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Issues and solutions on Inventive Problems-Solving Skills (IPSS) in invention course

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ABSTRACT

Inventive Problem-Solving Skills (IPSS) is the ability to solve difficulties efficiently and without hindrance. The aim of this study is to identify issues, importance, and solutions in identifying the causes of inventive design problems among students and teachers of Invention. In addition, there are two objectives of the study (1) to identify the differences in the importance and issues of IPSS among students and teachers of Invention, and (2) to identify the importance, issues and proposed solutions of IPSS by Invention's teachers. This study has a used mixed-method an approach that includes quantitative and qualitative methods. For the first objective quantitative will be used by making a questionnaire while for the second objective, the mixed method was used by using questionnaires and semi-structured interviews. The survey covered a total of 133 students and 30 Invention teachers from a secondary school in Johor. In this study, SPSS software was used to obtain the data. As a result, there was no significant difference in significance [t (133) = 2.915; p = .194, (p > .05)] or problem [t (133) = .142; p = .09, (p > .05)] for gender, according to t-test findings. The level of significance was then determined using a two-way ANOVA test. Subsequently, two-way ANOVA tests revealed that importance (F (30) = 2.874, p = .061) and problem (F (30) = 6.846, p = .112) abilities were not influenced by teacher gender or teaching experience. To identify the root cause of inventive problems, the majority of teachers prefer to use Functional Analysis to apply the Theory of Inventive Problem-Solving Skills (TRIZ). As a result, the creation of self-learning modules is offered as a teaching resource to help students use their abilities in the Invention course. Thus, the objective has been well achieved to (1) identify the differences in importance and issues of IPSS among students and teachers of Invention, and (2) identify the importance, issues and proposed solutions of IPSS by Invention's teachers. Among the challenges faced in this study was that communication between students and teachers was done virtually on deck due to the Covid-19 issue that struck.

Keywords: inventive problem; problem-solving skills; functional analysis; root causes; teaching materials

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INTRODUCTION

The technical and vocational parts of employee skill development are the major emphasis of the 11th Malaysia Plan. The difficulty that develops, however, is graduates' limited market-ability. Based on department of Statistics Malaysia Official Portal (2020), in 2020, the employed person dropped by 0.8 per cent (-116.7 thousand persons) to 15.0 million persons as against 15.1 million persons in 2019.70.2 % of the world's companies seek individuals who can solve issues successfully (National Association of Colleges and Employers, 2013), which is the third-highest trait that is considered seriously in the professional sector. Besides, all countries have suffered a major setback in 2019. This is because Malaysia's unemployment rate jumped to 5.0 % in April 2019 compared to the same month previous year, leading to a large increase in the number of

jobless persons to 778,800 (Ministry of Education Malaysia, 2015). One of the reasons for Malaysia's high unemployment rate among graduates is a lack of inventive problem-solving skills (Mohamed et al., 2010). This clearly demonstrates that Malaysia need competent and semi-skilled people that meet the k-worker requirement and can solve issues in order to compete with other nations. In order to compete with other nations, most organisations want competent workers that meet k-worker requirements such as inventive problem-solving ability. According to Porto et al. (2022), most Malaysian organisations prefer to recruit individuals with talents rather than qualifications such as schooling or experience.

Furthermore, according to Berita Harian April 2021, companies in Malaysia seek for three primary qualities, namely inventive problem solving skills, communication skills, and strategic thinking, while hiring internally. In comparison to other markets in Asia Pacific, inventive problem solving skills (46 %) stand out as one of the skills that are in great demand (APAC). The necessity of creating human capital capable of improving productivity, producing a highly trained workforce, and generating an economy for social development is also highlighted in the 11th Malaysia Plan. Meanwhile, the Technical and Vocational Education and Training (TVET) programme is critical in developing a high-quality, highly-skilled workforce to propel the economy forward. TVET is, without a doubt, the most important platform for students to prepare for the future job market. Employers in Malaysia laud technical graduates' talents, but are less happy with marketability skills such as inventive problem-solving skills that are not mastered (Azmi et al., 2018). In addition, integrity, intellectual capacity, collaborative skills, analytical, and inventive problem-solving skills are the four highest-ranking characteristics needed by workers to survive and prosper in the workplace (Suarta et al., 2017). This is in accordance with the findings of Hairi et al. (2011), who said in a research that companies in Malaysia's manufacturing industry want personnel with not just technical capabilities but also general skills such as inventive problem-solving abilities.

