INCORPORATING SOCIAL COGNITIVE LEARNING INTO LEARNING ENVIRONMENT OF MATHEMATICAL SCIENCE STUDENTS

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ABSTRACT

It is essential to establish a classroom environment in which students feel safe and motivated to collaborate, cooperate, and pursue mathematical understanding. Mathematics is a core subject that all science and technology students must earn at least a grade C. This study was conducted by distributing questionnaires to 163 students enrolled in Malaysian institutions of higher education. The respondents were Mathematical Science students aged 18 to 32 with study levels ranging from diploma to master. The questionnaires include thirty questions organised into four sections: learner-centered, community-centered, assessment-centered, and knowledge-centered. The purpose of this study is to investigate how the three components of social cognitive learning (SCL) influence the learning environment for mathematical science students by utilising correlation and regression analysis to determine the relationship between the variables. Incorporating the principles of SCL into the learning environment had a positive effect on student and educator engagement, as demonstrated by the findings.

Keywords: Learning environment, Mathematical science, Social Cognitive

1.0 INTRODUCTION

A learning environment is more than a classroom; it is a place where students feel safe, supported, and inspired in their pursuit of knowledge. Consequently, the teacher needs to create a learning environment in which students are motivated to learn within the parameters and expectations of a safe classroom.

Donovan and Bransford (2005) highlighted that students perform best in settings that emphasise the learner, the community, assessment, and knowledge. For example, before introducing new material, teachers can address students' prior knowledge and beliefs in the classrooms. Thus, to address what, why, and how of instruction, teachers can structure students' mathematical knowledge around fundamental concepts. Teachers can encourage students to ask questions, listen to one another, and take intellectual risks by providing daily opportunities for students to demonstrate their comprehension of course material. This view coincides with the theory of social learning, individuals acquire social norms and conventions by observing and imitating the actions of others. It seems that incorporating the theory into the learning environment is essential to create a conducive classroom. Hence, this study is to investigate the connection between the learners, the community, assessment, and knowledge in the learning environment of mathematical science students in the context of undergraduate students in Malaysian universities.

The theory of social learning was first developed by Bandura in 1977. Bandura acknowledged that people gain significant insight from observing the rewards and punishments meted out to others.

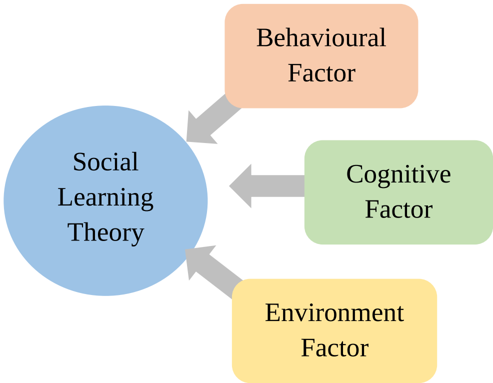

Fig. 1 Social Learning Theory by Bandura (1977)

Fig. 1 depicts the key components of Bandura's 1977 social learning theory. Later developed in 1986, the social cognitive theory asserts that learning occurs in a social context with constant and shared interaction between the individual (cognitive), the environment, and behaviour. Consequently, social cognitive learning (SCL) refers to the process by which a person learns by observing and imitating the actions of others in various contexts (Kouroubas & Galanakis, 2002).

Content knowledge (knowing what to teach) and pedagogical knowledge (knowing how to teach and how to address students' problems and learning difficulties) are the two main knowledge required in teaching mathematics (Yigit, 2014). The environment connects students' learning to the core concepts of the mathematical discipline. Another opinion came from Kirikcilar and Yildiz (2018) stated that learning mathematics can only be successful if students construct their knowledge rather than merely extending their knowledge through memorization. Therefore, teachers should assist students in applying and enhancing their existing knowledge as well as creating new information, hence the teaching approach shifts from being centred on the teacher to being more student-centred (Tondeur et al., 2017).

