the Student Online Learning Readiness (SOLR) scale (Yu 2018) to assess the dimensions of technical competencies, social competencies with fellow students, social competencies with lecturers and communication competencies in general.

Basically, the SOLR instrument (Yu & Richardson 2015) consists of 20 self-reported items. This includes five items for the measurement of social competencies with the instructor in online learning (Shen, Cho, Tsai & Marra 2013), five items for the measurement of social competencies with classmates in online learning (Shen et al. 2013), four items for the measurement of communication competencies in online learning (Dray et al. 2011), and six items for the measurement of technical competencies in online learning (Wozney, Venkatesh & Abrami 2006). In addition, all the items were measured on a 5-point scale (1 = disagree, 2 = tend to disagree, 3 = neutral, 4 = tend to agree, 5 = agree).

RESEARCH DESIGN

A convergence mixed method model also known as concurrent triangulation design was used, where quantitative and qualitative data were collected simultaneous as recommended by Creswell & Plano Clark (2011). Both data types were collected from the participants in order find out how motivation is associated with different dimensions of student online learning readiness after using gamified learning objects. The mixed method was used by administrating a questionnaire (Likert scale) and questionnaire (open-ended) as research instruments in order to collect quantitative and qualitative data respectively. The data from the questionnaire were analysed using correlation analysis, and the open ended answers were coded and analysed to support the findings of the questionnaire

POPULATION AND SAMPLE

Three undergraduate students from three higher education institution participated in this study. The sampling technique was stratified for each of the three higher education institutions, then simple random sampling. Participants included diploma and degree students in both technical and social science course. For quantitative survey, a total of 34 participants responded to the questionnaires (16 male and 18 female). The overall response rate from the three higher education institutions was 56.6%. In the qualitative approach, a total number of 12 participants were purposively selected.

The criteria for inclusion in the study were that participants were undergraduate students with at least four months experience in using any game based or gamified learning objects or apps such as Kahoot!, Socrative or Quizizz. This is done to ensure homogeneity among samples and also to verify that these participants have the required experience to make a general perception on the gamified learning object framework being developed. Data were collected in October 2018.

DATA COLLECTION PROCEDURE

Before the data collection process, the researchers discussed how the process is going to be conducted. The participants were briefed about the research objective and were explained that their participation was voluntary. In the first stage, the participants answered the online questionnaires (Likert Scale). The participants were given a link to the online questionnaire to be completed at their own convenient time. This is followed by a series of open ended questions after purposefully selecting the participants. The average duration of the open ended questions was 20 minutes.

The quantitative data analysis was done once all questionnaires were gathered, and SPSS 15 was used. For qualitative data, the analysis was done concurrently with data collection process which allowed modification of collected data and process. The data were continuously compared and were analysed thematically. The obtained open ended answers were coded, cluttered codes into themes, then into categories. To ensure trustworthiness, data-records were kept as an audit trail. During data collection, the accuracy of data was checked

on the spot at the end of each session through verification and during analysis; transcripts were verified through member checks. Three individuals conducted the analysis (two researchers, and a higher education institution lecturer who is experienced in both qualitative and quantitative methods) verified the themes and categories.

A pilot study was conducted involving a total of 30 degree students for the purpose of determining the face validity of the research instrument. Face validity indicates the instrument appears to be appropriate to the study purpose and content area. The students were asked to review the instrument to determine whether the items were phrased correctly and being clear and concise. They were encouraged to suggest or re-word statements, whether the items correctly focused on the dimensions to be examined, and whether additional questions should be included. They were also asked to state comments or suggestions concerning the instrument. The students made several recommendations and the wording in the instrument was revised based on their comments.

The internal consistency was tested using Cronbach's alpha for each competency in SPSS. If the alpha value is higher than 0.9, the internal consistency is excellent, and if it is at least higher than 0.7, the internal consistency is acceptable (Blunch 2008). Excellent internal consistency means that the survey items tend to pull together. An analysis of the items and scale reliability was made for the quantitative survey. The evaluation concluded that all the dimensions in SIMS (Deci & Ryan, 1985; Guay, Vallerand & Blanchard 2000; Hartnett, St. George & Dron 2011) were reliable enough for further evaluation after item no.11 was dropped. In addition, all the dimensions in SOLR (Yu & Richardson 2015) were reliable enough for further evaluation.