The Ministry of Education Malaysia developed the Invention course in 1995 in response to the country's need to improve the quality of its human resources (MOE). Invention is a Professional Elective Subject in the Science, Technology, Engineering, and Mathematics (STEM) group that was created to focus on the need for curricular modification and evaluation based on invention (Radha et al., 2021). Upper secondary schools provide a technology-based optional subject called Invention (Curriculum Development Centre, 2002). The goal of the Invention course is to generate technologically literate students who can learn to think creatively, in keeping with the Malaysian Education Ministry's goal of producing innovators who can handle a variety of applications and create new goods with a high marketability value (Azmi et al., 2018). Learning is a teaching and learning activity for instructors and students with the goal of assisting students in developing their cognitive, emotional, and psychomotor abilities. Learning's ultimate objective is for pupils to be able to solve difficulties that arise in their everyday lives (Kurnianto et al., 2020; Makhrus & Hidayatullah, 2021). Furthermore, students' maturity may be noticed in the decision-making process for producing a developed product. Unfortunately, students frequently struggle to pinpoint the source of a product's issues. In addition, The Invention is technology-driven, with a focus on student innovation. Its goal is to prepare students with information, skills, values, and attitudes thinking that is creative, critical, imaginative, and ingenious, as well as maybe nourishing themselves with the evolution of the country's industrial development and expansion, sustainable practises are becoming more important (Radha et al., 2021).

For students in the Invention course, mastery of root inventive problem solving skills is critical. These abilities can assist students with beginning the design process in a methodical manner, that is, identifying the source of the problem before moving on to the next step of creating and assessing actions. Inventive problem solving is a cognitive process that seeks to attain a goal when there is no apparent solution approach to a problem (Schubert et al., 2019), which may assist with a variety of things such as completing work on time, minimising wasted effort, decreasing ambiguity, and more (Undesa, 2020). The existence of obstacles can also give pupils with challenges that inspire them to solve problems (Saavedra, 2020). Furthermore, this method can boost students' decision-making confidence as well as the quality of their problem-solving. Students might indirectly push themselves by feeling what it's like to be in the actual world of

employment. This is because a lack of inventive problem-solving abilities among students leads to a lack of competent thinking when it comes to tackling difficulties in the workplace.

According to Kiong et al. (2020), failure in inventive problem-solving leads to the loss of an organisation owing to the use of ineffective tactics. Inventive problem-solving skills should be trained in the Invention so that this abilities can lessen difficulties in the workplace using problem-solving procedures in phases (Indeed Editorial Team, 2021). Students must also improve their thoughts in order to generate inventive problem-solving ideas (Zaharin et al., 2018). Therefore, innovative thinking should be ingrained in the educational system to assist students in analysing and synthesising information so that they can think critically and solve complicated challenges (Othman & Mohamad, 2014; Radha et al., 2021; Shakir, 2009).

The objectives of this research are (1) to identify the differences of importance and issues on IPSS among students and teachers of Invention, and (2) to identify the IPSS importance, issues and suggestion on solutions by the Invention's teachers.

METHOD

Research methods are described based on several parts namely study design, study population and sample, study instruments, analysis of study data, and study implementation procedures. For the first objective quantitative will be used by making a questionnaire among students and teachers of Invention while for the second objective, mixed method was used by used questionnaire and semi-structured interviews. The survey covered a total of 133 students and 30 Invention teachers from a secondary school in Johor. In this research, SPSS software has been used to obtain data from t-test based on gender between students and two-way ANOVA based on gender and teaching experience between Invention's teachers.

Research Design

As support for the research data, this project employed a survey study design with quantitative and qualitative methodologies (semi-structured interviews) and focus groups.

Population and Sampling

The participants in this study are 206 Johore State Form 4 students. 133 samples were chosen using a basic random assign sampling procedure based on the table created by Krejcie and Morgan (1970). On the other side, the participants in this study were 35 Johore State inventions teachers. Using the same method, 30 examples were chosen for Invention's teacher. Respondents were chosen solely for the purpose of the study (Hargreaves & Fink, 2006). A survey questionnaire was used to obtain data directly from respondents for this investigation. Invention's teachers were interviewed in semi-structured interviews.

Instruments

The objective of this study was to construct a questionnaire that would meet the objectives of the study and answer the research questions. A questionnaire is a group of questions with an organized response area given to the respondents. Two research instruments have been developed among others, (1) to identify the differences in importance and issues of IPSS among students and teachers of Invention. This instrument was conducted by questionnaire. Meanwhile, (2) identify the importance, issues and proposed solutions of IPSS by Invention's teachers. This instrument was conducted through questionnaires and semi-structured interviews with Invention's teachers. The interview procedure was used to gather the opinions of experts (Invention's teachers) on the three main components, namely to identify the importance, issues and proposed solutions of IPSS in Invention. To verify its validity, the interview methodology goes through a validity and reliability phase. There are five qualitative research professionals in all. Five qualitative research experts were assigned to (1) evaluate the interview procedure and confirm its suitability, and (2) examine the language of the interview protocol to ensure its suitability and clarity. Conversations in the focus group were recorded with the respondent's permission through a letter of permission.

