NEEDS ANALYSIS IN SOLVING STEM PROBLEMS AMONG JORDANIAN STUDENTS

Khadijeh Mohammad Musa Naser
Siti Hajar Halili
Rafiza Abdul Razak
Faculty of Education, Universiti Malaya
khadijehnaser78@gmail.com

This quantitative study aims to determine the capabilities of primary school students in problem-solving skills. Problem-solving inventory (PSI) was used as a reliable source for collecting data on students' perceptions of their abilities in problem-solving. The focus of the study is on the seventh-grade female students in a private school in Jordan. Their responses on PSI were collected and analyzed through statistical methods to determine the mean and standard deviations of factors within the inventory. The results showed that students have overall moderate perceptions about their ability to solve real problems. Their perception of the three factors in the inventory such as problem solving confidence (PSC), approach avoidance style (AAS), and personal control (PC) is moderate. The results emphasized the necessity of conducting an intervention at various levels to improve the level of primary students' perception of their capabilities in solving problems due to the correlation with their performance and achievement in issues related to solving problems.

Keywords: *Problem-solving inventory; students' perceptions; Science, Technology, Engineering and Mathematics (STEM); needs analysis.*

Over the past five decades, Jordan has invested heavily to develop its education system, both qualitatively and quantitatively, to ensure Jordan's effective coexistence with 21st-century challenges (Rutkowski, 2008). Furthermore, an impressive improvement has been made in terms of the number of students enrolled in different levels of education. Unfortunately, recent reports indicate that there are several improvements to be done regarding the quality control and assurance of education. Such a problem is widely recognized by many circles. For instance, an indicator about the poor quality of education is the results of the well-known international test in mathematics and science; the Trends in International Mathematics and Science Study (TIMSS) which revealed that Jordanian students have weakness in dealing with problems especially authentic ones.

Follow up results of Jordanian students (9 and 14 years age) in the TIMSS international test which reveals academic achievement and the extent to which students have advanced skills in science and math are low, The lowest performance was recorded in the content area of nature of science and for the skill of integrating knowledge in resolving complex problems (Ababneh, Al-Tweissi, & Abulibdeh, 2016).

It seems that some fundamental factors influence the results of students in the TIMSS study. The first factor is the curriculum; how it is planned, the nature of its scientific content, curriculum activities, and how it is implemented in the classroom (Roseth, Johnson, & Johnson, 2008). Education experts consider the curricula in Jordan has become heavy in

content and irrelevant to students 'concerns and do not develop their learning competencies. Thus, when more serious learning is required, such as Science, Technology, Engineering and Mathematics (STEM), students have not developed sufficient foundational competency (Development, 2017) and become unable to choose the appropriate solution strategy or problem-solving plan (Gholami & Bagheri, 2013). Since students are rarely asked to solve meaningful problems as part of their curriculum. well- structured problems that students face are usually do not contribute to teaching students solving problems in their daily lives (Jonassen, 1997). The decision-makers in education undertook reforms related to the curricula offered to students especially of STEM subjects which has a role in providing students with many skills of thinking and solving problems and the impact of this on successful life (Martin, Mullis, Foy, & Stanco, 2012).

The second factor that influences the results of the students' evaluation and performance is the teacher and his teaching experience and deep knowledge of the content of the subject matter (Chetty, Friedman, & Rockoff, 2014). Lack of assistance with STEM strategies such as discovery, investigation, and problem-solving leads to the weakness of understanding STEM problems, This makes many teachers consider problem-solving a very difficult process to teach (Soancatl, León, Martínez, & Torres, 2010). This lack of dealing with problems sends a warning about the need to develop problem-solving skills as one of the most important skills to be taught in Jordanian STEM curricula as problem-solving skills, as a major component of Mathematics curriculum, assist students to become equipped and competent individuals for the requirements of the century. The Ministry of Education (MOE) and the Queen Rania Al-Abdullah Academy Succeeded in preparing and qualifying teachers through teacher preparation programs organized before the practice of the teaching profession. Despite these reforms, it was noted that the students 'results in the previous tests remained below expectations. The third factor is the students and their abilities, knowledge, and skills, in addition to interests and motives toward learning (Eccles & Wigfield, 2002). A study of Abu Tayeh, Al-Rsa'I and Al-Shugairat (2018) was conducted to determine the reasons behind the low level of students in TIMSS from the teachers' point of view so that the opinions of 130 teachers were taken on questionnaire items. The results showed that the reasons related to students and their families took a higher rate than those related to teachers and curriculum.