Recently, the technology-related approach in the learning environment of mathematics class presents new pedagogical challenges for teachers. A survey of 29 mathematics teachers from nine European countries (15 females and 14 males) was conducted and employed semi-structured interviews, the Approaches to Teaching Inventory (ATI-16), and the Technological Pedagogical Content Knowledge (TPACK) questionnaires were used to test technology-related pedagogical competencies. According to the results, one-third of teachers use a more student-centred approach, one-third a more teacher-centred approach, and one-third a mixed approach (Nantschev et al., 2020). It means a variety of approaches can be used to create a learning environment and teachers should understand the appropriate educational technologies and their potential. On top of that, Bringula et al., (2017) implemented mobile-assisted learning which resulted in the complexity of the problems on linear equations being solved by the students more than fifty percent of the problems correctly.

Moreover, the study by Hongbiao et al. (2020), found that the mathematics classroom environment was associated with affective and cognitive mathematics outcomes by taking the role of mathematics beliefs including mathematics conceptions and efficacy as mediators in the context of mainland China. Analysis of a sample of 1443 undergraduate students from a university in northern China found that a desirable classroom environment was related to students' cohesive conceptions, enhanced self-efficacy, and higher mathematics achievement.

Based on the above, this study is done to examine the relationship between the three components of social cognitive learning (Behavioural – learner and knowledge, Cognitive – assessment, Environment – community), and learning environment in the context of mathematical science classrooms in Malaysian Universities. The following conceptual framework serves as the foundation for this study.

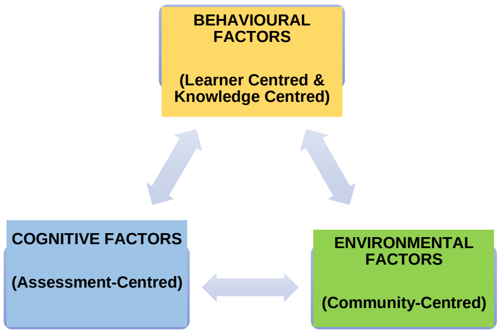

Fig. 2 Conceptual Framework of the Study – Social Cognitive Learning in the mathematics classroom

Fig. 2 presents the conceptual framework of the study. This study is adapted from Bandura's (1977) social cognitive theory and the environmental factors by Hassan et al. (2020).

2.0 METHODOLOGY

This quantitative study aims to examine social cognitive learning in a mathematics learning environment. Public and private universities in Malaysia have contributed 163 participants, of which 35% are male and 65% are female. 95.1% of respondents attended a public university, while 88.8% held a diploma. The instrument is a modified version of a survey by Hassan et al. In addition to Section A's demographic profile, there are four additional sections which include 30 questions. Section B includes seven items that are learner-centred, Section C includes seven items that are community-centred, Section D includes eight items that are assessment-centred, and Section E includes eight items that are knowledge-centred.

The data is collected through a Google form and analysed using SPSS version 23 for Windows. The Cronbach Alpha for learner-centred, community-centred, assessment-centred, and knowledge-centred questions is 0.855, 0.877, 0.925, and 0.928, respectively. The fact that the Cronbach Alpha is greater than 0.70 indicates that every questionnaire item is valid. Thus, the data in this study can be categorised as good and sufficient for the research.

3.0 RESULTS

This study employs correlation and regression analysis to examine the relationship between variables and estimate the influence of behavioural, environmental, and cognitive factors on the learning environment of Mathematical Science students.

3.1 Correlation

Correlation analysis determines the relationship between variables. This study involved the relationship between behavioural factors, environmental factors, and cognitive factors that influence the learning environment.

3.1.1 To Determine the Behavioural Factors that Influence the Learning Environment

Table 1 shows that learner centred (r = 0.891, p = 0.000) and knowledge-centred (r = 0.913, p = 0.000) have a significant value of 0.000 which is below 0.05. Thus, there is a significant relationship between behavioural factors that influence the learning environment.