FINDING AND DISCUSSION

Finding

Respondent Profile

According to groups of Invention's teachers and students in Johor, the frequency distribution and proportion of respondents were 30 Invention's teachers and 133 Form four Invention's students. According to the demographic analysis of the respondents (Table 1), there were 80 male students (60.15 percent) and 53 female students (39.85 percent) in this study, a difference of 20.3 percent. The student is a form four student at a secondary school in Johor who studied invention. The Invention's teacher was made up of 19 (63%) males and 11 (37%) females.

Table 1. Profile of study respondents on students and teachers of invention

	Respondent	Frequency	Percentage
Students	Male	80	60.15%
	Female	53	39.85%
Teachers	Male	19	63%
	Female	11	37%

The study's findings are divided into three sections: an (1) importance of the study's value; (2) a discussion of the issue of abilities for identifying the source of innovative challenges, and (3) recommendations for strengthening those skills for students and instructors of invention.

T-Test of the Importance of IPSS Based on Gender to Invention's Students

According to Table 2, there was no significant difference in Form 4 student's results depending on gender [t (133) = -2.915; p = .194, (p > 0.05)]. This is because the mean value for the amount of relevance of innovative issue root identification skills does not differ significantly by gender. The mean difference in scores between male (M = 3.8563, SD = .7439) and female (M = 4.2170, SD = .6241) students was.3607.

Table 2. T-Test of the importance of IPSS based on gender to invention's students

Gender	N	Mean	Standard deviation	T	Df	Sig.
Male	80	3.8563	0.74394	-2.915	131	0.194
Female	53	4.2170	0.62411			

T-Test of IPSS Issues Across Gender Against Invention's Students

There was no significant variation in the level of analysis between genders [t (133) = .142; p = .09, (p > .05)] at the level of analysis (Table 3). Male students had a cognitive level of (M = 3.4969) at the issue-level of innovative problem identification skills, whereas female students had a cognitive level of (M = 3.4811). The difference in mean values is insignificant (mean difference = 0.0158). This demonstrates that the issue of male and female pupils' imaginative problem-solving abilities is the same.

Table 3. T-Test of IPSS issues across gender against invention's students

Gender	N	Mean	Standard deviation	T	Df	Sig.
Male	80	3.4969	0.53441	0.142	131	0.09
Female	53	3.4811	0.74493			

Bilateral ANOVA Test of Importance and Issues of IPSS Across Gender and Teaching Experience of Invention's Teachers

The relevance of innovative issue identification skills was rated higher by male teachers (mean = 4.0000) than by female teachers (mean = 3.8182). Furthermore, male teachers had lower judgments of innovative problem root cause identification skills (mean = 3.6842) than female teachers (mean = 3.7879) on the issue-level (Table 4). This suggests that men teachers place a larger value on these abilities than female teachers. Female instructors, on the other hand, are

more inclined to place a higher value on the problem of talents.

Table 4. Mean importance and issues of IPSS on gender and teaching experience of Invention's teachers

Gender	Teaching experience	Importance		Issue		N
		Mean	Standard deviation	Mean	Standard deviation	
Male	> 1 year	3.5000	0.23570	3.3333	0.47140	2
	1-5 years	3.5000	0.18257	3.5556	0.45542	6
	6-10 years	4.1667	0.23570	3.8333	0.23570	2
	11-15 years	4.5556	0.38490	4.1111	0.19245	3
	> 15 years	4.3333	0.29814	3.6667	0.29814	6
	Total	4.0000	0.50918	3.6842	0.39242	19
Female	> 1 year	3.6667	0.00000	4.2222	0.38490	3
	1-5 years	3.6667	0.00000	3.6667	0.00000	4
	11-15 years	3.8333	0.70711	3.1667	0.23570	2
	> 15 years	4.3333	0.47140	4.0000	0.00000	2
	Total	3.8182	0.37605	3.7879	0.42876	11
Total	> 1 year	3.6000	0.14907	3.8667	0.60553	5
	1-5 years	3.5667	0.16102	3.6000	0.34427	10
	6-10 years	4.1667	0.23570	3.8333	0.23570	2
	11-15 years	4.2667	0.59628	3.7333	0.54772	5
	> 15 years	4.3333	0.30861	3.7500	0.29547	8
	Total	3.9333	0.46650	3.7222	0.40194	30

Table 5 shows that there was no significant difference in the value of inventive problem root identification abilities based on gender (F (30) = .663, p = .424) to Invention's teachers, with a tiny size impact (eta squared = .031). This means that these abilities are equally important to male and female teachers. However, there was a significant difference in the relevance of these abilities for Invention's teachers based on teaching experience (F (30) = 9.121, p = .000). With more than 10 years of experience, the majority of male teachers (M = 4.5556) and female teachers (M = 3.8333) provided favourable responses to the relevance of these abilities. There was no significant interaction impact between teacher gender and teaching experience on judgments of the relevance of inventive issue root identification skills (F (30) = 2.874, p = .061), based on Table 5. This suggests that the relevance of such abilities is unaffected by the teacher's gender or previous teaching experience. Problem identification abilities, are critical in the classroom teaching and learning process (Palavan, 2020). So, depending on the gender and teaching experience of the Invention's instructors, 61.9 percent indicated a favourable impression on the relevance of these talents.