Literature Review

It is necessary to determine the needs of students through their perceptions about their capabilities to solve problems in light of the Jordanian curricula that have been reformed. As known, students are the foundation of the educational process, and any reforms should stem from their needs. Therefore, it was necessary to carry out studies concerned with analyzing students' needs, as it considers an important stage before instructing curricula. However, students are one of the essential elements of the educational process since they are the target for which the educational designer is designed (Stufflebeam, McCormick, Brinkerhoff, & Nelson, 1985). Exploring the level of students 'abilities to solve problems from their perspective, reflect the extent of their ability to engage in learning this issue, Besides, determining students’ needs places the focus on the problems facing them and thus determining the characteristics of the internal design process of curricula. Taking into account the personal characteristics of students helps in identifying the problems facing them, and thus determines the nature of the curriculum, activities, and realistic goals (Richards, 2001).

The literature recommends analyzing students' needs before starting any reform process. And that identifying these needs from the students' point of view is no less important than the perceptions of their teachers or their achievement results on tests or tasks. Owning

problem-solving abilities consider a global indicator of the improvement of the educational system (IEA, 2015). Since it supports students and encourages them to participate in unique thinking to create ideas, propose and refine solutions, thereby enhancing their interest in life issues and knowledge development (Pekgoz, 2020). Problem-solving has become a necessity in schools because of its positive impact on academic outcomes in k-12 education (Argaw, Haile, Ayalew, & Kuma, 2016; Ertmer & Simons, 2006; Savery, 2006).

Needs analysis can be used for a variety of purposes, one of them is to identify learners' perception of their abilities in dealing with real-life problems. Approaches to problem-solving vary depending on the nature of the problem (e.g. complex or simple); the problem solver's experience, knowledge, and mental ability; and the alternative or option chosen to solve the problem (Craven, Hirnle, & Henshaw, 1992). How people respond to difficult life problems is an exceedingly complex process (e.g., (Anderson, 1983; Heppner & Krauskopf, 1987) and seems to depend on many personal and environmental factors (see (Zeidner & Endler, 1996) how individuals appraise their problem-solving capabilities and whether they tend to approach or avoid the many problems of life. Butler and Meichenbaum (1981) went on to hypothesize that an individual's appraisal of his or her problem-solving skills will not only affect the problem solving performance but might be an important predictor variable of the problem-solving process(Butler & Meichenbaum, 1981). Research has indicated that an individual's perception and beliefs about his/her problem-solving skills somewhat influences how a person deals with a problem (Heppner & Krauskopf, 1987) and his or her ability to solve problems (Heppner, Witty, & Dixon, 2004). Problem-solving appraisal has been defined as an individual's belief in his or her problem-solving ability and style (Heppner, 1988; Heppner & Petersen, 1982).

International Association for the Evaluation of Education Achievement (IEA),2008 analyzed the results of students' achievement in mathematics and science in private schools were better than MOE schools. This was positively related to the availability of school resources including textbooks, computer hardware, and software, appropriate instructional space, and library materials(mohammad Qablan, 2020). Our choice was for students of a private school in Jordan to explore their needs in TIMSS test skills, especially problem-solving skills and determining whether their results are related to their high perceptions of their capabilities, or they still need to be provided them the skills that the TIMSS test focuses on, especially problem-solving skills.

