Swedish students' problem-solving perceptions and its implications for teacher training and development

Ernest Ampadu
Department of Learning
Royal Institite of Technology-
KTH. Stockholm, Sweden
ernesta@kth.se

Batoul Chechan
Department of Learning
Royal Institite of Technology-
KTH. Stockholm, Sweden
batoul@kth.se

Abstract—Students' ability to solve problems that require higher order thinking skills is not just necessary but also a sufficient condition in our quest for training students who have the skills and competencies to compete effectively both at the national and international levels. Achieving SDG4 is underpinned by examining how UNESCO's sustainable competencies with emphasis on systems thinking, anticipatory, normative, strategic, critical thinking, self-awareness, and integrated problem-solving competencies are integrated or understood within the classroom context. Despite the integration of problem-solving into the Swedish school curriculum, students' performance in this area has not been as expected. This study, therefore, examines the problem-solving attitudes of Swedish students and its implications for teacher training and development. Using a survey design and the Problem-Solving Attitude Inventory (PSAI) data was collected from 432 (primary, lower and upper secondary) students. Descriptive and inferential (ANOVA) statistics analyses were conducted to examine the problem-solving attitudes among the different grade levels. The results show that two of the constructs (problem-solving tendency, personal control) were statistically significant., $F(2, 429)=5.007$, $p=0.007$ and $F(2,429)=3.071$, $p=0.047$ respectively. The constructs (problem-solving confidence and avoidance style) did not show any statistically significant difference, $F(2, 429) = 1.609$, $p = 0.201$ and $F(2, 429) = 0.484$, $p = 0.616$ respectively between school levels. The results show that primary school students ascribed more positively to the items in the four constructs as compared to their lower and upper secondary peers. Personal control was the main contributing construct and had a direct influence on the other constructs. The ANOVA also showed a significant difference between gender and problem-solving attitudes with males ascribing more positively to all the four constructs except personal control. The results provide critical implications for teacher training and development. The conceptual framework shows that there is a need for teacher training programmes to equip teachers on how to change or influence students' self-control characteristics. We suggest the use of contextual and challenging activities to help enhance students' personal.-control construct.

Keywords- personal-control, problem-solving competency, problem-solving competence, avoidance strategy, expectancy-value theory, SDG, teacher education, UNESCO.

I. INTRODUCTION

Developing student's problem-solving skills, perceptions and attitudes have become necessary in many classrooms, especially in heterogeneous classrooms with students from diverse backgrounds, ability and needs [1]. Problem-solving has therefore become an integral component of instruction and understanding students' problem-solving attitudes is important in our quest for training teachers who can help students develop these skills. Students' ability to solve problems that require Higher Order Thinking Skills (HOTS) has been scrutinized by many national and international studies [1], [2], [3], ; [4]. In many countries problem solving is not integrated into the teaching and learning of the different school subjects but students are introduced to it or taught separately [5]. In Sweden, the school curriculum provides a clear framework for promoting students' problem-solving skills and competencies and stated that "school should stimulate pupils' creativity, curiosity and self-confidence, as well as their desire to explore their ideas and solve problems" [6]. However, like in most other countries, the guidelines and principles for integrating or teaching problem-solving have not been made explicit.

It is therefore not surprising for [7] to argue that while Swedish national tests have a lot of problem-solving questions, teacher-designed tests usually contain a small proportion of such questions. Despite the importance of students developing an understanding of basic concepts and lexicons appropriate for learning, providing challenging activities to help students boost their problem-solving skills is paramount. However, critical analysis of the 2019 PISA and previous years' results have shown that just about 53% of students from participating countries were able to solve problems requiring problem-solving skills [4]. Similarly, an analysis of TIMSS results from 2007 to 2019 also shows that generally, students' performances in tasks requiring problem-solving skills were far below their performances in tasks that require the solving of routine problems [3]. In Sweden research by [8] also shows that the

performance of Swedish students in PISA and TIMSS has been plummeting over the years and students' problem-solving competencies have not been encouraging. According to [9], although research on problem-solving has progressed considerably, there is evidence that researchers and for that matter, their research output still struggle to specify how to develop students' problem-solving skills and abilities. [10] are however of the view that the problem-solving performance and competencies of the learner depend on their attitudes and beliefs. Similarly, research by [11] has also shown that the individual learner's ability to deal with barriers when dealing with non-routine problems does not only depend on their previous knowledge, abilities, skills and competencies but also on their attitudes/perceptions and beliefs which shape their conceptions and dispositions about the concepts under consideration.