Table 5. Bilateral ANOVA test the importance of IPSS towards gender and teaching experience of invention's teachers

Source	Power of two type III	df	Mean power of two	F	Sig. (p)	Eta
Gender	0.055	1	0.055	0.663	0.424	0.031
Teaching experience	3.024	4	0.756	9.121	0.000	0.635
Gender * teaching experience	0.715	3	0.238	2.874	0.061	0.291
Error	1.741	21	0.083			
Total	470.444	30				

a. R power of two = 0.724 (Adjusted R power of two = 0.619)

According to Table 6, there was no significant difference in the value of inventive issue root identification abilities among Gender to Invention teachers (F (30) = .529, p = .475), with a

tiny size impact (eta squared = .025). This means that the same degree of expertise is required of male and female teachers. However, the problem of abilities based on teaching experience (F (30) = 0.682, p = .612) of Invention's teachers showed a significant difference (F (30) = 0.682, p = .612). The majority of male (M = 4.1111) and female (M = 3.1667) teachers with more than 10 years of experience responded positively to the abilities question. There was no significant interaction impact between teacher gender and teaching experience on judgments of the relevance of inventive issue root identification skills (F (30) = 6.846, p = .112), according to this Table. This suggests that the level of the skill issue is unaffected by the teacher's gender or expertise.

Table 6. Two -Way ANOVA test of IPSS issues on gender and teaching experience of invention's teachers

Source	Power of two type III	df	Mean power of two	F	Sig. (p)	Eta
Gender	0.055	1	0.055	0.529	0.475	0.025
Teaching experience	0.284	4	0.071	0.682	0.612	0.115
Gender * teaching experience	2.137	3	0.712	6.846	0.112	0.494
Error	2.185	21	0.104			
Total	420.333	30				

a. R power of two = 0.534 (Adjusted R power of two = 0.356)

Comparison of the findings of Invention's students and teachers on the importance and issues of IPSS.

The study's findings suggest that the mean difference between the genders in the importance of inventive problem-solving skills (IPSS) for students (difference M = .3607) was greater than that of Invention's teachers (different M =.1818). The mean difference between the genders of IPSS issues of teachers (difference M = .1037) was larger than the mean difference between the genders of Invention issues of teachers (difference M = .0158). Because the value of M is greater in Table 7, the mean of female students exhibited stronger understanding of the relevance of IPSS than male students. When it comes to teaching, female teachers place a higher priority on IPSS than male teachers.

Table 7. Mean differences of importance and issues of IPSS to invention's students and teachers

Respondent	Gender	Importance KPPMI		Issues KPPMI		N
		Mean (M)	Standard deviation	Mean (M)	Standard deviation	
Teachers	Male	4.0000	0.50918	3.6842	0.39242	19
	Female	3.8182	0.37605	3.7879	0.42876	11
Students	Male	3.8563	0.74394	3.4969	0.53441	80
	Female	4.2170	0.62411	3.4811	0.74493	53

Instrumentation of Semi-Structured Interviews for Invention's Teachers

The information on the invention's teachers on the issue, the relevance, and the aspects of inventive problem root cause detection skills was obtained using semi-structured interview instruments in this study. Interviews are a type of trigger that aims to verify the data or information that has been gathered (Ismail et al., 2015). Semi-structured interviews were done by asking designed formal questions and allowing the interviewer to inquire more about the respondents' responses.

Discussion

The issue of IPSS among Invention's teachers: (1) Does the traditional teacher approach of teaching using only textbooks less helpful to students in problem root identification skills?; (2) Is

it easy to teach students in mastering these problem identification skills?; and (3) How long does it take to help students master these skills?.

Here are the questions proposed to the teachers of Invention. As a result, 80% of teachers agree that the traditional teacher approach of teaching using only textbooks is less helpful to students in skills. Explanations given by the teacher are:

> *"Due to the passage of time, the conventional instructor style of teaching solely from textbooks is less beneficial to pupils in discovering the fundamental cause of the problem."*
>
> *"Students want diversity in order to maintain their interest in learning while avoiding boredom."*
>
> *"Traditional learning can still be done, but it is very challenging to attract kids' attention and trust." From then, the time it takes to transmit information will not be able to meet the deadline."*
>
> *"The majority of the issues that arise are not just the identification of the problem's origin, but the questions are also difficult to grasp, and the students are emotional and refuse to answer the questions offered."*
>
> *"Solving the problem's underlying cause is a vital challenge for Invention students to begin the project."*

According to the findings of the interviews, the teachers of Invention's course concluded that conventional learning has to be gradually updated over time to increase students' motivation in continuing learning and therefore be able to use teaching and learning time systematically. He also stated that teachers must update their expertise and have a distinctive teaching technique. According to Aslam and Khan (2021), instructors at all levels must constantly refresh their knowledge and abilities in evaluation methods and strategies in order to stay current with the newest educational developments. To summarise, competent teachers will engage in building their value systems and, as a result, strengthening their practises in order to continually improve the performance of their students.

