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# Effect of PBL Supported by QR Code on Developing Intellectual over Excitability, and Creative Thinking

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Contemporary education systems emphasize the need to develop CTS, especially in the early stages of education, Given that children's creativity is linked to their level of intellectual over excitability, the current study aims to explore the impact of PBL supported by QR codes on activating their level of intellectual over excitability and developing their CTS. CTS test and intellectual over excitability test were applied on students, and observation card was applied by the classroom teacher, on a sample of 40 sixth-grade students. They were then divided into two equivalent groups. PBL supported by QR codes was applied on the experimental group in ten sessions, included real problems; this group was internally subdivided into cooperative groups. The control group studied in a traditional manner. Finally, both groups were evaluated by using the same tools, and they were assigned an individual task assessed by experts to measure their creative performance. The results revealed that PBL supported by QR codes served as a supportive context for students' intellectual over excitability, it also had a positive impact on students' creative performance. Moreover, it positively affected specific sub skills of CT—flexibility and originality—but did not significantly impact fluency, details, or overall CT level.

Keywords: creative thinking skills (CTS), intellectual over excitability, problem-based learning (PBL), quick response code (QR code), thinking skills

## INTRODUCTION

One of the main goals of the contemporary education system, which is witnessing rapid, and immense technological advancement, is building a new generation which has creativity and capable of facing challenges and producing original solutions to problems. Creativity is an urgent necessity in the education system of the 21$^{st}$ century (Navarrete, 2013; Sternberg, 2006). Therefore, contemporary curricula emphasizes the development of creative thinking skills for learners (Suratno, et .al, 2019), especially in the early stages of education. It is essential to enable children to make discoveries, use their imagination, and generate original ideas and strategies to find the best solutions to problems they encounter in learning situations and in their life generally (Minister of

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Education, 2021; Susilowati & Suyatno, 2021). Creative thinking skills help them continuously adapt to new and unprecedented challenges (Sternberg, 2006).

Unfortunately, although it is necessary for students to master creative thinking skills in problem-solving from a young age, some research indicates that the ability to think creatively in problem-solving is limited, with only a very small percentage of students being proficient in creative problem-solving (Jaenudin, 2023; Maharani,et. al, 2017). Hence, the importance of the current study, which aims to develop creative thinking skills by creating a supportive context for emotional and affective forces and stimulating psychological over excitability, which are prerequisites for creativity due to their prominent role in many cognitive, intellectual, and emotional aspects (Carman, 2011; Garces-Bacsal, 2011; Martowski, et. al, 2018).

When individuals are exposed to internal or external stimuli that align with their over excitability, they tend to exhibit high levels of emotional and behavioral responses (Piechowski & Chucker, 2011), enhancing their perception of reality and viewing it differently (De Bondt, et. al, 2019). Therefore, it is essential to employ appropriate educational strategies to stimulate over excitability that increases student engagement and motivates them to produce unconventional solutions and reveal their creative abilities (Sousa & Fleith, 2021), especially given the scarcity of experimental studies targeting the activation of over excitabilities (Martowska, 2016).

The context stimulating student over excitability and supporting creative thinking skills in the current study was real problem-based learning (PBL), which represents a motivating environment, which leads students to meaningful learning (Mayer & Wittrock, 1996). In such environments, students are more active, engaged, collaborative, and more capable of solving problems (Sari, et .al, 2021).

When the goal is to stimulate individuals' abilities, and develop creative thinking skills in the context of real-world problems, it serves as rich knowledge (Ericsson, et. al, 2006; Finke, et. al, 1992). The effectiveness of this context is enhanced when supported by QR codes, as the use of technological tools can help stimulate children and reveal their creativity (Resnick, 2007). Hence; the study problem is represented in the following questions: What is the effectiveness of problem-based learning supported by QR codes in stimulating intellectual over excitability?

What is the effectiveness of problem-based learning supported by QR codes in developing creative thinking?

**Context and Review of Literature**

**Creative Thinking in Problem Solving**

Creative thinking is considered an equivalent pathway to success in all fields and disciplines. Merely acquiring knowledge is no longer sufficient for an individual to be successful in life; instead, one needs to think and act creatively (Resnick, 2007).

Potur & Barkul (2009) defined creative thinking as an innate cognitive ability that allows individuals to use their intelligence uniquely during problem-solving to achieve original and distinctive outcomes. It is considered a high-level skill that involves both divergent thinking, where an individual can generate multiple ideas and perspectives, and convergent thinking, where ideas are evaluated, and critiqued to retain the best and most optimal alternative (Mumford & McIntosh, 2017).

Torrance identifies a creative person as someone who is sensitive to problems, understands knowledge gaps or obstacles, identifies difficulties, excels in formulating hypotheses, modifying and testing advanced ideas, finding solutions, and determining outcomes (Maharani, 2017). This requires high levels of fluency, flexibility, originality, and details during problem-solving (Silver, 1994).

It is important to note that creative thinking are closely related to emotional and affective forces, which provide the necessary requirements for its occurrence, such as energy, purpose, and direction for this cognitive endeavor (Dai & Sternberg, 2004). Therefore, psychological over excitability is considered one of the important factors for creativity (Carman, 2011; Garces-Bacsal, 2011; Martowski, et. al, 2018).

