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Problem Solving Skills Based on IDEAL Model in Implementing Undergraduate Final Year Project

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Abstract: Problem-solving skills are the formal framework for undergraduate programs in science and technical knowledge. This work aims to define the problem skills of the final year project (FYP) students. Most educators believe problem-solving is among the most important and practical learning and thought. One of the approaches of problem-solving skills introduced by Brandsford in the IDEAL Model. This model consists of five stages of problem-solving: identify problems as opportunities, define the problems, develop and understand goals, explore possible strategies, and anticipate potential effects before applying and looking back and learning. These research objectives are to develop a research instrument based on the IDEAL Model and identify problem-solving skills among students in conducting FYP. There are 324 students involved in this research from eight Universiti Tun Hussein Onn Malaysia faculties. The findings indicate that the reliability of the research instrument is sufficient to use and that the mean of identifying problems as opportunities in the IDEAL model showed higher scores than other approaches. To sum up, problem-solving receives considerable attention in the undergraduate and helps students to improve their academic and problem-solving skills. Research on the development of problem-solving skills by students, the transfer of problem-solving skills to new contexts, and the effectiveness of particular pedagogical approaches to problem-solving teaching have provided a basis for academic accomplishments by students.

Keywords: Problem-solving skills, final year project (FYP), identify, define, explore

1. Introduction

Problem-solving models are useful information levels or theoretical structures that define the specialists' cognitive method as soon as they solve problems within their domain. These models require considerable care freshly drawn as an instrument applied to advance powerful and well-organized information-based schemes. In academic settings, students often encounter problem-solving as little more than a systematic application of scientific and technological knowledge to well-constrained problems. Still, they are expected to graduate with the ability to solve complex, open-ended problems that require consideration of a wide range of problem constraints, including economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (Ruby et al., 2013). Most educators believe problem-solving is among the most critical and practical learning and thought. Nonetheless, most models of learning taxonomy and instructional design do not consider this a learning result. Since rejecting problem-solving by name in his earlier taxonomy, problem-solving was later seen as integrating certain laws and principles into laws of the higher order, which can be implemented in a limited collection of situations.

Problem-solving requires high analytical and synthesis skills, though it is not specifically classified (Jonassen, 2000). Problem-solving has been perceived as an effective strategy for helping students reflect and experience in-depth thinking (Hwang et al., 2014). Some authors identify critical and creative thinking as core skills that are applied to problem-solving (Bransford & Stein, 1994). Define problem-solving as the primary skill with critical and creative thinking as components (Frenseh & Funke, 2014). Problem-solving skills exist without subject context. Be all of that as it may, to be considered effective problem solvers, engineering educators should be able to draw upon a wide range of analytical, synthetic, and evaluative thinking tools, problem-solving heuristics, and decision-making approaches

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(Meltzer & Schwartz, 2018). When a problem has to be solved, they should be prepared to identify the target and put it in context; arrange a structured plan of attack that combines an appropriate mix of analysis, synthesis, assessment and problem-solving; locate sources of information; identify key ideas, underlying assumptions, and logical fallacies, and evaluate the credibility of the identified sources; create numerous options and classify and prioritize them; make appropriate observations and draw sound inferences from them; formulate and implement appropriate measurable criteria for making judgments; develop cogent arguments in support of the validity or plausibility of a hypothesis or thesis; generate new questions or experiments to resolve uncertainties; and monitor their solution process continuously and revise it if necessary (Kim & Hannafin, 2011). Problem-solving is cognitive reasoning aimed at achieving an objective when the Problem solver does not find a solution approach obvious (Córdova et al., 2015). Problem-solving is the structure inside which innovative thinking and thinking happen. Problem-solving is the structure within which innovative thinking and thinking occur. It is a procedure for removing obstacles that appear to interfere with achieving goals.