Furthermore, a handful of Invention teachers argue that teaching children to understand these inventive problem-solving abilities is easy. However, fundamental obstacles must first be surmounted. One of them is the time as well as the method of imparting learning to the pupils. As a result (Hartono, 2012) research suggests that an unsolved situation might cause a person's emotions to be disturbed. Problem-solving is also a key component of teaching and learning for pupils, according to the standard high school curriculum. This is because students' challenges in inventive problem-solving have a negative impact on the design process. The inference is that the goods are of poor quality, resulting in waste of money, resources, energy, and time throughout the manufacturing process. Problem solving skills entail using one's expertise to link old and new information in order to solve difficulties (Nirwana, 2021; Sari & Nayır, 2020). That’s why majority of students are unable to master it.

Importance of IPSS in the invention course: (1) Do students master problem identification skills in solving a project?; (2) Do you agree that the skill of identifying the root cause of the problem is widely used in the course of Invention?; (3) 3. Do you agree that the lack of problem solving skills among students will cause difficulties in creating a project?; (4) Do teachers need teaching aids (BBM) to help students master the skills of identifying the root cause of the problem?; and (5) Your suggestion in continuing the teaching and learning process (T&L) or Problem Based Learning (PBM) that is appropriate and able to solve the issue of problem identification skills nowadays (Covid-19 Pandemic Issue). Point 5 consist of: (i) Workshop; (ii) Through the skills of expert energy; (iii) Mind map learning system; (iv) Module System; and (v) Other suggestions.

The following questions were highlighted to elicit answers from Invention's teachers to determine the level of relevance of talent in recognizing the root causes of this innovative challenge. As a result of the questionnaire that was made with the Invention's teachers, the majority of teachers (96.6%) agreed that IPSS is indeed needed in the Invention process. In parallel, 90% of teachers also believe that the lack of IPSS in students makes it difficult for students to do the Invention process. Thus, 93.3% of Invention's teachers need teaching aids to help students master IPSS well. The following is one of the explanations given by Invention's teachers on the importance of IPSS in Invention's students in particular.

> *"In order to perfect a skill, pupils must always desire to be reminded in order to do a task correctly. This is due to the fact that most pupils 'blur' when it comes to starting something new. As a result, teachers must devote some time to assisting them in generating ideas before completing an activity with them."*
>
> *"Design is a course that focuses on developing skills. Because it is a complicated talent, it cannot be cultivated simply by reading or sitting motionless. It also needs something practical so that the concept can develop gradually."*
>
> *"In order to develop the talent of recognising the underlying cause of a problem in the P&P process, teachers must assist students in developing their own ideas, as the majority of them lack confidence in themselves. That is why they are lacking in such abilities. Furthermore, most students prefer to remember rather than grasp an idea during tests. As a result, the pupils' ability to internalise the talent is limited."*
>
> *"Before they create, they must first identify a problem; else, they will not know how to produce something. As a result, pupils are frequently stuck on the invention's initial scale. When alone, without other members of the group, teachers, or instructions on the side, "*

According to the findings of the interviews, inventive problem-solving abilities are a must-have talent for Inventive students. However, in order for these abilities to be fully entrenched in students, enhancements and facilitation must be established. Furthermore, critical thinking is one of the essential higher order thinking abilities. In a word, critical thinking abilities are a mental process of understanding the environment utilising prior information (Rosidin et al., 2019).

That is, critical thinking abilities and inventive problem solving skills are linked, with the stronger critical thinking skills leading to greater inventive problem solving skills. Various elements impacted critical thinking skills, one of which is the structure of thinking, which is the framework of thought articulated in oral and written form, and is known as argumentation (Rosidin et al., 2019).

As a result, inventive problem-solving abilities are crucial talents that should be cultivated via learning that is planned and structured in the context of a field of study with a 21st-century learning theme. The National Philosophy of Science Education likewise sees the use of imaginative thinking abilities as being in accordance with the National Philosophy of Science Education. This is because, students may combine their artistic and technological talents with critical and creative thinking skills to create goods that satisfy the demands of current society using these innovative thinking skills (Radha et al., 2021).

Besides, the term 'innovation' derives from the Latin word 'invenire,' which meaning 'discovery.' The final outcome of that creativity is discovery, which entails thinking, publishing ideas, and solving issues. Thus, in order for students in the topic of invention to be successful, they must use inventive thinking. It is possible to attain the goals and objectives necessary to produce a competitive workforce (Radha et al., 2021). According to Csapó & Funke (2017) inventive problem solving is a concept of information processing that is analysed in depth and detail before being able to be interpreted theoretically, including assumptions about the cognitive processes of components involved in performance, with the goal of modifying and achieving reasonable solutions in a variety of ways. This method also aids in the completion of tasks on time, the avoidance of wasted effort, and the reduction of ambiguity (Meiers, 2014).