II. Research objectives and questions

Although it may be difficult to change perceptions and for that matter attitudes over time, understanding the problem-solving attitudes of the learner will help in developing activities that can help improve their problem-solving competencies. The current study, therefore, adapts the Expectancy Value Theory (EVT) to explore students' problem-solving perceptions and their implications for teacher education and development. The overarching research question guiding the study is what are students (primary, lower and upper secondary) perceptions about problem-solving confidence, personal control, avoidance style and problem-solving tendency? The specific research questions are;

1) Is there any difference between students' problem-solving perceptions and their school level?
2) Is there any difference between students' problem-solving perceptions and their gender?
3) What are the implications of these perceptions for teacher training and development?

III. Theoretical framework

A. *The concept of problem-solving*

There is a plethora of research on the need for promoting effective teaching and learning in our schools, and problem-solving has been discussed extensively in the literature as one of the effective and fundamental methods for teaching [12]. Problem-solving has been defined differently by many researchers, for example, [13] described problem-solving as "an activity that involves the students' engagement in a variety of cognitive actions including accessing and using previous knowledge and experience" (p. 510). Similarly, [14] also defined problem-solving as "the art of dealing with non-trivial problems which do not yet have a known, routine solution strategy to the student, but which provide opportunities for the student to develop new solution strategies" (p. 405). That is problem-solving is the process of solving non-routine problems in which the problem solver (learner) could not just tell the answer without engaging in a variety of cognitive actions. It is anticipated that during such engagement students develop the competencies that they need to think critically and analyse issues from different perspectives to have a holistic picture and understanding of the issue under discussion.

Different problem-solving frameworks are distinguishable in the literature. One of the most commonly used frameworks is that of [15], [16]. Polya's framework consists of four strategies; understanding the problem (identifying the known and unknown variables), devising a plan (choosing strategies for responding to what is asked), carrying out the plan (implementing the plan) and looking back (checking the plan and solution). Teaching students or helping students to develop problem-solving skills revolves around our understanding of the fundamental principles of problem-solving as developing problem-solving skills and competencies takes time and it can be challenging for some students who are not used to this approach or new method. However, despite the challenges, the benefits associated with these skills are well documented in the literature. As highlighted above it does not only help in creating students who are critical thinkers but helps them to be innovative in their learning process [17]. The ever-changing needs and aspirations of society require people who can conceive, design, implement and operate solutions that are relevant to the current situation and also help us understand how things will look in the future. Such information and competencies are needed to understand the unfolding patterns and changes in our societies and the world at large.

B. *Understanding student's attitudes toward problem-solving*

The concept of learners' attitudes has been researched extensively and most of these studies have shown a direct relationship between students' attitudes towards the learning of a particular subject and their performance. The terms perceptions and attitudes have been used interchangeably by some authors and researchers in the quest for explaining what it means. However, for this

study, since the emphasis is on students who were asked to indicate how they agree or disagree with several statements from their perspective rather than how they will react to a given phenomenon or situation, we assume that the use of perceptions is most appropriate. That is, these perceptions will lead to attitudes which will change the behaviour of the student. For this study, the concept is conceptualized not to just know students' perceptions or attitudes toward problem-solving but also the implications of this for teacher training and development.

It is evident from the above discussion that problem-solving skills and competencies have a prominent role in the Swedish national curriculum at all levels. Teachers in their quest for helping students develop these skills have not been explicitly conceptualized into the school curriculum, but teachers are expected to integrate these into their teaching, teachers need to understand the kind of perceptions that these students have about problem-solving. As highlighted by [18] attitudes are dispositions to like or dislike objects, persons, institutions, or events and these attitudes and dispositions are usually influenced by the kind of perceptions that the individual has and this intention influences their behaviour and ability to cope or work with such concepts. [19] suggested that: "...attitudes are made up of effective components consisting of your emotional reactions toward the attitude; a cognitive component consisting of your thoughts and beliefs about the attitude object; and a behavioural component, consisting of your actions or observable behaviour toward the object" (p. 229).