One of the main instructional duties is to develop the potential of the final year group's cognitive styles and problem-solving. Such capabilities depend to an enormous degree on success, efficacy, and joy in life. A child is not conceived on these capacities but rather needs to create these capacities developed in his lifetime with the assistance of his folks, instructors and society (Volkova & Rusalov, 2016; Jena, 2014; Norman, 1988). Problem-solving skills greatly impact student success for undergraduate students dealing with their final year project (FYP). The student's final year demands self-thinking, which can solve many complicated issues. Last year, students had to develop highly thought-provoking and reasoning skills to solve complex problems. In fact, many of the world's greatest contributions have derived from insightful and purposeful problem solving (Mayer & Wittrock, 2006).

Problem-solving skills are an analytical, logical, and systematic methodology that assists individuals when coping with problems, looking for multiple solutions, and choosing the greatest solution for circumstances. Previous research suggested that problem-solving will develop skills and self-confidence in various situations. Problem-solving is fundamental to undergraduate final-year project (FYP) conduct and writing. FYP 's principles are students being able to solve the Problem based on the problems and problem analysis in their study. The issue occurs when a final-year student desires a goal in FYP but needs to know immediately what steps to take to achieve that target. Problem solving as a tool, a skill and a method. A tool because it can help FYS solve an immediate problem or achieve a goal, a skill because it can be used repeatedly and as a process once learned because it involves the procedural stages. Therefore, this research will develop the problem-solving skills instrument and identify the capacity of the problem-solving skills of the final year students dealing with their FYP. The research objectives are as follows 1) to develop a research instrument of problem-solving skills based on the IDEAL Model; and 2) to identify final year students' problem-solving skills based on the IDEAL Model.

2. Literature Review

The IDEAL approach to Problem-solving is based on many powerful ideas, yet it could be better in the sense of being perfect or the best system that could be created. Nevertheless, it can be very helpful to those who want to improve their problem-solving skills (Brandsford & Stein, 1994). The IDEAL approach is designed to help identify and understand different parts or components of problem-solving. Based on Fig. 1, Brandsford identifies the five (5) stages of ideal Problem solving as vital to successful problem solving as well as the relationship among these stages.

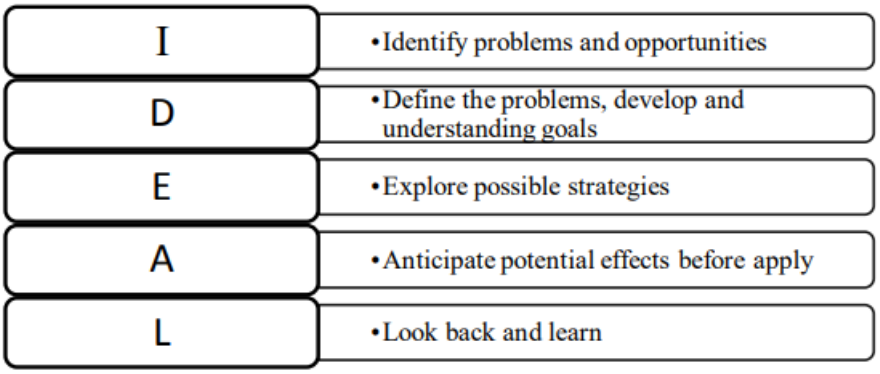

Fig. 1: Brandsford's IDEAL model in problem-solving

The third step is to discover innovative ways to address issues and determine their value before setting goals; in the final year, students must be able to explore various opportunities when working alone or writing their final-year thesis. When arrangements remain created, the fourth step is to anticipate the potential effects of these solutions (the solution they applied from the third stage while writing their final year project) before they are acted upon. Finally, once solutions are applied, problem solvers should look at the effects of their efforts and learn from their successes and failures (the effect of their efforts to see success and failure in their final year project (Abdullah et al., 2013).

Undergraduate final year student are required with communication skill and problem-solving skill (Rodzalan & Saat, 2015). If the Problem is not addressed, an implication would be a growth in the number of jobless graduates in the forthcoming (Pumphrey & Slater, 2002) claimed that technological advancement is also a factor that causes the development of cognitive style and problem-solving skills less efficient. With the technology advancement, students can access all the information through the Internet, which causes negative effects as they adopt the information without analyzing, interpreting and thinking critically. This also hinders their ability to solve problems because the Internet offers most of the solutions (Rodzalan & Saat, 2015).