Furthermore, inventive problem-solving abilities relate to a collection of cognitive-behaviours that a person engages in order to identify or develop effective solutions to real-world situations (Simanjuntak et al., 2021). Then, after successfully applying the solution and analysing the appropriateness of the response, persons who master these abilities are able to solve a problem (Wanya, 2016). This is because students ask a lot of questions to their peers and teachers during this process. They also attempt to provide answers to some of the issues that occur during the inventive problem-solving process. In comparison to traditional learning, they also articulate their thoughts and work faster to solve an issue (Simanjuntak et al., 2021).

Students are also taught how to use real thinking to come up with unique ideas and solutions to problems that no one else has considered. Arikan (2017) emphasises this notion, claiming that kids who can create real challenges have the ability to think creatively. To teach youngsters how to solve issues, they must be taught to think creatively by applying the inventive problem solving skills (Kashani-Vahid et al., 2017). However, the idea that creativity is a talent that is intriguing but not required in the field of analytics or science has lessened the emphasis and attention placed on developing these abilities in the classroom.

In reality, there is compelling evidence that creativity and problem-solving abilities augment ordinary cognitive processes, resulting in remarkable outcomes (Simonton, 2000). Integrity, intellectual ability, collaborative skills, analytical abilities, and inventive problem solving are determined to be the four highest level competences necessary by workers to be able to survive and prosper in the world of work (Suarta et al., 2017). As a result, the necessity of these abilities is taught to Invention students so that the goods created are of high quality, and students may be trained to become competent employees in the future.

Suggestions in continuing the process of teaching and learning (T&L) that are appropriate and able to solve the issue of IPSS.

The data is evaluated in order to provide suggestions for strengthening these abilities (Figure 1). Workshops were chosen by 60% of instructors to assist students in the R&D process, and 63.3 percent of teachers said that expert skills and a mind map learning method might develop these skills. According to Redhana et al. (2021), mind and concept maps may convert the shapes of contents that were previously in the form of a long explanation into compact map forms that can help students recall contents more readily.

Visual representations are easier for students to grasp than written descriptions or conversational ones (Huxham et al., 2012; Zvauya et al., 2017). As a result, using idea and mind maps in the classroom can help students retain and comprehend knowledge more effectively. Visual formats are easier for students to comprehend than written or vocal descriptions (Davis, 2011). As a result, using idea and mind maps in the classroom can help students retain and comprehend knowledge more effectively.

Furthermore, 80% of them agreed that the development of a self-learning module system can help students learn on their own, which is in line with the current situation, which requires students to act on their own to gain knowledge, making module is the primary tool for students to improve root inventive problems identification skills. They also can refresh it back at home as their references. A few studies have found that learners who used the study-from-home learning plan made little progress throughout the epidemic timeframe (Kisno et al., 2021; Muhlisin et al., 2022; Per et al., 2021).

In addition, students' problem-solving abilities were likely inadequate, as evidenced by observations made throughout the learning process, which revealed that students were passive, less capable of analysing difficulties, and less equipped to provide answers to a challenge posed by the teacher. Not to be outdone, creating experiences and doing information searches via the internet are among the other ideas made to assist students in mastering these abilities. Several techniques for increasing student happiness were also discussed in the studies, including integrating technological approaches, providing experience value (Gunarto & Hurriyati, 2020), and using tracer study services (Soegoto et al., 2018).

From this, it can be stated that the majority of instructors value the ability to identify the core cause of an inventive problem since the world is becoming increasingly hard in the twenty-first century, and inventive solutions are essential for getting things done. According to (Abdullah & Osman, 2010), just exposing students to tasks that demand (innovative) thinking has no substantial impact on their abilities. It is ideal if students are not only provided with an environment that promotes their imaginative thinking talents, but also explicitly taught how to develop and utilise these inventive thinking skills through modelling, guided practise, and training (Radha et al., 2021).

> *"Students should have an interest in what they are learning. This is because, high interest in something will add more self -confidence to be more successful."*

> *"Most students who are interested in the things they are learning will show high achievement because they put a high emphasis on the things they do. Meanwhile, if students have a moderate or low interest, they will show low achievement and often do things carelessly."*

> *"Teachers play an important role in the world of education because teachers play a role as planners, managers, facilitators, mentors and as role models. Thus, educating a person intellectually, emotionally, spiritually and physically is not an easy task. Therefore, most of our teachers need fun teaching aids to do P&P sessions so that they are happier in imparting knowledge. Next, students will also have fun in learning."*

> *"Teachers can try to create a creative learning styles that have been highlighted by Amabile (1989): (1) Creating meaningful and fun learning, (2) Create a feeling of being valued, loved and respected between students and teachers, (3) Create an active atmosphere during R&D (doing question and answer activities or open discussion). With that, students are comfortable discussing their problems openly, and (4) Create learning strategies that encourage collaboration and often come up with ideas together."*