C. *Expectancy Value Theory*

Designing and developing complex hand-on-activities helps in generating problem-solving skills and competencies as such activities allow students to combine different knowledge and thinking skills [20]. However, it is worth noting that the design and development of such activities could not yield the expected results if the perceptions and attitudes of these learners are not known. For example, drawing on [21] Expectancy Value Theory (EVT) students' beliefs about success in learning or using a particular method has a direct impact on their learning as lower utility values usually predict lower learning aspirations [22]. EVT provides three motivation questions; expectancy, values and goals, and students will normally before they start any task or use any method ask "Can I do this task?"; "Do I want to do this task and why?"; and,"What do I have to do to succeed on this task?" [23]. [23] further argued that the individual student's expectancies for success, subjective task value and ability beliefs for success is very cricual in the teaching-learning process. Motiovation which is a critical component for students learning is directly linked to the student's expectancies for success and the utilitarian motive behind the concept that the student is learning or introduced to. One one of enhancing students motivation is through the deliberate attempt of providing activities that will help shape the individual student's personal control. Personal control or self-efficacy is therefore critical in understanding how learners approach a particular problem. [24] and [25], [26] and others have argued that there is a direct relationship between the individual learner's personal control or self-efficacy and their attitudes toward problem-solving. The use of EVT will provide some understanding of how the responses of the learners to the different questions shape their energy, attention and self-regulated actions which will, in turn, provide some valuable information about the kind of support they will need.

D. *Overview of the Swedish teacher education system*

The Swedish educational system and for that matter the teacher education system "the Swedish Model" has gained a global reputation and many countries have adopted the principles underpinning the Swedish system. The unique characteristics of the Swedish system have to do with the fact that the system is publicly driven and underpinned by the principle of quality education for all which is consistent with SDG 4. This is enshrined in the Swedish Code of Status "the education provided in each school form and the leisure-time centre should be equivalent, regardless of where in the country it is provided" [27]. As highlighted above and reiterated by [28] the declining PISA results and politically motivated constraints brought about several reforms with the hope of better accountability for quality education. The renewal of Swedish teacher education is dated back to the 1940s with particular emphasis on the progressivist and educational science orientation [29]. However, in the early 1990s there was a partial change with emphasis on subject knowledge in teacher education where the academic orientation with the call for well-educated subject teachers became the order of the day.

In the year 2001 the country's teacher education system revisited the progressivist paradigm with the overall aim of realigning the role of the teacher as a result of the rapid social changes. In 2011 there was a resurgence in the academic orientation with the return of separate programmes for grades 1-3 and 4-6 and subject teachers for grades 7-9 or upper secondary [29]. From the

above, it can be argued that the Swedish teacher education system has been characterized by two main traditions: the seminar and academic traditions. The seminar traditions are for young pupils and the academic tradition is for teachers teaching older learners. The need for tested experience through the seminar tradition and a strong tie to research through the academic tradition. As highlighted by [30] the seminar tradition is to model behaviour while the academic tradition strives to gain knowledge of subject matter and conduct independent studies. Despite these changes and challenges in the teacher education system, the issue of quality education and teacher training has been paramount in all the traditions and this is consistent with what [31] said that "the quality of an education system cannot exceed the quality of its teachers" (p. 16).

Despite the different routes, Swedish teachers at each level use a decentralised curriculum were developing students' problem-solving is centrally placed. That is the current curriculum encourages teachers not just to see problem-solving as content and knowledge but also as a competency that every learner should acquire. However, research by [32] and others have shown that the specification of the competencies and how to teach problem-solving has not been made explicit in the curriculum, hence teachers are free to decide how and when they teach problem-solving. Hence, understanding the problem-solving perceptions of students could be an important framework for helping teachers in designing innovative lessons and activities that promote higher-order thinking among students and also help change students' problem-solving attitudes and behaviours.

E. Teachers supporting students develop problem-solving skills

The role of the teacher in helping students develop problem-solving skills and competencies cannot be underestimated especially in socially, economically and culturally diverse classrooms. These differences in students' backgrounds not only influence their learning abilities and expectations but also requires teachers who are trained to handle these differences. It is for this reason that [33, p.6] argued that; certain aspects of our way of life, certain kinds of knowledge, certain perceptions, attitudes and values are regarded as so important that their transmission to the next generation is not left to chance in our society but entrusted to specially-trained professionals (teachers) in elaborate and expensive institutions (schools). [34] in their analysis of the knowledge of instructional strategies expressed by Swedish technology teachers, established that despite the differences in teaching methods and the use of different instructional strategies among Swedish teachers, the paramount focus has been on problem-solving and the designing of activities that will help students develop their problem-solving skills and competencies. Apart from the importance of understanding the perceptions of students and how these perceptions influence their attitudes, in our quest for providing support that could help them develop their problem-solving skills and competencies, the issue of inequality is another major factor that can undermine the teacher's effort in supporting students.