However, several studies have been conducted to analyze the needs of students in various other topics; students' and teachers' behavior during the English language (Abdo & Breen, 2010) English and academic skills for students(Umairah, 2014). English for Specific Purposes Mathematics and Science learning (Kaewpet, 2009: Kifer, 2002). While the literature on needs analysis and curriculum development provides important principles for investigating learner needs, however, there is no study in analyzing Jordanian students' needs considering problem-solving abilities. so conducting studies related to identifying learners' needs to establish curricula that correspond to those needs was recommended (Saifan, 2018). Therefore, this study has been created to explore students' needs related to their perceptions about their ability in solving authentic problems.

Thus, the findings of this paper are presented according to the research question as follows:

1. What are the Jordanian 7th graders' perceptions of their level of problem-solving skills to deal with STEM problems?

This study is useful for knowing students' perceptions about their abilities to deal with the problems presented by the curricula by knowing their confidence in their ability to solve problems and the extent of personal control during dealing with problems and the extent to which they follow the pattern of problem-solving provided by the Jordanian curricula. Based

on these perceptions, decisions can be made by decision-makers about the shape of programs and curricula later.

Methodology

Different types of methods used to collect data for determining learner's needs; vary from qualitative tools such as interviews and observations to quantitative documents and surveys.

Instrument. To assess 7th-grade students' perceptions of their levels of problem-solving skills, the Problem Solving Inventory (PSI) developed by Heppner and Peterson (1982) was used. Heppner and Peterson (1982) developed the PSI consisting of 35 items to capture an individuals' perception of their problem-solving behaviors. The inventory presents 6-point Likert - scale type items indicating 1=strongly agree to 6=strongly disagree. Lower scores indicate a higher perception of problem-solving abilities while higher scores reflect lower self-perception. The total PSI and factor scores showed satisfactory internal consistency and reliability estimates across various cultures and populations (P. Heppner, 1988; P. P. Heppner et al., 2004; Nota et al., 2013).

Heppner and Peterson (1982) derived three distinct constructs from factor analysis results relating to problem-solving perception; Problem-Solving Confidence (PSC: 11 items:- 5, 10, 11, 12, 19, 23, 24, 27, 33, 34, 35), Approach-Avoidance Style (AAS: 16 items:- 1, 2, 4, 6, 7, 8, 13, 15, 16, 17, 18, 20, 21, 28, 30, 31), and Personal Control (PC: 5 items:-3, 14, 25, 26, 32). Only 32 items are used based on Heppner and Petersen's (1982) rationale in their study that "based on factor analysis, the 35- item questionnaire was reduced to 32-items" …applying the rule of retaining only those factor loadings above .3.

Translating the PSI. The PSI is a self-report measure of applied problem solving that has been used in more than150 empirical investigations(P. P. Heppner et al., 2004). These studies provided growing evidence in support of the validity and reliability of the PSI in US samples as well as in other cultural contexts (Soliman, 2014).

Only one Arabic study intended to translate the PSI into the Arabic context. But it was conducted through college students (Soliman, 2014). So the inventory had to be translated for use in the context of primary school students. An original English language inventory developed by Heppner and Peterson was first translated into Arabic by two Arabic authors; a native English speaker living in Jordan then translated it back into English. The back-translated English inventory was reviewed by one of the original authors and evaluated to improve the inventory items. According to suggestions made by the original author, the Arabic PSI was then modified and finalized.

Participants. A total of 120 of 7th-grade Jordanian female students, participated in this study. All of the participants were taking a science course at a private school in Amman the capital. All participants were of middle to high socioeconomic status, which was collected through the student files at the school psychological counseling department. All participants were selected randomly and voluntarily took part in this study.

