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Mathematical Cognition and Big Data Analytics: Are Sarawak Teachers Ready?

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ABSTRACT

To remain relevant in Sarawak's Digital Economy Agenda (2018-2020), Mathematics teachers in Sarawak need to align their content with current expectations for the future workforce in the state. Big data analytics is a crucial driver to the Digital Economy Agenda, as it is stipulated to intensify economic growth in Sarawak. To be fluent in big data analytics, one has to master mathematical cognition. This study investigates the readiness of Mathematics teachers in urban and rural Sarawak, to highlight mathematical cognition in their teaching, to prepare their students for the requirements of big data analytics for the digital economy in Sarawak. The participants are 38 teachers who are currently teaching mathematics in primary and secondary schools from urban and rural areas across Sarawak. Data was collected using an online survey that was distributed via social media. It was found that there was no difference in the choices of teaching strategies used by mathematics teachers in Sarawak despite multiple demographic factors such as gender of their students, types of school, districts and years of teaching experience. Teachers were fully aware of the digital economy agenda, and they were conscious of the current state of their students who were deemed still unprepared to take part in the Sarawak Digital Economy Agenda.

Keywords: Mathematics; Mathematical cognition; Big data analytics; Digital economy

INTRODUCTION

In 2017, it was announced that Sarawak would undergo a statewide initiative known as Sarawak Digital Economy Strategy (2018-2020). Approaching the digital economy is one of the first steps to reduce and hopefully end the dependence on natural resources for economic growth in Sarawak. Through information and communication technologies (ICT), a wide range of economic activities, professional interactions and commercial transactions occurs, thus generating a digital economy. Shifting the focus will create an alternative for various business opportunities through digital marketing. Differences

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between rich and poor developing nations can be reduced as the digital economy provides numerous benefits among most developing countries with adequate access to ICT (Lazović & Duričković, 2014).

The digital economy is different from the internet economy, in that the internet economy is centred on internet connectivity whereas the digital economy is widely grounded on any of the many digital media tools used in today's financial world. Big data is among one of the main components in Sarawak's Digital Economy Agenda. Big data plays a crucial role especially in big data analytics which aids in boosting economic growth by gathering a considerable amount of data from each citizen based on their online behaviours which are in parallel with the current global movement towards the Fourth Industrial Revolution (4IR). To perform big data analytics, one must have the mathematical skills needed to be a data analyst.

To understand how prepared Sarawak's human resource is for big data analytics revolution in the state, the primary purpose of this study is to investigate Mathematics teachers' readiness to realise the importance of implementing analytics capabilities among their students towards fulfilling the demands of Sarawak's Digital Economy Agenda. Teachers' teaching strategies are influenced by demographic factors such as types of schools (urban and rural), types of students (primary and secondary) and their age groups. For instance, Mathematics teachers in urban schools are able to incorporate technology as their teaching material and expose the students with cognitive tools that aid in their process of learning mathematics. However, teachers in rural schools have limited access to current technologies and have difficulty in gaining internet access quickly. Besides that, teachers' teaching strategies are different for primary and secondary school students. The students' capabilities in constructing knowledge and their assessments differ as those in primary schools are still young to grasp in-depth mathematical concepts fully. Lastly, teachers who are from a younger age groups can adapt quickly to changes in terms of teaching strategies which includes using current technologies that can be used as their teaching aid and apply gamification in learning for those who have low interest in learning mathematics whereas those from the older age groups may stick to their preferred methods of teaching mathematics which is mostly using blackboards and chalks and increase in the number of home works for their students. Big data analytics is slated to play a significant role in most companies that are doing business to increase their financial gain. Teachers are at the forefront of the education channel, in that their roles are crucial in preparing the future workforce to spearhead the Digital Economy Agenda. Teachers also need to recognise how big data analytics will have an impact on the state's economic growth. Indirectly, teachers are challenged to boost the emphasis of mathematical cognition in their teaching, as mathematical skills are part of 21st-century skills for future learners who will be the beacon of hope for Sarawak's future development.

The research questions that guide the study are as follows:

a) Are there differences between teaching strategies of Mathematics teachers in Sarawak by selected demographic factors

(Gender, Types of School, Years of Teaching and District)?

b) Are urban and rural Mathematics teachers ready to prepare their students for Sarawak's Digital Economy Agenda?

Teachers play an essential role in educating and preparing their students for the future development of the country. With the recent launch of Sarawak's Digital Economy Agenda, mathematics teachers play a pivotal role in realising the agenda, and they need to review and realign their teaching strategies to adapt to the demands needed by the digital economy and sharpening their students' skills regarding mathematical cognition to be applied in big data analytics.