In Sweden like in most other countries, there has been several curricula restructuring to improve students learning and standards. The introduction of the new curriculum in 2011, [35] reiterates the fact that despite the numerous advantages associated with this curriculum, there is the risk of reproducing inequality in schools as there is a greater division between vocational and academic education curricula. He is of the view that the two programmes attract different types of students with the vocational educational programme attracting most students from lower socio-economic backgrounds. Such inequalities may hinder our quest for training and developing students who have problem-solving competencies and can solve problems that require some higher-order thinking skills. However, understanding the perceptions and attitudes of students toward problem-solving is critical in developing challenging and motivating activities that can help students develop the needed problem-solving skills. That is, understanding the individual learner's control, problem-solving confidence, and approaches/avoidance style will help the teacher to understand the background characteristics of his/her learners when designing the content of the lesson.

In addition to this, scaffolding is considered one of the innovative approaches to helping students develop problem-solving skills as it helps students to learn problem-solving skills and solve problems independently. Scaffolding includes the provision of support and guidance by a knowledgeable individual to help bridge the individual learner's Zone of Proximal Development (ZPD) [36]. However, as highlighted by [37] it is worth noting that scaffolding works well when the task or activity used or given to the learner is at the appropriate level within the learner's ZPD for the scaffolding experience to be successful and foster the knowledge development process. It is for this reason that the researchers are of the view that understanding the problem-solving perceptions and attitudes of students is crucial in our quest for helping students develop problem-solving skills. Using the EVT as a lens we envisage that

the findings from this study will add to the existing literature on how students experiences and perceptions for success and beliefs about the ability to succeed are among the strongest psychological predictors of performance [21].

IV. METHODS

A descriptive survey design was used and a total of 432 students from different Swedish primary, lower and upper secondary schools completed the survey instrument online. The Problem-Solving Attitude Inventory (PSAI) was adapted for the study. The original questionnaire has 18 questions used for measuring students' attitudes towards problem-solving. The instrument was translated into Swedish and the content was validated to suit the Swedish language and context. The instrument was first piloted with some 20 students after which more changes were made to the the language reliability. The has 18 questions categorised under four constructs personal control (five questions), problem-solving confidence (six questions), approaches/avoidance style (four questions) and problem-solving tendency (three questions). The current study used a 5-point Likert scale (i.e.1=strongly disagree … 5 = strongly agree) to measure the respondents' perception to each of the questions. The four constructs are interconnected to help understand the students' problem-solving perceptions and their implications for teacher training and development and this is represented in the conceptual framework diagram below. Our initial conceptual framework was that teacher training and development should have a direct influence on students' problem-solving attitudes. However, after the data analysis and critically examining the results, it was observed that personal control was the single most important construct that could influence the learner's problem-solving confidence, avoidance style, problem-solving tendency and for that matter the student's problem-solving attitudes.

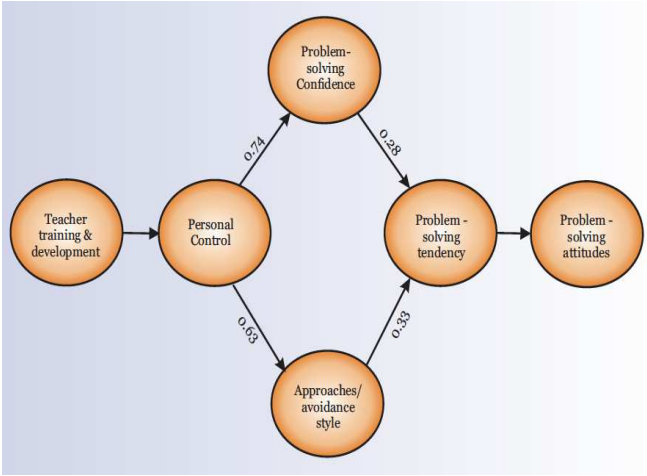

Figure 1: Conceptual Framework

As highlighted above, the sample for this study included some 432 students and the background characteristics of the participants are depicted in Table 1 below. To check for the internal consistency of the scales Cronbach Alpha analysis was conducted, and a reliability result of 0.88 was achieved was considered to be sufficient [38]. A Pearson correlation was conducted to examine the correlation between the constructs and even though there was a positive correlation between the different constructs, the correlation between personal control and problem-solving confidence and approaches/avoidance style was highest which is 0.74 and 0.63 respectively. Hence, we concluded that teacher training and development programmes should aim at influencing students' personal-control or self-efficacy constructs as this will intend to change their problem-solving confidence, tendency, and attitudes in general as depicted in Figure 1.