he final year project develops a key aspect of the program's curriculum and must be geared towards developing research or innovation in the student's specialized field. The final year project is considered the students' most comprehensive and important evidence of research or innovation; it will play an important role in their final degree. Furthermore, the FYP offers opportunities for students for their academic and personal development and can also facilitate their professional integration. Through the FYP, students must apply the skills learned during these four years of study with professional and integrated, creative and innovative standards, incorporating new ones relating to the FYP itself, such as autonomy, initiative, knowledge development, abilities and tactics, and bring solutions to the research problems that derive from the final year project (Mateo et al., 2012). The person in charge of approval is often just a lecturer who decides according to their standards. Criteria for another instructor could be different, and the conditions for approving the proposal could vary significantly. Also, though it's a committee responsible for giving consent, the question persists. Since the committee's criteria are based on its members, the criteria change when other lecturers replace committee members (Villamañe et al., 2014).

3. Methodology

Before the data collection process, this research analyzes the validity and reliability of the research instrument developed by the researcher. The instruments developed are based on the IDEAL Model, and the research instrument section will further explain the process. This research employed a survey research design with a quantitative approach analysis that applied descriptive survey design to collect data from respondents on problem-solving skills in coping with FYP; the survey was chosen for its ability to obtain quantitative data, quantitative study methodology efforts to expand and build understanding of how things came to be in our way society (Ritchie et al., 2003). According to (Edmonds & Kennedy, 2016) the quantitative way to deal with gathering information emphasizes relating a phenomenon through a more important number of individuals in this way, giving a chance to summarize features across collections. This approach examines many individuals and applies statistical methods to classify overall forms of procedural relations. The use of reviews over groups should be possible cross-sectionally. In this research, individuals are the artefacts or human resources a researcher uses to study. According to Oyinloye and Popoola (2013), participants can be described as societies, objects, or people with the same characteristics relevant to the research (Edmonds & Kennedy, 2016). This study design used a questionnaire of problem-solving skills based on the IDEAL Model of problem-solving final year project. This study selected all final-year students in 8 faculties of UTHM.

The population is usually a huge collection of people or things that are the main emphasis of a scientific query. It is for the benefit of the population that investigation is done. However, due to the huge sizes of populations, researchers often need help to test every individual in the population. This is why researchers rely on sampling techniques (Lewis, 2015). The population from which the number will be drawn comprises the eight (8) Faculties in UTHM. Faculties were selected for this study as a result of their syllabus. The total number of faculties is eight (8), and the total number of final year students is 3327 male and female from each faculty. Sampling is a procedure of selecting a representative number of samples from the population; particularly, the sample should reflect the properties or qualities of the population component. The sample selection depends on the data and situation because the sampling techniques have different kinds. Stratified random sampling was applied when selecting the number of respondents. Stratified sampling is a probability sampling method and a form of random sampling in which the population is divided into two or more groups (strata) according to one or more common attributes (Boschetti et al., 2016). Table 1 shows the number of populations and samples involved in this research.

Table 1: Population and sample size

No	Faculties	Population	Sample
1	FKEE	594	64
2	FKMP	568	50
3	FKAAS	483	53
4	FTK	281	36
5	FPTV	421	60
6	FPTP	413	47
7	FSKTM	370	40
8	FAST	197	30
	Total population	3327	380

4. Results

4.1 Developing Problem-Solving Research Instrument Based on IDEAL Model

The problem-solving questionnaire measures the individual's perceptions of solving skills of final year project problem, it measures how learners identify the problem, develop, explore, act/apply and look back. The instrument in this study contains three sections: personal information and performance in Problem-solving skills; a questionnaire was adopted from Bradford and Stein (1984) and modified based on final-year project course learning outcomes. The researchers modified the instrument to measure the problem-solving skills of final-year students undergoing final-year projects. The instrument is based on the IDEAL Model of problem-solving and contains 40 questions. The test of the instrument was given to 40 Final year students undergoing FYP, and they were required to rate and fill the questionnaires according to the content validity, language, and clarity. The FYS were asked to respond on the Likert scale, on a range of one to five, ranging from strongly disagree to strongly agree. In addition, researchers also gave the test instrument to three experts who are lecturers in the areas of educational psychology. These three experts were required to validate the content validity of the test instrument. A pilot study was carried out to obtain the reliability of the questionnaires. The samples of the pilot study comprised 40 Diploma FYS. The questionnaire is divided into 2 sections: section one is personal information from the respondents, while section two contains 40 questions which were answered using numbers such as Strongly agree (1); Agree (2); Neutral (3); Disagree (4); Strongly disagree (5).