In the study, it was deemed necessary to focus on demographic factors because of the geographical vastness of the state of Sarawak, where teachers are assigned to teach at various locations. Each location denotes a variety of instructional issues, indigenous to the area. For instance, local dialects, values and expectations are some of the challenges often quoted by teachers who are assigned to communities they are not familiar with. Many teachers originate from localities different from those in which they teach. Hence this study intends to find out if demographic factors play any role in influencing the instructional strategies teachers use.

METHODOLOGY

Research Design

The research design used for this study is Quasi-Experimental Exploratory Design. This design is considered appropriate and useful as there are high levels of uncertainty and ignorance about this subject, especially in Sarawak. This approach is used regularly to form an understanding of how best to proceed in studying an issue or what methodology would be constructively applied to garner more information regarding this issue.

Population and Sampling

The population selected for the study are all Mathematics teachers who are actively teaching the subject throughout the state of Sarawak. As the study intends to understand the readiness of Mathematics teachers to prepare their students for Sarawak's Digital Economy goals cognitively, all in-service teachers are invited to participate in the online survey. The survey was made available for three weeks and using the snowball approach; teachers were recruited to respond to the items in the survey. Invitations were sent through networks of teachers in all central districts and using social media tools; the survey was circulated to as many existing networks identified through influential teachers.

Instrument

The instrument used in this study is a questionnaire of Teaching Strategies by Mathematics teachers (M. Hamzeh, 2014). The questionnaire is then modified to suit the purpose of this study. It consists of two parts on three main domains (behavioural strategies, cognitive strategies and effective strategies) and three subjective questions.

Behavioural strategies focus on behavioural strategies that could affect students' mathematical cognition. It consists of 22 questions. Cognitive strategies comprise of 33 questions regarding cognitive strategies of teachers during teaching and learning session in schools. Effective strategies refer to teaching strategies which are deemed useful to help students comprehend content knowledge. In the survey, there are 25 questions on effective strategies in teaching Mathematics. All items are put on a 5-point Likert scale.

The final part of the survey consists of three subjective questions. The questions centred on teacher's knowledge and awareness about Big Data Analytics and its connection with Mathematics. Respondents were expected to provide a one-paragraph worth of comments and input in the component, to enable a cross-sectional analysis of the data.

Data Collection

Respondents were required to complete an online survey containing demographic questions and the following measures that were distributed via social media platforms and known teacher networks in Sarawak. Test of reliability was done based on the data collected. Random sampling is carried out in this study to reduce selection bias, and to get a sample of people that is representative of the larger population.

Data was collected from Mathematics teachers who were actively teaching at urban and rural schools across Sarawak (n=38). The majority of them were teaching in rural schools (68.4%); the remaining 31.6% were in urban schools. 44.7 per cent were male teachers with seventeen respondents were teaching in the capital city, Kuching.

RESULTS AND DISCUSSION

Testing the instrument

A reliability test was done for all three domains to determine the reliability of the instrument used in this study. Cronbach's Alpha for behavioural strategies is 0.813. Cronbach's Alpha for cognitive strategies is 0.935, whereas for effective strategies is 0.948. As all values for Cronbach's Alpha were valued at more than 0.70, the instrument was deemed to have high internal consistency and reliability.

From this survey, a total of 38 respondents collected. This shows that the data is not normal due to the small sample size. Since the data is not necessary to fit a normal distribution, a statistical approach known as nonparametric statistics is applied.

Influence of Demographics on Mathematical Teaching Strategies

Mann-Whitney U test was conducted to determine if Gender and Types of Schools cause any difference in the teaching strategies of Mathematics teachers in Sarawak. Kruskal-Wallis test was used to determine if there are differences in teaching strategies of Mathematics teachers based on Years of Teaching and District. Means from all four variables (gender, types of schools, years of teaching and district) were compared with means of three domains (behavioural strategies, cognitive strategies and effective strategies). Results obtained are shown in the Table 1.

The p-value obtained from the Mann-Whitney U test for gender against all three domains is 0.866 for behavioural strategies, 0.976 for cognitive strategies and 0.560 for effective strategies. Since all p-values are larger than 0.05, the null hypotheses are accepted.

For types of school, the p-value shown in Table 1 were 0.444, 0.088 and 0.153. These p-values were larger than 0.05. Therefore, the null hypotheses are retained.