TABLE I
DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

Personal Information	**Number of Participants**
Gender	
Male	197 (45.6%)
Female	221 (51.2%)
Other	14 (3.2%)
Total	**432**
School Level	
Grundskola Primary School)	43 (10%)
Grundskola(Lower Secondary)	209 (48.4%)
Gymnasieskola(Upper Secondary)	180 (41.7%)
Total	**432**

The results were exported into SPSS for analysis and a normality test was conducted to be certain of the kind of analysis to be done. The normality test showed that the data was normally distributed hence the need for a parametric test. Both descriptive (frequencies) and inferential statistics (ANOVA) were conducted to measure students' perceptions across the three (primary, lower secondary, upper secondary) school levels. Three ethical considerations (informed consent, anonymity and voluntary participation) were adhered to and these were negotiated through the school heads, teachers, and parents. The data collected had no traceable questions and the names of the schools and students involved were not collected during the data collection process.

V. RESULTS

A. *R1: Is there any difference between students' problem-solving attitudes and their grade level?*

To answer the first research question, by examining students' problem-solving attitudes based on the four constructs (problem-solving confidence, personal control, avoidance style, and problem-solving tendency) we used both descriptive statistics (frequencies) and inferential statistics (one-way ANOVA) to measure the relationship between school level, gender and problem-solving attitudes and the results are depicted in Tables 1 and 2.

TABLE II
ONE-WAY ANOVA OF SCHOOL LEVEL AND PROBLEM-SOLVING PERCEPTIONSS

Constructs		Sum of squares	Df	Mean square	F	Sig
Problem-solving Tendency	Between Groups	55.84	2	27.9	5.0	0.007
	Within Groups	2392.2	429	5.58		
Problem-solving Confidence	Between Groups	57.25	2	28.6	1.6	0.201
	Within Groups	7631.9	429	17.8		
Personal Control	Between Groups	81.78	2	40.9	3.1	0.047
	Within Groups	5712.2	429	13.3		
Avoidance Style	Between Groups	7.11	2	3.56	0.48	0.62
	Within Groups	3148.8	429	7.34		

* All constructs were statistically significant p<0.05

The ANOVA results indicate that two of the constructs (problem-solving tendency, personal control) are statistically significant, F(2, 429) = 5.007, p = 0.007 and F(2, 429) = 3.071, p = 0.047 respectively. On the other hand the constructs (problem-solving confidence and avoidance style) did not show any statistically significant difference, F(2, 429) = 1.609, p = 0.201 and F(2, 429) = 0.484, p = 0.616 respectively. However, there is a significant mean difference in the mean scores between the three groups and the four constructs. For example, although there was no statistical difference between school level and problem-solving confidence the descriptive statistics show that primary school students (mean=3.5) ascribed more positively to these statements than their colleagues at the lower secondary (mean=3.3) and upper secondary (mean=3.26) levels. Similarly, there was no statistical difference between school level and avoidance style but the descriptive statistics show that primary school students (mean = 3.8) are more likely to look for alternative ways of solving a challenging problem than students at the lower secondary (mean = 3.4) and upper secondary (mean = 3.36). On personal control, the results indicated that primary school pupils (mean=3.6) also expressed more personal control than their colleagues in the lower secondary (mean=3.42) and upper secondary (mean = 3.56) levels. The above indicates that there is a direct relationship between personal control and the other three constructs, and this, in turn, shapes the problem-solving attitudes of the learner.

B. *R2: Is there any difference between students problem-solving perceptions and their gender?*

TABLE III

ONE-WAY ANOVA OF GENDER AND PROBLEM-SOLVING PERCEPTIONS

Constructs		Sum of squares	Df	Mean square	F	Sig
Problem-solving Tendency	Between Groups	14.80	2	7.40	1.31	0.27
	Within Groups	2433.2	429	5.67		
Problem-solving Confidence	Between Groups	268.04	2	134	7.75	<.001
	Within Groups	7421.2	429	17.3		
Personal Control	Between Groups	89.05	2	44.5	3.35	0.036
	Within Groups	5705	429	13.3		
Avoidance Style	Between Groups	54.69	2	27.3	3.78	0.024
	Within Groups	3101.3	429	7.23		

* All constructs were statistically significant p<0.05

Table 3 shows the result of one-way ANOVA (F (2,429) = 1.305; 7.747; 3.348; 3.782, p =0.272; <0.001; 0.036; 0.024) for the constructs problem-solving tendency, problem-solving confidence, personal control, and avoidance style confidence, personal control, and avoidance style respectively. The results show a statistically significant difference between gender and the last three constructs. A critical analysis of the descriptive data shows that male students ascribed positively to all the constructs apart from personal control where female students indicated more positive attitudes than their counterparts. The mean score of female students perception of personal control (M = 3.52, SD= 0.1.09) is slightly higher than male students (M = 3.37, SD = 1.01) and others (M = 3.49, SD= 0.98).