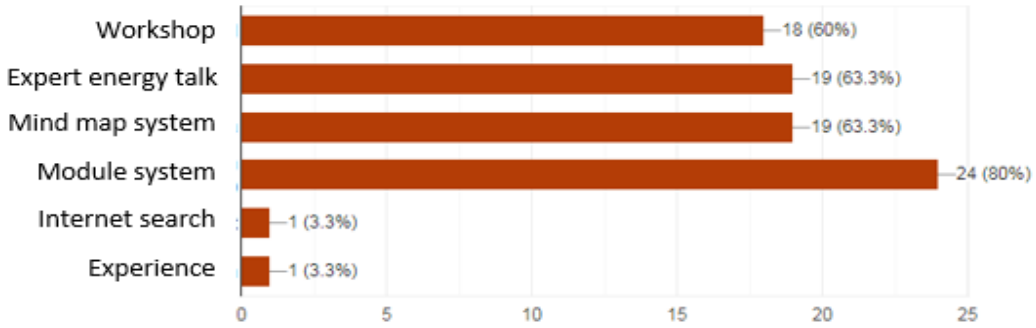

Figure 1. Suggestions in Continuing the Process of Teaching and Learning (T&L) or Problem-based Learning that are Appropriate and Able to Solve the Issue of IPSS Today

However, there are a few teachers who disagree and are unsure about the value of this talent. In addition, in the 4.0 industrial era, inquiry techniques, inventive problem-solving, action research, thinking skills, and other learning strategies and approaches are all on the rise in teacher research and development (Aldahmash et al., 2019). Parallel with that, teachers' teaching and learning must include creative thinking skills in order to benefit students to enhance their skills so that they may compete for additional employment very well (Johari et al., 2019). Despite the fact that the majority of senior and vocational high school teachers have attended numerous trainings and seminars/workshops, they are not always able to put what they have learned into practise (Soenarto et al., 2020).

The majority of students also need self-reference as material for them to further strengthening the skills of identifying the root cause of the problem. 38.3% of them also strongly agreed that if module was created, it would help them master those skills (Table 8).

Table 8. Suggestions in strengthening the skills of identifying the root cause of inventive problems for Invention students

	5 = Strongly agree; 4 = Strongly agree; 3 = Agree; 2 = Disagree; 1 = Strongly Disagree	Do not agree		Agree		
		SD (1)	D (2)	A (3)	SA (4)	SS (5)
1	I need self-reference sources as aids in Design lessons, especially in identifying the root cause of the problem.	0.8% 1	0.8% 1	26.3% 35	42.9% 57	29.3% 39
			1.6% 2			98.4% 131
2	I am confident that the existence of the Cause of Problem Identification Module can help me identify the root cause of the problem for the course of Reka Cipta more effectively.	0	0	24.1% 32	37.6% 50	38.3% 51
			0			100% 133

Elements suggested of identifying the IPSS in the course of Invention

Innovative problem-solving talents are a combination of creativity and critical thinking skills that result in novel solutions to problems (Radha et al., 2021). Genrich Altshuller and colleagues (Altshuller & Shapiro, 1956) created Problem Solving Theory Innovative (TRIZ) as a discovery tool, first as an algorithm to solve inventive issues (known as ARIZ), and finally as a scientific theory for discovery, creativity, and invention. The researchers provided the TRIZ theory to the Invention teachers in order to discover the aspects of issue inventive root identification. TRIZ, or Teoria Rechenia Izobretatelskih Zadatchi in Russian, is a widely utilised industrial theory that was developed by Genrich Altshuller and his colleagues between 1946 and 1985.

As a result, TRIZ's research is focused on the issue and patent solution of a product design when there is uncertainty about finding a solution to a problem that is guaranteed to arise (Gadd, 2011). TRIZ is one of the ideas that employs methodical approaches to boost creativity in inventive problem-solving situations (Altshuller, 2002). Several well-known firms, like Intel, Samsung, LG, Motorola, Christian Dior, and others, have applied this idea to discover difficulties in order to manufacture a high-quality product and increase their yearly sales percentage (Choo et al., 2011). TRIZ is divided into four stages. The first step is to figure out what's causing the issue. The problem is modelled in the second step. The selection of problem-solving tools is the third process, and modelling a specific solution is the fourth. Human cognition, consists of only two types of thoughts: positive and negative. As a result, it is via this reasoning that decisions must be made in order to solve an issue.

According to (Lemke, 2002), one of the most significant components of 21st century abilities is innovative thinking, which allows students to critically analyse situations, acquire information, cooperate in communication, and offer diverse solutions. As a result, TRIZ has a significant edge over other inventive problem-solving and innovation methodologies. Focus groups and brainstorming are good for identifying or discovering issues and their causes, but they aren't good at really pointing out solutions to problems (Chen et al., 2021).