Based on the Kruskal-Wallis test, the p-value for years of teaching is 0.315 for behavioural strategies, 0.189 for cognitive strategies and 0.307 for effective strategies. All three values

Table 1: Gender, Types of School, Years of Teaching and District against Means of Behavioural Strategies, Cognitive Strategies and Effective Strategies

Variables	Behavioural Strategies	Cognitive Strategies	Effective Strategies
Gender			
Male	83.8125	124.0625	102.1250
Female	83.1429	122.667	97.8095
Test statistics (U)	162.500	167.000	149.000
***p*-value**	.866	.976	.560
Types of School			
Urban	84.1667	128.7500	103.4167
Rural	83.0800	120.6400	97.8800
Test statistics (U)	126.500	97.500	106.000
***p*-value**	.444	.088	.153
Years of Teaching			
Less than 5 years	84.5000	134.5000	109.0000
5-10 years	79.8750	119.6250	92.5000
11-15 years	84.6000	131.0000	105.6000
16-20 years	86.1429	123.4286	98.2857
More than 20 years	83.3846	119.0000	99.6923
Test statistics (H)	4.745	6.141	4.814
***p*-value**	.315	.189	.307
District			
North	77.0000	113.0000	86.0000
Central	81.7778	122.3333	99.2222
South	84.5000	124.3846	100.8846
Test statistics (H)	.979	.491	1.843
***p*-value**	.613	.782	.398

*** Significant at $p < 0.05$**

shown appears to be larger than 0.05; thus, the null hypotheses are accepted.

Lastly, the *p*-value for district shown in Table 1 is 0.613 for behavioural strategies, 0.782 for cognitive strategies and 0.398 for effective strategies. Since all three *p*-values were larger than 0.05, the null hypotheses were accepted.

DISCUSSION

Findings indicate that all of the null hypotheses were accepted. The findings justified how demographic factors such as choices of teaching strategies of Mathematics teachers in Sarawak were not determined by the gender of their students, types of school, districts and years of teaching experience, were not influencing factors for the respondents in the study when teaching Mathematics. Based on the values reported for each demographic factor, it is assumed that every mathematics teacher who responded to the survey applies similar teaching strategies in terms of behavioural strategies, cognitive strategies and effective strategies. Based on the findings, it is assumed that the standards of teaching from every mathematics teachers throughout Sarawak is assumed to be equal.

Are Mathematics teachers in Sarawak ready to prepare their students for the Digital Economy Agenda? Findings from this study revealed how the respondents admitted to attempting to raise awareness about the importance of mastering Mathematics. Knowledge and skills in Mathematics are crucial in gearing the human resource of the state for the Digital Economy Agenda. While all respondents indicated they were aware of the importance of Mathematics for the Digital Economy, out of 38 respondents, 31 of them tried to raise awareness on the importance of mathematics concerning digital economy agenda in Sarawak.

Regarding their students' readiness in participating in Sarawak's Digital Economy Agenda, a majority of them were still not ready meanwhile most of the teachers are aware of this initiative and are ready to brush up their students' mathematical skills. The phenomenon could be because this initiative was recently launched state-wide, and there are teachers whose students are still in primary schools and are unable to fulfil the demands of this digital economy initiative.

It can be concluded from this study that the teaching strategies of mathematics teachers teaching in urban and rural schools in Sarawak are not affected by demographic factors such as the gender of their students, the types of schools, districts and years of teaching experience.

Further research should focus more on big data analytics instead of mathematical cognition. When big data analytics is being focused more, indirectly mathematical cognition will be taken into account. The relationship between big data analytics and the growth of the digital economy should be the main highlight.

It was also found that 20 out of 38 mathematics teachers have begun to guide their students to see the connection between mathematics and big data analytics. The findings indicate that most of these teachers were aware of the connection between big data analytics and mathematical cognition in their teaching, a promising start to enabling the development of the agenda from the school level.

Due to the small sample size, normality tests were weak in power to reject the null hypothesis. Therefore, all null hypotheses were accepted in this study. The results would be different if the sample size were bigger since Sarawak is the largest state in Malaysia. Besides that, the subjective questions in this study can be added to increase the accuracy of the research outcome. Instead of focusing only on the digital economy, more questions regarding challenges and opportunities faced by teachers in exposing their students with big data analytics and how it would impact the state's economic growth.

Mathematics teachers are encouraged to emphasise on mathematical cognition in their teaching to encourage students to have an interest in big data analytics. However, there is a disparity. Most teachers in urban and rural schools are unaware of its importance, and many students are not ready to fulfil the demands for data analysts for the digital economy in Sarawak. Mathematics teachers are induced to modify their teaching strategies that highlight mathematical cognition to prepare their students with the requirements for big data analytics.

The study can be replicated and disseminated widely to more participants to advance the inquiry on human resource preparedness for Sarawak Digital Economy Agenda. Participant groups could include teachers, parents, federal and state-level agencies which are related to Education and Training, and those who are providing STEM-based training in the state. The agenda is new to Sarawak, and some distinct challenges and gaps need to be identified and bridged, to enable Sarawak to excel in its future. The state education department can take the lead to elevate support for the teaching of Mathematics in Sarawak. The state government's machinery for the Digital Economy can also take on roles to create career pathways which emphasise the need for Mathematics for the development of Big Data and future technologies. A collective, systematic and sustainable effort from all relevant agencies and teachers are crucial to make Sarawak's Digital Economy agenda possible.

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