C. *What are the implications of these perceptions for teacher training and development?*

From Table 1 and 2 it is clear that students personal control or self-efficacy plays a crucial the development of problem-solving skills. It can therefore be argued that the is the need for teacher education training and development programmes to pay particular attention to helping students develop good personal control or self-esteem. There is also the need to critically examine secondary school teacher training and development programmes to incorporate innovative ways of helping teachers at this level to support their student problem-solving skills development. As highlighted above, students perception of their problem-solving skill and competencies were more positive at the primary school level as compared to the their colleagues at the lower and upper secondary levels. There may be the need to examine the teacher training curriculum at these levels to see if the combination of the seminar and academic traditions could be useful in training teachers who could help these students understand the utilitarian motive of the concepts that they will learn and also design and create activities and tasks that will help improve their self-control which may in-turn increase their problem-solving confince and improve their problem-solving attitudes in general.

VI. DISCUSSION

The importance of problem-solving skills and competencies cannot be underestimated in our quest for training students who understand learning as learning for tomorrow's world. Employers are interested in people who can think imaginatively, and design innovative methods of solving the many problems that society faces today which are new. The push for STEM, STEAM and STREAM programmes in schools reflects this new trend. Our results confirm previous findings [25], [26] that personal control or self-efficacy of students correlates with their problem-solving tendency, problem-solving confidence and avoidance style which in turn shapes their problem-solving attitudes.

The results established that a major determinant of students' problem-solving attitudes is influenced by the choices of the learner, the effort they are likely to put in, their perseverance in the face of difficulties, and their confidence in the individual's personal-control factors [24]. There was a significant difference between school level and the constructs of problem-solving competence and personal control with primary school students ascribing more positively to the statements in these constructs than their lower and upper secondary counterparts. Similarly, the findings from the study support the findings of other researchers, for example [39] that there are gender differences in problem-solving skills, attitudes and competence favouring males. It is, however, interesting to note that similar to the findings of [40] girls' responses were more competent and showed more personal control or self-efficacy than those of boys, but this did not reflect in their responses in the other constructs as expected.

The above results show that majority of the students at each level ascribed positively to the items under the different constructs. This suggests that these students have a positive problem-solving attitude and this could be a great asset in our quest for training students who are critical thinkers and have higher-order thinking skills that are consistent with UNESCO sustainable competencies. However, it is worth noting that despite these positive attitudes, the majority of the respondents were not sure of how they will handle issues of personal control, avoidance style, problem-solving tendencies and problem-solving confidence as most results hover around the mean of 3 and this has implications for teacher training and development. Teaching teachers how to help students develop problem-solving skills and competencies should be an integral part of teacher education programmes with particular emphasis on designing activities that are challenging and relevant to the context and background characteristics of students.

The integration of the seminar and academic traditions should be enhanced to provide these teachers with both the academic and professional knowledge that

they need to be able to support students from a holistic point of view. Developing problem-solving skills and competencies can be challenging and takes time, hence teachers should make deliberate attempts of teaching students these skills and integrate them into their daily teaching. The use of scaffolding and motivating students to understand the utilitarian motive behind the different concepts and principles that they are learning. This could be achieved through the provision of authentic feedback and setting up high expectations for students and providing regular guidance on how to achieve these expectations and the importance of these in their day-to-day life as highlighted by the Expectancy value theory.

One of the main challenges in developing students problem-solving skills is the designing of good problem-solving tasks that are original, non-routine, interesting, challenging and new to the students. It is therefore imperative for teachers to make deliberate attempts in looking for tasks and activities that could stimulate students thinking and interest rather than just requiring them to find a solution. That is why we suggest that teachers need to conduct a need analysis to examine the background characteristics of their students and also examine the contextual factors when designing their activities as not all activities will work out well for each student or group of students. Students are motivated and more willing to engage and learn new concepts when context problems, that is problems in which the problem situation is experientially real to the student [41]. The conceptual framework for this study, therefore, calls for a new dimension in our quest for helping students develop problem-solving skills and competencies. As highlighted by [21] students' self-control or efficacy is the strongest psychological predictor of performance and achievement and these relations are evident in children as young as first grade and strengthen across age, there is the need to train teachers on how to positively influence students personal-control construct as this will intend to have a positive influence on the other constructs. From the results, it is clear that students' personal-control construct was very positive among primary school pupils but decreases as they progress which contradicts the assertion by [21] that students' personal control, expectancy and values strengthen as they grow. The results show that lower and upper secondary school students' personal-control and problem-solving tendencies were lower than that of primary school pupils. This, therefore, calls for teachers and for that matter teacher education programmes to critically examine how to design lessons and activities that will help influence students' personal control positively across ages.