Reliability test. A pilot test was conducted on 30 of 7th-grade students were selected through purposive sampling to ensure the reliability of the questionnaire. The students were from a private school in the capital city Amman. Cornbrash's alpha reliability coefficient of the overall inventory (PSI) shows an internal consistency of .89. As for each factor in the inventory, PSC has a Cornbrash's alpha of .84; AAS has an internal consistency of .80, and PC with .86. These show that the 32-items in the PSI are reliable table 1.

Table 1
Internal Consistency of the Problem-Solving Inventory

Domains of PS	Cronbach's Alpha	N of Items
PSC	0.84	11
AAS	0.80	16
PC	0.86	5
Overall	0.89	32

The reliability estimates show that the total inventory has internal consistency (α = .89) and is stable over two weeks (α = .89).

Implementation of the PSI. The Arabic form of Problem-Solving Inventory adapted from Heppner and Peterson (1982) is carried out to generate 120 of 7th-grade students' perceptions of their level of problem-solving skills. Before the participants respond to the inventory they are briefed on the purpose of the study. The researcher presented to the students an authentic problem related to STEM that will be addressed and asked them to find a solution, next the researcher clarified some concepts such as: What is meant by the problem, information gathering strategy, possible solutions, decision-making, analyzing and comparison of alternatives, evaluation of the pros and cons of alternatives, the course of work. This is to be able to deal with the PSI questionnaire and understand its items by providing some explanation without influencing the students' responses.

The data from the inventory were analyzed using the Statistical Package for Social Science (SPSS) version 24 software. It comprised descriptive statistics with the analysis of mean, standard deviation, percentage, and frequency to determine the needs to construct instructional designers based on students' views.

Findings

The findings cover how students appraise their problem-solving ability and skills with regards to the three factors; PSC, AAS, PC.

Table 2
Descriptive statistics for students' perceptions of their level of problem-solving skills to implement flipped STEM courses

Factor	Number	Mean	Rank	Std. Deviation	Variance	Minimum	Maximum	Perception level
PSC	120	3.52	2	0.71	0.50	1.45	5.09	Moderate
AAS	120	3.45	3	0.49	0.24	2.00	4.50	Moderate
PC	120	3.98	1	1.04	1.08	1.00	6.00	Moderate
Total	120	3.65		0.47	0.22	2.54	4.74	Moderate

Table 2 shows the overall mean of 7th-grade students' perception of their problem-solving abilities. It also shows the mean for each factor. Results show that students mostly slightly agree to the items relating to Problem-Solving Confidence (PSC) (mean=3.52, SD= 0.71). This shows that most participants have satisfactory PSC. The 7th-grade students reported having a moderate perception of Approach-Avoidance Style (AAS) about their problem-solving ability (mean=3.45, SD= 0.49). On their perception of Personal Control (PC), students have a low to moderate perception for this factor (mean=3.98, SD=1.04). Overall, students have a moderate perception of their problem-solving abilities (mean=3.65, SD=0.47).

It suited the purpose of analyzing the perception of students on their level of problem-solving skills in dealing with STEM problems. Results show that 7th-grade students mostly slightly agree to the items relating to Problem-Solving Confidence (PSC) (mean=3.52). This shows that most participants have a moderate perception of their PSC. The 7th-grade students reported having a moderate perception of Approach-Avoidance Style (AAS) concerning their problem-solving ability (mean=3.45). On their perception of Personal Control (PC), the 7th-grade students have a moderate perception of this factor (mean=3.98).

The findings show that 7th-grade students have a satisfactory perception of their problem-solving abilities (mean=3.65). Yet, there is a need to improve 7th-grade students' perception of their problem-solving abilities. They need to have a high perception of problem-solving abilities to approach and solve problems with confidence. In terms of factors relating to PSC, AAS, and PC, there is a need to improve these skills so that 7th-grade students have a higher perception in terms of their
abilities to solve problems.