RESULTS

Table 1 shows the descriptive statistics, including the means, standard deviations, minimums, and maximums of the four dimensions of the SIMS and the four dimensions of the SOLR instrument. For the SIMS, participating students had a high level of two type of motivations; intrinsic motivation (M=4.03) and identified motivation (M=3.84). The participants had low level of motivation for the remaining two type of motivations; extrinsic motivation (M=3.50) and amotivation (M=3.07). Menwhile, the SOLR instrument revealed that participating students had a high level of social competencies with classmates (M=3.35), and technical competencies (M=3.30). The remaining SOLR was relatively low compared to the previous two competencies.

TABLE 1. Descriptive statistics of each element of the Situational Motivation Scale (SIMS) and the Student Online Learning Readiness (SOLR) instruments

Scale (No of Items)	Min	Max	M	SD	α
Intrinsic Motivation(4)	1	5	4.03	0.78	0.79
Identified Motivation (4)	1	5	3.84	0.83	0.78
Extrinsic Motivation (3)	1	5	3.50	0.81	0.74
Amotivation (4)	1	5	3.07	1.16	0.79
Technical Competencies (6)	2	4	3.30	0.54	0.92
Social Competencies with classmates (5)	1	4	3.35	0.63	0.88
Social Competencies with lecturers (5)	2	4	3.29	0.56	0.87
Communication Competencies (4)	1	4	3.26	0.63	0.87

Notes: Min/Max = scale range of answers, M = means, SD = standard deviations, α = Cronbach's Alpha

Histograms, Q-Q plots and a Shapiro-Wilk test of normality indicated that most of the variables (intrinsic motivation, identified motivation, and amotivation) were normally distributed. In addition, the histograms and Q-Q plots also showed that the data are normally distributed since the data points were close to the diagonal line.

The study chooses to use content analysis to qualitatively analyse the open-ended answers. Content analysis is a method of analysing written, verbal or visual communication messages (Cole, 1988) systematically with the aim of describing and quantifying phenomena (Sandelowski,1995). According to Harwood & Garry (2003), content analysis was first used as a method for analysing hymns, newspaper and magazine articles,

advertisements and political speeches in the 19th century. Specifically, the study uses the qualitative content analysis process as proposed by Elo & Kyngas (2008). All analysed text passages from the open ended questions were subsequently inserted into a table and allocated to the three pre-defined main categories of "perception", "experience", and "motivation" (Table 2). Finally, the quotations were paraphrased and generalized for use in the results.

The following paragraphs will present the results from the quantitative and qualitative data in a side-by-side strategy as recommended by Creswell & Plano Clark (2011). Findings from the quantitative and/or qualitative data are then used to answer the research questions and hypotheses of this study.

TABLE 2. Extract of the coding guideline

Category	Definitions	Examples
Perception (P):	P1: positive perception	"Absolutely, I will join it with pleasure.. and of course for the sake of my marks." (P1)
	P2: not sure	"Maybe" (P2)
	P3:negative perception	
Experience (E):	E1: positive experience	"easy to learn" (E1)
	E2: not sure	"honestly speaking, im not entirely sure but the idea itself is quite interesting and should be implemented for a certain period of time."(E2)
	E3:negative experience	"I think it is not very good"(E3)
Motivation (M):	M1: intrinsic	"Because it is interesting °_°" (M1)
	M2: identified	"Yes because it makes me think faster than usual learning techniques"(M2)
	M3: extrinsic	"Yes. Because nowadays industry need an advance technology skills employees." (M3)
	M4:amotivation	"probably yes because there is a lot of things to be learn from doing something new from what you have been doing regularly." (M4)

DISCUSSION

Based on the quantitative result, the students were divided into two groups; one group for students with intrinsic and identified motivation, and another group for students with external and amotivation. Findings (Figure 1) showed high values on all dimensions of SOLR for intrinsic and identified motivated group of students (between 50% and 58%), as high scores of SOLR were associated with high scores of autonomous motivation (intrinsic and identified motivation). Within the scale of SOLR, the social competencies with lecturers obtained the highest values of agreement from the students in the online questionnaire.

In addition, the results in Table 3 showed that significant positive associations were found between three dimensions in SOLR (technical competencies, social competencies with classmates, and social competencies with lecturers) with both intrinsic and identified motivation. However, no such association between SOLR dimensions and amotivation was found for the participants.