VII. Conclusion

Quality education linked to improved student achievement has been burgeoning in the international literature in response to the demand of society for improved teaching and learning strategies. In addition to this, both national and international (e.g. PISA and TIMSS) results have shown that in Sweden like in most other countries students' performance in higher-level tasks designed to assess applications of non-routine problems has not been encouraging. We conclude by saying that learning through problem-solving has a lot of benefits but it can be challenging considering the cognitive drills that one has to go through. However, as one grows his/her cognitive abilities develop and hence are expected to be motivated to engage in more cognitive drills. However, the results tell us something different and the question we are contemplating is why students' personal control, problem-solving tendency and problem-solving competence reduce as they grow or move to higher grade levels? Is it because of lack of motivation, the nature of activities used, much emphasis is placed on grades at the higher level, over-reliance on textbooks, or lack of understanding for learning for tomorrow's world? These questions have implications for teacher training and development, and there is the need for a deliberate attempt on the part of teacher educators and teachers to provide more opportunities for all students to develop their problem-solving skills and competencies. It is recommended to pay attention to problem-solving at lower and upper secondary school levels and the textbooks used at these levels should use contextual, interesting and challenging problems that students will be much interested in to help develop their interest and improve their self-control.

References

[1] Klang, N., Karlsson, N., Kilborn, W., Eriksson, P., & Karlberg, M. (2021). Mathematical problem-solving through cooperative learning—The importance of peer acceptance and friendships. In *Frontiers in Education* (p. 324). Frontiers.

[2] Ampadu, E. (2019). Mathematics teachers' perceptions about problem-solving: The case of Ghana. *The Oguaa Educator, 13*, 1-18.

[3] Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 international results in mathematics and science.* Boston College, TIMSS & PIRLS International Study Center.

[4] OECD. (2019). *PISA 2018 results (Volume I): What students know and can do. Paris:* OECD Publishing. Doi: 10.1787/5f07c754-en.

[5] Cai, J. (2010). Commentary on problem-solving heuristics, affect, and discrete mathematics: A representational discussion. In *Theories of mathematics education* (pp. 251-258). Springer, Berlin, Heidelberg.

[6] National Agency for Education (2011). *Curriculum for primary school, preschool class and leisure center 2011*. Stockholm: National Agency for Education.

[7] Brehmer, D., Ryve, A., & Van Steenbrugge, H. (2016). Problem solving in Swedish mathematics textbooks for upper secondary school. *Scandinavian Journal of Educational Research,* 60(6), 577-593.

[8] Henrekson, M., & Jävervall, S. (2016). *Educational performance in Swedish schools is plummeting—What are the facts?* Stockholm, Sweden.

[9] Smith, M. S. & Stein, M. K. (2011). *Five practices for orchestrating productive mathematics discussions*. Reston, VA: National Council of Teachers of Mathematics.

[10] Sturm, N., & Bohndick, C. (2021, February). The influence of attitudes and beliefs on the problem-solving performance. In *Frontiers in Education* (Vol. 6, p. 25). Frontiers.

[11] Verschaffel, L., Greer, B., and de Corte, E. (2000). *Making sense of word problems.* Netherlands: Swets and Zeitlinger.

[12] Stacey, K. (2005). The place of problem solving in contemporary mathematics curriculum documents. *Journal of Mathematical Behaviour, 24*,341-350.doi:10.1016/j.jmathb.2005.09.004.

[13] Kehle, P. E., & Lester, F. K. (2003). A semiotic look at modeling behaviour. Beyond constructivism: Models and modelling perspectives on mathematics problem solving, learning, and teaching. ZDM, *35* (6), 97-122.

[14] Doorman, M., Drijvers, P., Dekker, T., Heuvel-Panhuizen, M. van den, Lange, J. de & Wijers, M. (2007). Problem solving as a challenge for mathematics education in the Netherlands. *ZDM, 35* (6), 405–418.

[15] Polya, G. (1945). *How to solve it?*.Princeton, NJ: Princeton University Press.