Conclusion

According to Zimmerman and Campillo (2003), "having knowledge and skill does not produce high-quality problem solving if people lack the self-assurance to use these personal resources." More practice is needed in their course because more practice leads to improvements in problem-solving skills, hence a higher perception of problem-solving abilities. When there are confidence and self-efficacy in problem-solving skills, there is indeed persistence and effort to solve problems (Zimmerman & Campillo, 2003). Research has indicated that an individual's perception and beliefs about his or her problem-solving skills somewhat influences how a person deals with a problem (P. P. Heppner & Krauskopf, 1987), and his or her ability to solve problems (Heppner et al., 2004).

As in the results and analysis of the data obtained from the analysis of the PSI to explore students' perceptions about their capabilities in solving STEM problems, it can be concluded that all 7th-grade students in Al-Omareyah school need to raise their capabilities to solve problems in the teaching and learning process, especially in STEM disciplines. This must be taken into account to design curricula, educational programs, and future models that contribute to learning STEM in primary school. The interesting thing about the product that will be developed is that determining the needs of learners to solve the problem pattern is the base from which designers and decision-makers will design and develop curricula for learning STEM more flexibly and realistically that can be applied in the curriculum or separate from it. Another special thing is the adaptation of the PSI in an Arabic format, so it can be used in other Arab contexts to determine the needs of learners in solving problems in different academic subjects.

Based on this study, several findings can be used as references in developing problem-solving learning, especially in STEM topics. The suggestions in this study analyze the informational needs and skills about solving life problems faced by students to identify needs and adapt teaching and learning methods while designing STEM curricula. For more research, to investigate the needs analysis of students using different methods and respondents, more research is needed on determining the needs of students in the elementary stage to help them solve problems of science, technology, engineering, and mathematics that help students understand science and its link to reality.

References

Ababneh, E., Al-Tweissi, A., & Abulibdeh, K. (2016). TIMSS and PISA impact–the case of Jordan. *Research Papers in Education, 31*(5), 542-555.

Abdo, I. B., & Breen, G.-M. (2010). Teaching EFL to Jordanian students: New strategies for enhancing English acquisition in a distinct Middle Eastern student population. *Creative Education, 1*(1), 39-50.

Abu Tayeh, K., Al-Rsa'i, M. S., & Al-Shugairat, M. F. (2018). The Reasons for the Decline of the Results of Jordanian Students in" TIMSS 2015". *International Journal of Instruction, 11*(2), 325-338.

Anderson, J. R. (1983). *Cognitive science series. The architecture of cognition*. Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2016). The effect of problem based learning (PBL) instruction on students' motivation and problem solving skills of physics. *EURASIA Journal of Mathematics, Science and Technology Education, 13*(3), 857-871.

Butler, L., & Meichenbaum, D. (1981). The assessment of interpersonal problem-solving skills Assessment strategies for cognitive–behavioral interventions (pp. 197-225): Elsevier.

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the impacts of teachers I: Evaluating bias in teacher value-added estimates. *American economic review, 104*(9), 2593-2632.

Craven, R. F., Hirnle, C. J., & Henshaw, C. (1992). Fundamentals of nursing: human health and function: Lippincott.

Development, A. B. C. f. (2017). The Jordan STEM Education Landscape. https://www.britishcouncil.jo/sites/default/files/stem_4.0.pdf

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual review of psychology, 53*(1), 109-132.

Ertmer, P. A., & Simons, K. D. (2006). Jumping the PBL implementation hurdle: Supporting the efforts of K–12 teachers. *Interdisciplinary Journal of Problem-based Learning, 1*(1), 40-54.

Gholami, S., & Bagheri, M. S. (2013). Relationship between VAK learning styles and problem solving styles regarding gender and students' fields of study. *Journal of Language Teaching and Research, 4*(4), 700.

Heppner, P. (1988). *The problem solving inventory: Consulting Psychologists*. Press Palo Alto, CA.

Heppner, P. P., & Krauskopf, C. J. (1987). An information-processing approach to personal problem solving. *The Counseling Psychologist, 15*(3), 371-447.

