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Obstacles Faced by College Students in Solving Probability Word Problems

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Abstract

There are many difficulties that can be identified when students solve mathematic problems especially in solving probability word problems. This study was conducted to identify the major obstacles faced by matriculation college students while solving the probability of an event word problems. Seven college students were the sample for this case study. Clinical interviews are used as a data collection. This data collection technique was selected based on the researcher's observation on the participants as they answered the probability word problem task. The task was given during the interview session. Semi structured interviews are used to obtain in depth information. Think-aloud analysis involves observations leading to individual behaviours in the oral or nonverbal form of participants and the researcher's field notes. Participants were found to have difficulty interpreting probabilities. There are three categories of difficulties that have been identified, namely not knowing the meaning of the word, not knowing the nature of the probability and not being able to identify the goal of the probability word problem.

Keywords: Obstacles, Probability of an Event, Think-Aloud Analysis

Abstrak

Banyak kesulitan yang dapat diidentifikasi pada saat siswa menyelesaikan masalah matematika khususnya dalam menyelesaikan masalah kata probabilitas. Penelitian ini dilakukan untuk mengidentifikasi kendala utama yang dihadapi mahasiswa matrikulasi saat menyelesaikan masalah kata probabilitas. Tujuh mahasiswa menjadi subjek dalam penelitian ini. Teknik pengumpulan data yang digunakan adalah wawancara. Teknik pengumpulan data ini dipilih berdasarkan observasi peneliti terhadap subjek saat menyelesaikan permasalahan kata probabilitas. Permasalahan itu diberikan saat sesi wawancara. Wawancara semi terstruktur digunakan untuk memperoleh informasi yang mendalam. Analisis think-aloud melibatkan observasi yang mengarah ke perilaku verbal dan non-verbal individu peserta dan catatan lapangan peneliti. Hasil temuan dalam penelitian ini yaitu peserta mengalami kesulitan menafsirkan probabilitas. Berdasarkan hasil identifikasi terdapat tiga kategori kesulitan yaitu tidak mengetahui arti kata, tidak mengetahui sifat dari probabilitas dan tidak dapat mengidentifikasi tujuan dari masalah kata probabilitas.

Kata kunci: Hambatan, Probabilitas Suatu Peristiwa, Analisis *Think-Aloud*

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INTRODUCTION

Problem solving is a very important learning process in the mathematics curriculum. Based on the Malaysian Education Development Plan, problem solving is an element contained in 21st century skills, which is one of the focus of mathematics learning (Kementerian Pendidikan Malaysia, 2013). Therefore, problem solving skills among students must be taught from young as problem solving is closely related to word problems.

The development of students' mathematical learning depends on the type of word problem both verbally and in the written form (Daroczy, Wolska, Meurers, & Nuerk, 2015; Schley & Fujita, 2014). Word problems serve as contributors to student's achievement in mathematics,

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generally. Previous studies showed that many students experience difficulties in mastering problem solving skills, specifically problem solving skills involving problem translation, problem integration, solution planning (Zakaria & Yusoff, 2009; Gagatsis & Elia, 2004), and also calculation, memory capacity and the problem solver (Guven & Cabakcor, 2013; Phonapichat, Wongwanich, & Sujiva, 2014; Swensen, 2015; Kusdinar, Sukestiyarno, Isnarto, & Istiandaru, 2017).

In mathematics, among the disciplines of knowledge that dominate the daily situation is probability. This is because probability is a very important aspect to predict the outcome of future events. The probability of an event dominates daily life activities such as controlling the flow of traffic through the highway system, predicting the number of people of all ages involved in an accident and estimating the spread of rumours (Batanero, Chernoff, Engel, Lee, & Sánchez, 2016). Probability is not about predicting whether a particular event will occur but about determining how that probability is distributed over possible events (Baltaci & Evran, 2016; Galavotti, 2015).

Learning the concept of probability and solving the word problem of probability presents a challenge to the students. This is because students need to master the concept of probability, problem solving process and understand the probability of problem simultaneously when solving probability word problem (Beitzel & Staley, 2015; Galavotti, 2015; Usry, Rosli, & Maat, 2016). The review of previous studies has largely focused on problem solving for a probability topic, such as conditional probability either manually or by using software (Beitzel & Staley, 2015; Gabriel, 2002; Gugga & Corter, 2014; Inzunza, 2006; Xing, 2016), joint events probability (Beitzel, Staley, & DuBois, 2011; Zahner & Corter, 2010) and the Bayes network (Ong & Lim, 2014). The probability of an event seems simple when it involves the sample space, the probability of an event, and the conditional probability. However, there are scarce empirical research on probabilities and events (Corter & Zahner, 2007).