Two types of validity occur, each intended to confirm that the exact features of measurement tools are exactly measuring what they are intended to measure and that the results can be applied to real-world settings. The validity of the instruments was assessed using the content and construct validity (Ko et al., 2017). Content validity is the degree to which the instrument in the questions and the scores from these questions represent all possible questions that could be asked about the skill or content (Mohamad et al., 2015). The current research used content validity to survey the questions' information, content areas, and difficulty. Three experts employed as evaluators determined the content and construct of problem-solving skills; experts were selected based on their knowledge and skills. The experts had to confirm that the items were valid. Then, a different group of experts had to assert the validity of the entire instrument. The criteria for selecting experts included knowledge and experience related to the area as well as relevant training. By contrast, experts with more than years of experience in the unit. Table 2 explains the criteria, operational definition and overall comment by the expert during the validation of an instrument. We prepared our instrument based on the expert comments. Each criteria refer to an operational definition so that the experts will clearly understand how to evaluate the instruments. Taherdoost (2016) proposed the evaluation form how to test the research instrument's validity.

Table 2: Experts validation of problem-solving skills questionnaire

Criteria	Operational definition	Expert (1)	Expert (2)	Expert (3)
Clarity	- The questions are direct and specific. Only one question is asked at a time. The participant can understand what is being asked - There are no double-barreled question	Some items are rogue and not straight forward	Some items are rogue and not straightforward	Some items are double-barreled
Wordiness	- Question is concise - There are no unnecessary words	-	Check grammar	Grammar mistake
Overlapping	- No response covers more than one choice - All possibilities are considered - There are no ambiguous questions	-	Some items are rogue and not straightforward	Some items are rogue and not straightforward
Balance	- The questions are unbiased and do not lead the participants to a response - The questions are asked using a neutral tone	-	Please alert on those negative items during analysis stage	Be careful when you analyze the negative items
Use of jargon	- The terms used are understandable by the target population - There are no clichés or	-	You have not shown the actual questionnaire	-

Table 2: Experts validation of problem-solving questionnaire (Continued)

Criteria	Operational definition	Expert (1)	Expert (2)	Expert (3)
	hyperbole in the wording of the question		that the samples will answer	
Appropriateness of responses listed	- The choices listed allow participants to respond appropriately - The response applies to all situations or offers a way for those to respond to the unique situation	-	-	Not measure what scale will be used in the question
Use of technical language	- The use of technical language is minimal and appropriate - All acronyms are defined	-	-	-
The measure of the construct. A: Identification of problem	All survey adequately measures this construct [include operational definitions and concepts associated with the construct	It will be useful if the definition for each construct is attached	-	-
Measure of construct. B: Define the problem	All survey adequately measures this construct [include operational definitions and concepts associated with construct]	-	-	-
Measure of construct. C: Explore the possible solution	All survey adequately measures this construct [include operational definitions and concepts associated with construct]	-	-	-
Measure of construct. D: Anticipation/apply solution	All survey adequately measures this construct [include operational definitions and concepts associated with construct]	-	-	-
Measure of construct. E: Look and evaluate	All survey adequately measures this construct [include operational definitions and concepts associated with construct]	The definition of look back and evaluate is unclear; it is the same with reflection	-	-

Source: Taherdoost (2016)

The reliability of the instrument was a pilot study, this pilot study was carried out in UTHM, and a questionnaire was administered to 40 students voluntarily. This study used problem-solving skills based on the IDEAL Model of problem-solving to examine the cognitive style field dependent/field independent and problem-solving skills based on the five (5) dimensions of the IDEAL Model of undergraduate final year students' projects and the Cronbach alpha .881.

