

PROBLEM-BASED LEARNING: ENHANCING HIGHER-ORDER THINKING SKILLS IN THE TOPIC OF DIFFERENTIATION THROUGH STEM APPROACH

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Dr. Sarveswary Velayutham is currently working at SMJK Chung Hwa Confucian in Penang, Malaysia as a Mathematics and Additional Mathematics teacher. Currently, her passion has driven her to conduct STEM workshops in conferences, higher institutions and school as a contribution to the mathematics field of study.

Dr. S. Kanageswari Suppiah Shanmugam is a senior lecturer at the School of Education and Modern Languages, Universiti Utara Malaysia, Malaysia and specializes in Psychometrics and Educational Measurement. She has conducted international and national colloquia/workshops/seminar on Higher-order Thinking Skills (HOTs), Item Development, Authentic Assessment, Lesson Study/Action Research and Mathematics Pedagogy. She was also a key personnel in the development of HOTs Manual by the Examination Syndicate, Ministry of Education, Malaysia that is being used nationwide.

Ms. Tan Phei Ling is the Head of Mathematics Department at Methodist Girls' School, Penang, Malaysia. She obtained her Master's Degree in Mathematics Education from University of Science Malaysia, Penang. Her aspiration to improve STEM learning experience for secondary Malaysian students was recognised by the Penang State Educational Department, with the Innovative Teacher Award in the year 2013.

Ms. Chia Hui Min is a PhD student of The Education University of Hong Kong. She obtained her Master's Degree in Mathematics Education from University of Science Malaysia, Penang. She has been a secondary school teacher for 10 years before she pursues her doctoral degree in 2019.

STEM have attracted the attention of researchers and educators from all over the world. There is increasing effort in promoting students' learning in STEM related subjects. However, study conducted by Nadirah Mohd. Nasir and her team (2013) found that students have difficulties in applying the concepts and basic problem-solving skills on differentiation related with science and engineering subjects. Similar findings were also reported by Wright (2014) and suggested that extra cognitive task and abilities were needed in solving algebraic word problem. As such developing higher order thinking skills in the topic of differentiation warrants attention. Hence, this workshop is aimed at adopting Problem-based learning through STEM for participants to experience hands-on in applying the concept of differentiation to enhance HOTs. The activities in this workshop are designed to facilitate students' HOTs through enquiry-based learning. With the use of GeoGebra, an open source software, participants will explore on the concept of tangent, perpendicular lines, minimum and maximum value, rate of change and small changes to construct models with low cost material and solve three problems involving concept of maximum and minimum value. Appropriate use of computer software could help to enhance students' learning in topic related to calculus (Bognar et al., 2018; Cekmez, 2020). Besides, Engineering the models promotes participants visualization, relational learning and application of STEM in real life and hence meaningful learning occurs from the series of STEM integrated activities. After the workshop, participants would be more confident in facilitating their students' inquiry learning in the topic of Differentiation and spur their interest in Mathematics.

Planned timeline	Planned activity	Working format /Responsible person												
10 minutes	<u>Introduction to the workshop and Pre-workshop questionnaire (Read your mind with sticky notes).</u> Discussion on the concepts related to differentiation and the relevance of the concepts in real life problems.	Colored sticky notes, attachment1, discussion/ Chia,H. M.&Dr Sarves												
20 minutes	<u>Understanding the model (interactive discussion)</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px; text-align: center;">1</td> <td>Solve Differentiation with traditional method and with exploring GeoGebra.</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Self-explored question.</td> </tr> <tr> <td style="text-align: center;">3</td> <td>Solving HOTS question with windows pane technique and construction of models, gallery walk, discussion and conjecture.</td> </tr> <tr> <td style="text-align: center;">4</td> <td>Verify result with 3D model from GeoGebra.</td> </tr> <tr> <td style="text-align: center;">5</td> <td>Calculating the density of the flour</td> </tr> <tr> <td style="text-align: center;">6</td> <td>Enrichment activity (a follow-up on density).</td> </tr> </table>	1	Solve Differentiation with traditional method and with exploring GeoGebra.	2	Self-explored question.	3	Solving HOTS question with windows pane technique and construction of models, gallery walk, discussion and conjecture.	4	Verify result with 3D model from GeoGebra.	5	Calculating the density of the flour	6	Enrichment activity (a follow-up on density).	Attachments 2-6, power point, interactive/ <i>Dr Kanages & Tan P. L.</i>
1	Solve Differentiation with traditional method and with exploring GeoGebra.													
2	Self-explored question.													
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4	Verify result with 3D model from GeoGebra.													
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30 minutes	<u>Case Study 1</u> Students perspective (more able and less able students) on teaching and learning differentiation with STEM approach. <u>Case Study 2</u> Educators perspective (Undergraduates from teachers' training college departments), teachers, district officers from the Education	Power point, interactive/ Tan P. L. Power point, interactive/ <i>Dr Sarves</i>												
5 minutes	<u>Question and answer sessions</u> Summary of the teaching and learning of Differentiation with STEM approach.	Discussions/ <i>Dr Kanages</i>												
10 minutes	<u>Post-workshop questionnaire and making reflection from the sticky notes from slot 1</u> Discussion on the concepts related to differentiation and the relevance of the concepts in real life problems.	colored sticky notes, attachment7, discussion/ <i>Chia H. M.</i>												

Venue requirement:

None-Online

References

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Nasir, N. M., Hashim, Y., Ahmad Zabidi, S. F., & Jusoh, R. (2013). Preliminary study of student performance on algebraic concepts and differentiation. *World Applied Sciences Journal*, 21, 162-167.

Wright, J. (2014). An investigation of factors affecting student performance in algebraic word problem solutions. Retrieved from https://digitalcommons.gardner-webb.edu/education_etd/26

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