Discussions about the difficulties or obstacles faced by college students while solving probability problems are also limited as most of the studies focused on skills and attitudes of students while solving problems (Zakaria & Yusoff, 2009; Yusof & Taib, 2006; Yusoff & Salleh, 2006). The performance of college students is still unsatisfactory as a question mark as these students have learned the basics of probability while at the secondary level (Danisman & Tanisli, 2017). There must be a reason why these college students still having problems while coping with probability of an event problems.

Thus, this study was conducted to identify solution strategies and obstacles encountered by students while solving probability problems. This study focuses on the difficulties experienced by students to achieve the correct solution to the word problem of the probability of an event. The presentation of this study will only answer the question of what are the obstacles faced by matriculation college students while solving the probability word problem.

METHODS

This study employed a case study design using clinical interview technique. This technique developed by radical constructivism is a direct observation in the context of one to one interaction with observing the behaviour of participants as they solve problems (von Glasersfeld, 2002). Seven participants were selected from a matriculation college in Peninsular Malaysia. Sampling techniques aimed at maximum variation are used to meet the characteristics of study participants who are required to obtain data from non-homogeneous study samples. This sampling plan helps the best to get data and go for saturation data. The instruments involved in the study include semi-structured interview protocols, observation protocols and probability word problem task. The task given has three questions of probability word problems. The probability word problem focuses on the subtopics of Probability of Independent Events and Probability of an Event.

Clinical interview sessions were conducted after lectures and at participants' leisure time. Interview sessions were recorded so that each participant's behaviour such as the eye balls moved to the right and left repeatedly, knocking hands on the table, sweating and so on could be observed and recorded for reference. All audio and visual data are transcribed in verbatim form. Data were encoded and distributed into appropriate categories after the refraction process. The analysis of observational data from field note entries were also coded. Comparative analysis techniques were used to record emerging themes to answer research questions. Student's written answer were also analysed to ensure they had difficulties in facing the problems.

RESULTS AND DISCUSSION

This section presents the findings of the study obtained from the clinical interviews that were conducted. Based on the constant comparative analysis implemented, among the themes emerged from this study is the difficulty of students to interpret probabilities. There are three categories of obstacles that students faced when solving the probability word problem, namely do not know the meaning of the word, do not know the nature of the probability, and cannot identify the goal.

The first obstacle identified was that participants did not know the meaning of the word. In this study, the participants did not know the meaning of some words, such as "subsequent", "given" and "perfect square number". Participants knew there was an underlying meaning of the words "subsequent" and "given", but they could not identify and understand in detail, although the participants tried to read the translations of the questions (Figure 1).

A school has an enrolment of 1000 students. The students buy newspapers daily at the school cooperative store. Sales records show that 200 copies of The Star newspaper and 120 copies of The NST newspaper were sold on a particular day. It is known that 30 students bought both The Star and The NST newspapers then. Find the probability of students did not buy either of the two newspapers.

Two fair dice are rolled at the same time. Find the probability of getting one even and one odd number.

Fatah Amin played "Wheel of Fortune" in a Math Fun Fair. The wheel is divided into 40 equal sectors and numbered 1 to 40. The wheel is spun and allowed to come to rest so that a pointer points within a numbered sector. Find the probability that he can get a number which is either a perfect square or the sum of its digits is 7.

You are leaving for holiday! Since it's March, the weather can still be unpredictable in Langkawi. There is a 30% chance that it will rain on the day you are scheduled to depart. So you call KLIA airport and ask them for some information. They tell you that the probability that a flight will take off on time GIVEN that it rains is 0.10. They also tell you that the probability that a flight will take off on time GIVEN that it doesn't rain is 0.80. What is the probability that is rain, given that the flight takes off on time?

Figure 1. Question of Probability

Participant A mentioned "Perfect square number is a number that can be square root. The number should be an even number, right. No decimals".

Participant B draw n label the wrong tree diagram as she did not understand the meaning of "given" where the label of next branches depends on the first label of a tree branch.

When participants are unable to comprehend the implicit meaning of the word, the participants tend to ignore the information conveyed. When the terms "subsequent" and "given" in the given word problem confuses the participants, they misunderstand the meaning by using future events, instead of employing the next event that occurs.

The findings of the interview explain that the participants understand the sentence "probability of event A occurs if event B also occurs " by relating the statement to the conditional probability formula. However, the findings of this study found that participants could not represent the statement "probability A, given B is 0.1" to the mathematical sentence " $P(A \mid B) = 0.1$ ". From the interviewed, researchers recognized that participants did not know the short words (probability A, given B is 0.1) used in the question.