In this study, content validity and construct validity were used because the researcher wanted to measure whether the questionnaire has good validity and content validity by comparing the gratified of the instrument. Since the instrument was published, one validity was assumed. The validity of the instrument was done by Rahardja et al. (2019); Kitagawa (2015), and Wyss (2002). Reliability establishes the skill of a measuring instrument to produce the same answer or result on consecutive times when no change has occurred in the thing being measured (Heale & Twycross, 2015). Reliability is known as trustworthiness or steadiness, usually as a reliability factor. There are at least five different methods to establish the reliability of an instrument in social science education research. For brevity, the present study deemed it necessary to consider three out of five known methods to establish its instrumentation reliability. Thus, the stability (test-retest), internal consistency, and scorer reliability methods are used. Reliability the accuracy of an instrument. In other words, the extent to which a research instrument consistently has the same results if used in the same situation on repeated occasions, reliability concerns the consistency of the measurements used.

4.2 Students' Problem-Solving Skills in FYP Based on IDEAL Model

A total of 324 responses from 380 respondents received from year students in all faculties participated in this research. Problem-solving skills instrument was administered to the final year students; the findings show how students responded based on the dimension; it indicated that students need more inspiration, attention, morals and good problem-solving skills while writing the final-year projects. Table 3 indicates that only 26.31% of the final year students can identify the problem, 23.23% can define the Problem, 22.24% can be able to explore alternatives, 11.6% can anticipate applying the solution to the Problem, and finally, 16.62% can be able to look back and evaluate. Final-year students required more attention to problem-solving skills.

Table 3: Problem-solving skills frequency and percentage

Scale	Identify		Define		Explore		Anticipate		Look back	
	F	%	F	%	F	%	F	%	F	%
Strongly disagree	19	5.90%	22	6.80%	18	5.55%	173	37.92%	131	40.40%
Disagree	66	20.37%	81	25.00%	91	28.09%	81	25.00%	72	22.20%
Neutral	52	16.04%	43	13.30%	51	15.74%	33	10.23%	23	8.00%
Agree	147	45.34%	137	42.90%	125	38.60%	51	15.74%	61	18.80%
Strongly agree	40	12.35%	39	12.08%	39	14.02%	36	11.11%	37	11.00%
Total	324	100%	324	100%	324	100%	324	100%	324	100%

Table 4 shows the mean often by student response based on dimension. Based on the responses of students, it can be concluded that students were persuaded to possess skills to have good problem-solving skills in the final year project.

Table 4: Overall mean and standard deviation of problem-solving skills

Dimension	Mean	Standard deviation
Identify	4.047	.501
Define	3.847	.542
Explore	3.936	.601
Anticipate	3.851	.611
Look back	3.941	.589

5. Discussion

A few previous research supports the findings of this study. Walinga (2010) reported that creative problem-solving is inherent to various performance realms, including effective decision-making, innovation, and organizational development; however, related processes of insight, innovation, and creativity remain intangible. The findings propose that insight involves a five-stage, cyclical process emerging as a primary appraisal of the Problem, a secondary appraisal based on prior knowledge, initial focus, problem representation, and solution generation when, if no solution is found, the cycle begins again. The research has implications for individual, team and organizational settings, suggesting that performance on various problems may be improved by utilizing an integrated focus rather than a barrier or goal focus alone.

6. Conclusion

The instrument development process is the main process in quantitative research, especially in collecting data for social science research. The items must be relevant information most reliably and validly. This research investigates students' capability of problem-solving skills in completing their FYP. Hence, the research instruments used in this research are developed by the researcher using the elements of IDEAL Models. The validation of instruments needs to be clearly described before explaining the further findings. The research instruments were constructed to measure students' capability in Problem-solving skills. Problem-solving skills require students to have good knowledge of applying solutions to the Problem, look back and evaluate their past Problem and need more ability to identify solutions to the Problem by having cognitive style skills and problem-solving skills to have good relationships between their cognitive style and problem-solving in the final year project. Finally, in teaching and research, account should be taken of the students' problem-solving skills. Teaching styles that matched the student's ability to solve the Problem could improve learning and research for the students. To conclude, teachers should reflect on their current teaching practices and suit the students' needs. The teaching and research process should emphasize more problem-solving activities in the tea.

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