TABLE 3. Correlations

	Intrinsic Motivation	Identified Motivation	Extrinsic Motivation	Amotivation
Technical Competencies	0.57*	0.58*	0.62*	0.31
Social Competencies with classmates	0.34*	0.37*	0.27	-0.06
Social Competencies with lecturers	0.61*	0.66*	0.55*	0.14
Communication Competencies	0.34*	0.29	0.28	-0.14

Note: *$p < .05$ (two tailed) significant, $n = 34$, r = coefficient of correlation

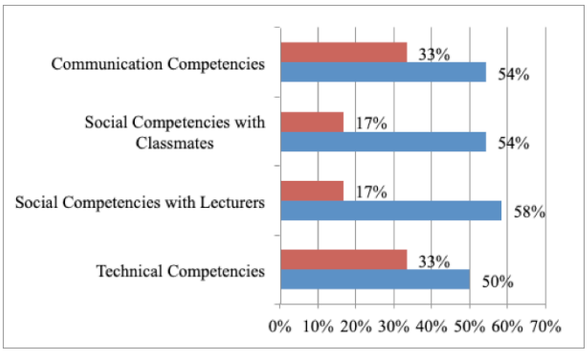

FIGURE 1. Online Learning Readiness and Types of Motivation (n=30)

Specifically, the dimension social competencies with lecturers showed a positive correlation with intrinsic motivation ($r = .61$, $p < .05$) as well as with identified motivation ($r = .66$, $p < .05$). Strength of relationship was interpreted in agreement with Evans (1996). Evans (1996) stated that $r < 0.19$ represents very weak, $r < 0.39$ weak, $r < 0.59$ moderate, $r < 0.79$ strong and $r \geq 0.80$ represents very strong association. Relationship significance was assessed at the standard level $\alpha = 0.05$. Thus, the size for both correlations is considered to be strong (Evans, 1996).

Next, the dimension technical competencies also showed a positive correlation with intrinsic motivation ($r = .57$, $p < .05$) as well as with identified motivation ($r = .58$, $p < .05$). The size for both correlations is considered to be moderate (Evans, 1996). Finally, in agreement with the previous results, the dimension social competencies with classmates also displayed a positive correlation with intrinsic motivation ($r = .34$, $p < .05$) as well as with identified motivation ($r = .37$, $p < .05$). Unfortunately, both the final correlations only suggest a weak correlation size (Evans, 1996). In addition, no significant correlation was found between any dimensions of SOLR and amotivation.

Statements answered in the open ended questions showed the importance of being able to know their learning progress while using the gamified learning objects without asking the lecturer (e.g. "Yes, because it state at last either win or lose"). The students deemed the gamification learning objects as learning tools to avoid lecture based learning (e.g. "Yes because at least we won't be bored just by listening", "now everything must go online so gamification can help to not lose focus or getting bored during online learning").

Values in technical competencies were strongly associated to values of autonomous motivation. Statements answered in the open ended questions suggested that the students displays themselves as being skilled in working with computers and computer technology (e.g. "because it like practical learning"). Meanwhile, the correlated of values for both social competencies with classmates and autonomous motivation showed that some students prefer to communicate with their classmates through the gamified learning object since it does not require physical interaction and commitment (e.g. "Because it help to communicate with each other", "Online learning is good for learning. But better with less chat", "yes as online interaction enables me to express anything that I can't in actual conversations").

CONCLUSION

Most of the answer from the open ended questions valued the online gamification learning objects. The students appreciated the ability of online gamification learning objects to increase their social competencies either with their lecturers or fellow students. The same result is also visible in term of communication competencies. As such, the students discovered concepts and facts unaided or with minimum assistance from the lecturers which made the learning of the topics more pleasurable and not boring, thus encouraging them to learn. This showed that learning objects and the instructional design of such learning objects should cater personalized learning. Consequently, the students will stand out if they are comfortable with the learning situation (Jagušt, Botički and So 2018). In addition, the use of new learning approach such as gamification can attract students to be more interested in learning difficult things like theoretical subjects (Leaning 2015).

The findings also propose that in class games do not necessarily have to be played in a static way. The highly correlated autonomous value and technical competencies supported this Thus, the research suggests that lecturers utilizing future online gamification learning objects should be prepared to revise all the relevant instructional materials (in this case, the gamified learning objects) required for each lesson and also to practise their use in the gamified mathematics lessons. This will allow the

lecturers to facilitate their students through each gamified lesson. As such, good teaching aid must meet its features; the suitability of the material with the contents of the taught lessons in order to ensure that the contents of the lessons are clearly conveyed to the students (Villagrasa, Fonseca, Redondo and Duran 2014). In addition, the gamified learning objects should also encourage tasks that involve competition among students. The competitions could help increase students' extrinsic motivation towards learning through rewards like badges and grades or punitive threats (Hanus and Fox 2015).

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