Furthermore, the TRIZ approach's ability and use are best suited for STEM (Science, Technology, Engineering, and Mathematics) knowledge and applications in technical and technical terms (Schubert et al., 2019). Some outcomes from the STEM-TRIZ integration model have indicated that it has a favourable impact on students' learning programmes (Belski, 2019;

Chen et al., 2021; Schubert et al., 2019). This study also demonstrates how an integrated STEM and TRIZ paradigm improves students' learning attitudes and levels of interest. The chosen TRIZ element is a suitable strategy for finding the problem's fundamental cause using a more organised and easy-to-understand functional analysis (Ershadi et al., 2018). The analysis function is defined as a methodical and simple approach of determining the root cause of an issue.

Thus, the selected TRIZ element is an appropriate method in identifying the root cause of the problem with a more structured and easy to understand that is functional analysis. Choo et al. (2011) defined the analysis function as a systematic and easy-to-apply method of identifying the root cause of a problem. In addition, functional analysis can detect the root cause of the problem more effectively and make it easier for students to identify the root cause of the problem in their creation. Functional analysis is a systematic method that helps identify the functionality, characteristics and relationships between each component and the components of the super-system. There are three main elements in functional analysis namely (1) Functional language; (2) Main functions; and (3) Functional analysis steps (Figure 2).

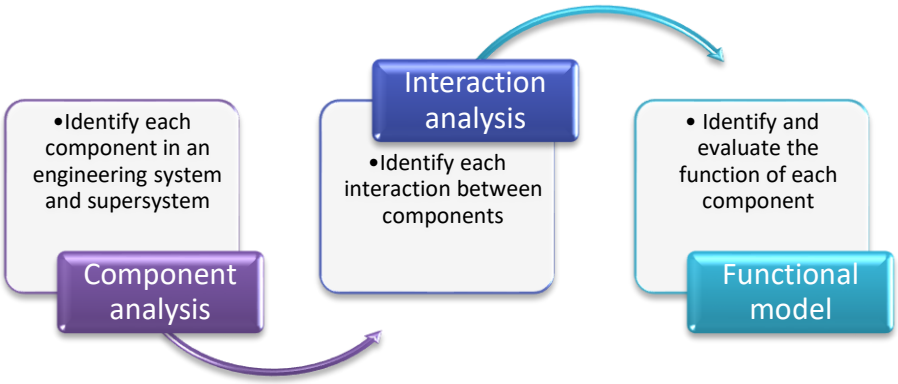

Figure 2. Functional Analysis Steps

The majority of the teachers agreed with the elements stated in Figure 3. The teachers also gave many suggestions for improvement to continue the study in improving the skills.

1. The objective of identifying the root cause of the problem
2. Inventive problem-solving phase (TRIZ Theory)
3. Functional Analysis
4. The concept of functional analysis
5. Use of functional language
6. Functional analysis steps
7. Examples for practicing inventive problem solving through functional analysis

Figure 3. Elements of identifying the root cause of an inventive problem

CONCLUSION

In conclusion, the two objectives of the study have been successfully achieved: (1) identify the differences in importance and issues of IPSS among students and teachers of Invention, and (2) identify the importance, issues and proposed solutions of IPSS by Invention's teachers. The results of the study show that students and teachers agree on the importance of IPSS in the design process. This is because IPSS is widely used in the subject of Invention. They also agreed that if the lack of IPSS among students, causes difficulties in them creating a project. Thus, the majority of teachers need teaching aids to help students master IPSS.

Next, the issue faced by students in applying IPSS is that the traditional learning style lowers the students' motivation to be interested in learning. Furthermore, conventional instructor teaching styles that are purely from textbooks are also less useful to students in finding the root

cause of inventive problems. In addition, students also find it difficult to understand the next complex questions students are emotional and reluctant to continue the ongoing project. Next, inventive problem solving will be challenging if students do not master these abilities as they develop them. As a result, some suggestions have been given based on this study such as making a mind map study, searching for data through the internet and making self -reference by developing IPSS modules.

The majority of students and teachers in the Invention course suggested to develop a module to identify the root causes of inventive problems should be created to assist Invention students in assisting the teaching staff in identifying the causes of innovative challenges. Among the elements proposed to be implemented in the IPSS module are TRIZ elements such as Analysis Functions; The concept of functional analysis; Use of functional language; Functional analysis steps and examples for practicing inventive problem solving through functional analysis in the subject of Invention.

As a result, TRIZ theory needs to be emphasized to assist students in mastering these skills. Indirectly, it can help students improve their IPSS, which are important in today's jobs. In addition, the unemployment rate among Malaysian children can be reduced. This clearly shows that through skills education to identify the root causes of problems in the Invention course, Malaysia is able to generate efficient and semi-skilled individuals who meet the demands of k-workers and can solve the challenge of competing with other countries. Finally, it is recommended that a theory -based module of TRIZ be developed for further research to assist students in developing the ability to detect the root causes of inventive problems.

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