Heppner, P. P., & Petersen, C. H. (1982). The development and implications of a personal problem-solving inventory. *Journal of counseling psychology, 29*(1), 66.

Heppner, P. P., Witty, T. E., & Dixon, W. A. (2004). Problem-solving appraisal and human adjustment: A review of 20 years of research using the Problem Solving Inventory. *The Counseling Psychologist, 32*(3), 344-428.

IEA. (2015). TIMSS and PIRLS. Retrieved 25th May, 2018, from https://timssandpirls.bc.edu/about.html

Jonassen, D. H. (1997). Instructional design models for well-structured and III-structured problem-solving learning outcomes. *Educational Technology Research and Development, 45*(1), 65-94.

Kaewpet, C. (2009). A framework for investigating learner needs: Needs analysis extended to curriculum development. *Electronic journal of foreign language teaching, 6*(2), 209-220.

Kifer, E. W. (2002). Students' attitudes and perceptions Secondary analysis of the TIMSS data (pp. 251-275): Springer.

Martin, M. O., Mullis, I. V., Foy, P., & Stanco, G. M. (2012). TIMSS 2011 International Results in Science: ERIC.

mohammad Qablan, A. (2020). التراجع المستمر في الاداء الاكاديمي لطلبة العلوم في الاردن في اختبار دراسة التوجهات الدولية للرياضيات والعلوم (TIMSS): الاسباب والحلول. *Humanities and Social Sciences Series, 33*(4).

Nota, L., Heppner, P. P., Ginevra, M. C., Ferrari, L., Heppner, M. J., & Soresi, S. (2013). Development of the Problem Solving Inventory with Italian youth. *International Perspectives in Psychology: Research, Practice, Consultation, 2*(3), 181-193.

Pekgoz, S. (2020). *Teachers and Students Mathematical Problem-Solving Beliefs and Skills with a Focus on PISA Problems*. Columbia University.

Polit, D. F., & Hungler, B. P. (1993). *Study guide for essentials of nursing research: Methods, appraisal, and utilization:* Lippincott Williams & Wilkins.

Richards, J. C. (2001). Curriculum development in language teaching: Ernst Klett Sprachen.

Roseth, C. J., Johnson, D. W., & Johnson, R. T. (2008). Promoting early adolescents' achievement and peer relationships: The effects of cooperative, competitive, and individualistic goal structures. *Psychological bulletin, 134*(2), 223-246.

Rutkowski, L. (2008). Educational Issues in the Middle East North Africa Region.

Saifan, H. M. A. (2018). Evaluating The Programs Of The Gifted Resource Rooms In Jordanian Public Schools In Light Of The International Standers (doctorate published), University of Jordan, Jordan. Retrieved from https://theses.ju.edu.jo/Original_Abstract/JUA0803777.pdf

Savery, J. (2006). Overview of problem-based learning: definitions and distinctions. *Interdiscip J Probl Based Learn 1* (1), 9-20.

Soancatl, V., León, A., Martínez, C., & Torres, L. (2010). Leading students to solve math problems using question-led learning. Paper presented at the Proceedings of the 4th European Conference on Games Based Learning.

Soliman, A. M. (2014). The Problem-Solving Inventory: Appraisal of problem solving in the Arab context, factor structure, and validation. *International Perspectives in Psychology: Research, Practice, Consultation, 3*(4), 252-267.

Stufflebeam, D. L., McCormick, C. H., Brinkerhoff, R. O., & Nelson, C. O. (1985). Introduction to needs assessment Conducting educational needs assessments (pp. 1-22): Springer.

Umairah, N. (2014). Cypriot Journal of Educational Sciences. *Journal of Educational Sciences, 9*(3), 203-229.

Zeidner, M. E., & Endler, N. S. (1996). Handbook of coping: Theory, research, applications.

Zimmerman, B. J., & Campillo, M. (2003). Motivating self-regulated problem solvers. The psychology of problem solving, 233262.