Table 1**.** Relationship between behavioural factors influence the learning environment

		Learning Environment	Learner Centred	Knowledge Centred
Learning Environment	Pearson Correlation	1	.891**	.913**
	Sig. (2-tailed)		.000	.000
	N	163	163	163
Learner Centred	Pearson Correlation	.891**	1	.721**
	Sig. (2-tailed)	.000		.000
	N	163	163	163
Knowledge Centred	Pearson Correlation	.935**	.721**	1
	Sig. (2-tailed)	.000	.000	
	N	163	163	163

3.1.2 To Determine the Environmental Factors that Influence the Learning Environment

According to the results shown in Table 2, community-centred (r = 0.935, p = 0.000) has a significant value of 0.000 which is below 0.05. Thus, there is a significant relationship between environmental factors that influence the learning environment.

Table 2. Relationship between environmental factors influence the learning environment

		Learning Environment	Community Centred
Learning Environment	Pearson Correlation	1	.935**
	Sig. (2-tailed)		.000
	N	163	163
Community Centred	Pearson Correlation	.935**	1
	Sig. (2-tailed)	.000	
	N	163	163

3.1.3 To Determine the Cognitive Factors that Influence the Learning Environment

Results shown in Table 3, assessment centred (r = 0.930, p = 0.000) has a significant value of 0.000 which is below 0.05. Thus, there is a significant relationship between cognitive factors that influence the learning environment.

Table 3. Relationship between cognitive factors influence the learning environment

		Learning Environment	Assessment Centred
Learning Environment	Pearson Correlation	1	.930**
	Sig. (2-tailed)		.000
	N	163	163
Assessment Centred	Pearson Correlation	.935**	1
	Sig. (2-tailed)	.000	
	N	163	163

3.2 Regression

Regression analysis is the analysis in which it investigates how independent variables are linked to a dependent variable. It can be explained by model summary, ANOVA model, and multi-regression coefficient table.

3.2.1 To Determine the Behavioural Factors that Influence the Learning Environment

Table 4 represents the overall sample learning environment with the learner-centred and knowledge-centred. These factors explain 97.3% of the variance of the learning environment. The R^2 (94.7%) of the learning environment is mainly due to the learner centred and knowledge centred and the 5.3% indicates another factor.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.973[a]	.947	.946	.12665

According to Table 5, the ANOVA Table shows F (2,160) = 1416.443, p = 0.000 for the overall regression relationship for learner-centred and knowledge-centred with learning environment is $p < 0.05$. Therefore, the research model has proved that the learner-centred and knowledge-centred are significantly affecting the learning environment. The variable significant value can be continued testing under the coefficient table.

Table 5. ANOVA Table

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17.598	3	5.866	1416. 443	.000[b]
	Residual	16.349	116	.141		
	Total	33.947	119			

Table 6 shows the results of coefficient for learning environment with the learner centered and knowledge centered. The significant values according to Table 6 are 0.000 and 0.000. Based on the result learner centered and knowledge centered have relationship with learning environment when $p < 0.05$.

Table 6. Coefficient Table

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.063	.075		0.846	.399
	Learned Centred	.452	.0025	.486	18.434	.000
	Knowledge Centred	.531	.0025	.562	21.317	.000

3.2.2 To Determine the Environment Factors that Influence the Learning Environment

Table 7 represents the overall sample learning environment with the community centered. These factors explain 93.5% of the variance of the learning environment. The R^2 (87.3%) of the learning environment is mainly due to community centered and the 12.7% indicates another factor.

Table 7. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.935[a]	.873	.873	.19432

According to Table 8, the ANOVA Table F (1,161) = 11110.338, *p* = 0.000 for the overall regression relationship for community centered with learning environment is $p < 0.05$. Therefore, the research model has proved that the community centered are significant affecting the learning environment. The variable significant value can be continued testing under the coefficient table.