[16] Polya, G. (1973). *How to solve it: A new aspect of mathematical method (2nd ed.).* Princeton, New Jersey: Princeton Univeversity Press.

[17] Polya, G. (1981). *Mathematics discovery: An understanding, learning, and teaching problem solving (combined edition)*. New York: John Willey & Son.

[18] Ajzen, I. (2005). *Attitudes, personality and behaviour*. Maidenhead, United Kingdom: Open University Press.

[19] Aronson, E. Wilson, T. D. and Young, J. (1995). *Social Psychology (2nd ed.)*, New York:Longman.

[20] Ahern, T., Leavy, B. & Byrne, P. J. (2014). Knowledge formation and learning in the management of projects: A problem-solving perspective. *International Journal of Project Management*, 32(8), 1423–1431.

[21] Eccles, J. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches (pp. 75-146)*. San Francisco, CA: Free man.

[22] Huang, N. T. N., Chiu, L. J., & Hong, J. C. (2016). Relationship among students' problemsolving attitude, perceived value, behavioral attitude, and intention to participate in a science and technology contest. *International Journal of Science and Mathematics Education, 14*(8), 1419-1435.

[23] Eccles, J. S. (2006). A motivational perspective on school achievement. In R. J. Sternberg & R. F. Subotnik (Eds.), *Optizing student success in schools with the other three Rs: Reasoning, Resilience, and Responsibility (pp. 199 -224)*. Greenwich, Connecticut: Information Age Publishing.

[24] Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, 25, 82-91.

[25] Luo, R. Z., Zhang, X. H., Zhang, C. M., & Liu, Y. H. (2019). Impact of self-directed learning readiness and learning attitude on problem-solving ability among Chinese undergraduate nursing students. *Frontiers of Nursing, 6*(2), 143-150.

[26] Nicolaidou, M., & Philippou, G. (2003). Attitudes towards mathematics, self-efficacy and achievement in problem solving. *European Research in Mathematics Education III*. Pisa: University of Pisa, 1(11).

[27] SFS: Svensk författningssamling (Swedish Codes of Status) (2010). *Skollagen (School law).* The Swedish government.

[28] Hellstén, M., Mickwitz, L., & Scharfenberg, J. (2020). Teacher education in Sweden: Revisiting the Swedish model. In *Teacher Education in the Global Era (pp. 99-114)*. Springer, Singapore.

[29] Furuhagen, B., Holmén, J., & Säntti, J. (2019). The ideal teacher: orientations of teachereducation in Sweden and Finland after the Second World War. *History of Education, 48*(6), 784-805.

[30] Sjöberg, L. (2019). The Swedish primary teacher education programme: at the crossroads between two education programme traditions. *Education Inquiry, 10*(2), 116-133.

[31] McKinsey, C., & McKinsey, M. M. (2007). *How the world's best performing school systems come out on top*. Recuperado de http://www.mckinseyonsociety.com/downloads/reports/Education/Como_hicieron_los_si stemas_educativos. pdf, 18.

[32] Boesen, J., Helenius, O., Bergqvist, E., Bergqvist, T., Lithner, J. et al. (2014). Developing mathematical competence: from the intended to the enacted curriculum. *The Journal of Mathematical Behavior, 33*, 72–87.

[33] Lawton, D. (2012). *Class, culture and the curriculum*. London: Routledge.

[34] Fahrman, B., Gumaelius, L., & Norström, P. (2017, July). It is mainly about problem solving. In Knowledge of instructional strategies expressed by Swedish Technology Teachers. *In 34th PATT conference, technology and engineering education, Philadelphia PA (pp.10-14).*

[35] Dahl, J. (2015, February). The three faces of problem solving. In *CERME 9-Ninth Congress of the European Society for Research in Mathematics Education (pp. 1571-1576).*

[36] Kim, M. C., & Hannafin, M. J. (2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers & Education, 56*(2), 403-417.

[37] Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.

[38] Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2009). *Multivariate data analysis*. 7th Edn. London, United Kingdom: Pearson.

[39] Neuschmidt, O., Barth, J., & Hastedt, D. (2008). Trends in gender differences in mathematics and science (TIMSS 1995–2003). *Studies in Educational Evaluation, 34*(2), 56-72.

[40] Walker, S., Irving, K., & Berthelsen, D. (2002). Gender influences on preschool children's social problem-solving strategies. *The Journal of Genetic Psychology, 163*(2), 197-209.

[41] Gravemeijer, K., & Doorman, M. (1999). Context problems in realistic mathematics education: A calculus course as an example. *Educational studies in mathematics, 39*(1), 111-129