The second obstacle is not knowing the nature of probability. The study also found that participants did not understand the concept of probability involving the law of probability. The properties of probability involve sample space as well as set notation. Participants list the outcomes without set notation for questions involving the listing for a sample space. They are able to list all the desired numbers as a calculation path. They also know how to find the probability of a desired event but did not record or represent the probability term with the symbol "*P*". Participants are also careless when implementing the final solution in the solution process. They fail to re-explain the final value obtained by leaving the calculation result without any statement (Figure 2 and Figure 3).

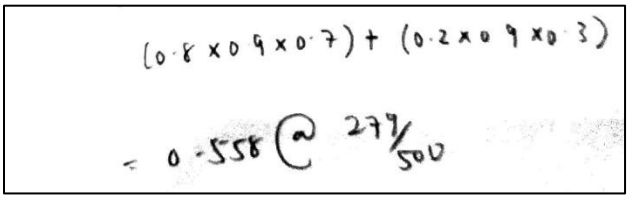

Figure 2. Solution by participant A

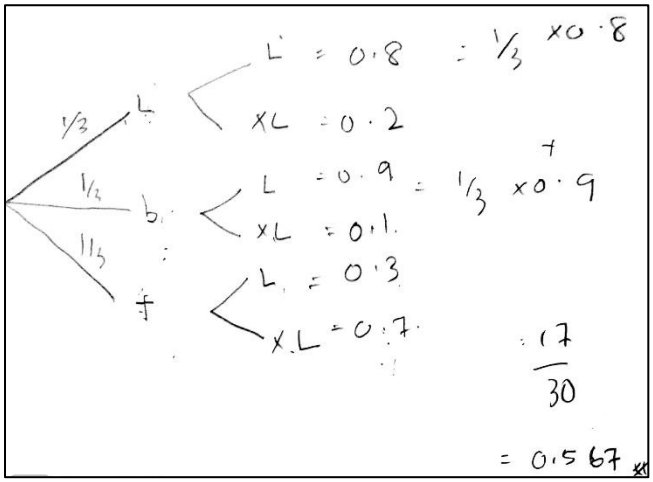

Figure 3. Diagram by participant C

Previous studies posit that the examiner was unable to identify the student's concept of probability if a solution is given without any statement (Bobek & Corter, 2010; Gugga & Corter, 2014; Xing, 2016). Charles, Lester, and O'Daffer (2005) also suggest that systematic mathematical problem solving and having certain procedures give a good impression on a student, and also teachers are able to evaluate the solution process smoothly. Thus, students need to be proficient with other numerical properties such as the use of probability symbols, set notations in the list of outcomes and probability values between one and zero (Batanero et al., 2016).

The third obstacle that participants face is not being able to identify the goal in the problem. The participants were found to have difficulty interpreting probability events. From the interviewed, some participants are confused by the problem text. Even though students read the question repeatedly, they still fail to identify the goal of the problem. From the observations, Participants who have difficulty interpreting probability events will read the question slowly and repeatedly even in front of their teacher. When students are unable to interpret probability events, they will assume the related questions are complicated to solve because they are unable to obtain information from the problem. This situation hinders the students to proceed to the next process of problem solving. Therefore, they cannot solve the questions even they tried to do the solutions. Similarly, Arum, Kusmayadi and Pramudya (2018) discussed pertaining to the difficulty of understanding probability problems. The study found that students who could not identify the goal of the problem indicated that they did not understand the problem.

Based on the observations and interpretations by the researcher, participants assume that the probability term is the same as the mathematical term and vice versa. Inzunza (2006) stated that difficulty faced by students in interpreting and using correct probability terms will disrupt the problem-solving process.

CONCLUSION

Many studies in the field of mathematical problem solving have focused on students' skills while solving problems. Thus, this study is expected to contribute to the lack of empirical studies in identifying weaknesses or difficulties faced by students while solving problems. This is because such studies provide information on the difficulties faced by students in learning and teaching probability, as well as contribute ideas to instructors in developing the pedagogical techniques practiced. Instructors can curate methods and approaches in addressing the issue of student difficulties in mathematical problem-solving process before, during or even after the learning and teaching sessions are implemented. These findings can have solved some of the problems faced by college students. They can use procedural methods in solution strategies without neglecting the probability statement. They have to mastered the nature probability by doing more practices. From the practises, they will know word problems relating the mathematical formula and vice versa. Besides, understanding probability word problems in terms of using correct terms and chosen right solution strategies can make students performed well.

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