Table 8. ANOVA Table

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	41.927	1	41.927	11110.338	.000[b]
	Residual	6.079	161	.038		
	Total	48.006	162			

Table 9 shows the results of coefficient for learning environment with the community centered. The significant value according to Table 9 is 0.000. Based on the result community centered have relationship with learning environment when p < 0.05.

Table 9. Coefficient Table

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.598	.103		5.806	.000
	Community Centred	.853	.026	.935	33.322	.000

3.2.3 To Determine the Cognitive Factors Influence the Learning Environment

Table 10 represents the overall sample learning environment with the assessment centered. The factors explain 93.0% of the variance of the learning environment. The R^2 (86.6%) of the learning environment is mainly due to assessment centered and the 13.4% indicates another factor.

Table 10. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.930[a]	.866	.865	.20008

According to Table 11, the ANOVA Table F (1,161) = 1038.194, p = 0.000 for the overall regression relationship for assessment centered with learning environment is $p < 0.05$. Therefore, the research model has proved that the assessment centered are significantly affecting the learning environment. The variable significant value can be continued testing under the coefficient table.

Table 11. ANOVA Table

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	41.561	1	41.561	1038.194	.000[b]
	Residual	6.445	161	.040		
	Total	48.006	162			

Table 12 shows the results of coefficient for learning environment with the assessment centered. The significant value according to Table 12 is 0.000. Based on the result assessment centered have relationship with learning environment when $p < 0.05$.

Table 12. Coefficient Table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.697	.104		6.728	.000
	Assessment Centred	.824	.026	.930	32.221	.000

4.0 DISCUSSION AND CONCLUSION

The purpose of this study is to investigate Bandura's social cognitive learning (SCL) in the learning environment of students of mathematical sciences. Hassan et al. (2020) investigated the influence of three components of SCL (behavioural factors, environmental factors, and cognitive factors) on learning environment factors. A learning environment is a physical or digital space that facilitates the process of acquiring, constructing, and applying knowledge. For instance, it is designed to be interactive and offers opportunities for learners to participate in meaningful and active interactions with one another. Learner-centred, knowledge-centred, community-centred, and assessment-centred learning environments are the focus of this investigation.

The correlation and regression analyses revealed that all factors, including behavioural, cognitive, and environmental, have a significant impact on the learning environment. Therefore, to solve the problem teachers who create learner-centred environments develop practices such as discovering what students think, discussing students' misconceptions, and planning learning experiences that assist students in readjusting their ideas and developing stronger, more robust mathematical concepts and ideas. Students are more likely to develop deeper understandings and new knowledge if they are permitted to make mistakes and then examine their repercussions.

In knowledge-centred environments, learning focuses on fewer topics, but students develop a deeper understanding of the concepts and learn to communicate their understandings in a variety of ways (Neuman, 2000). Moreover, students are given the opportunity to solve difficult mathematical problems in a manner that requires them to grapple with and struggle with, to engage with the subject. Students are permitted to share their ideas, improve each other's ideas, challenge and be challenged, seek advice from peers, explain their thinking, provide evidence for their solutions, and investigate evolving ideas and hypotheses.

On top of that, students in an assessment-centred classroom are routinely expected to demonstrate their comprehension of essential mathematical concepts and ideas by writing answers to every question on tests and final exams. Traditionally, assessment practices have tended to emphasise the mastery of procedures and facts; therefore, taking the assessment as learning has been shown to improve teaching and learning.

5.0 SUGGESTION FOR FUTURE RESEARCH

Based on the findings in this study, the research can be extended to determine the students' performance in mathematics by incorporating SCL in the learning environment of mathematics class by using experimental methodology. The pre-post analysis should be utilised.

CO-AUTHOR CONTRIBUTION

The authors affirmed that there is no conflict of interest in this article. The first author carried out the fieldwork, prepared the literature review, and overlooked the writeup of the whole article. The second author wrote the research methodology and did the data entry. The third author carried out the statistical analysis and interpretation of the results.

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