**Over-excitability and Its Types**

The concept of over-excitability is central to Dąbrowski's Theory of Positive Disintegration (TPD), which reflects an individual's tendency towards exceptional stimulation by stimuli. It is an above-average ability to utilize internal and external motivations, relying on heightened sensitivity of the nervous system. The person's reactions are much stronger than others or are continuous on cognitive, behavioral, and emotional levels (Piechowski, 1975).

Dąbrowski proposed five forms of over-excitability: imaginative, psychomotor, sensory, intellectual, and emotional. Imaginative over-excitability involves relieving emotional tension through imagination, vivid dreams, and wide-ranging associations. It is expressed through sharp and vivid images, the use of metaphors in verbal expression, keen visualization, and a love for the unusual (Rinn & Reynolds, 2012; Piechowski, 2017).

Psychomotor over-excitability manifests as an organic surplus of energy (vitality and enthusiasm) expressed through hyper-sensitivity of the neuromuscular system, often unrelated to athletic ability (Mofield & Peters, 2015). Sensory over-excitability includes rich and extended sensory and aesthetic experiences as a means to relieve internal tensions and conflicts (Mendaglio & Tillier, 2006; Mofield & Peters, 2015).

Intellectual over-excitability is characterized by a strong need for knowledge, problem-solving, curiosity, a desire for mental activity, understanding, and exploring the unknown (Miller et al., 2009). This type of over-excitability should not be compared to intelligence or problem-solving ability but rather to a love for these processes (Rinn & Reynolds, 2012).

Emotional over-excitability refers to the way relationships are experienced. A person with strong emotional over-excitability is deeply sensitive, has intense emotions and complex feelings, and high levels of empathy for others (Miller et al., 2009; Piechowski, 2017). Chang & Kuo (2013) described over-excitabilities as filters for an individual's sensory perception, through which all internal, and external stimuli pass before being subjected to cognitive information processing. When individuals with over-excitability are exposed to internal or external stimuli that align with their over-excitability, they tend to exhibit unparalleled levels of emotional and behavioral responses. According to TPD, these characteristics may lead to increased internal excitement (Piechowski, 2017) and heightened perception of reality (De Bondt, et .al, 2019).

**Over-excitability and Its relationship to creativity**

The concept of over-excitability has been used to understand various aspects of creativity. Gifted and creative individuals often exhibit intensity in the way they practice their lives, with reactions that may exceed the boundaries of excitement itself and last longer than expected (Mendaglio & Tillier, 2006).

Dąbrowski explained that over-excitabilities represent the highest forms of modification, constituting a continuous series of adaptation levels that support certain personal and mental traits in individuals, enabling them to generate ideas and produce the unconventional. People who exhibit any form of over-excitability perceive reality differently and focus more on the details of their environment, whether physical or abstract. They may demonstrate exceptional levels of information processing and creative thinking that directly support their creative potential (He, et. al, 2017; Piechowski & Chucker, 2011). Research has found that over-excitabilities play a role in predicting talent and creativity, generally showing that they are related (Carman, 2011; Garces-Bacsal, 2011; Martowski, et. al, 2018).

Over-excitabilities directly influence children's creative potential by enhancing their perceptual experiences (He, et. al, 2017) and indirectly by shaping their daily behaviors and play patterns (Piechowski & Chucker, 2011). In this regard, several studies have revealed a correlation between over-excitabilities, play patterns, and creative potential in kindergarten children (Fung & Chung, 2022; Fung, et. al, 2021).

Among the five types of over-excitabilities, Piechowski, (1975) emphasized the role of imaginative, intellectual, and emotional over-excitabilities as primary contributors to creative potential. This has been confirmed by studies that found high levels of intellectual, imaginative, and emotional over-excitabilities in gifted individuals (Harrison & Haneghan, 2011; Limont, et. al, 2014; Mendaglio & Tillier, 2006).

Sousa & Fleith (2021) found statistically significant differences between gifted and non-gifted students in patterns of intellectual and imaginative over-excitabilities. Similarly, Fung & Chung (2022) found a positive relationship between intellectual over-excitability and creative potential in a sample of kindergarten children. Additionally, a study by Pethö (2023) revealed significant differences in the level of over-excitability between intellectually gifted high school students and their average peers. Both intellectual and emotional over-excitabilities had substantial predictive power regarding intellectual creativity.

**The importance of Problem-Based Learning in stimulating students and encouraging Creative Thinking**

Educational and cognitive psychology significantly focus on facilitating the transition of learning and problem-solving in situations where problem-based learning and real-life scenarios are considered stimulating environments for students, leading them towards meaningful learning (Mayer & Wittrock, 1996). Children construct meaning through experiences, experiments, daily interactions with others, and object. It is also viewed as an effective tool for building more successful knowledge, especially when inquiry and creativity are present (Papert, 1993). If the goal is to develop creative thinking skills, it is important to note that creativity can be hindered in the absence of a supportive environment; therefore, enhancing a conducive environment in educational settings is essential to support creativity (Sternberg, 2006).

Problem-based learning context is considered a motivating and supportive environment for students to acquire creative thinking skills (Ericsson, et. al, 2006). It also helps in focusing on the problem-solving process required for creativity rather than solely focusing on reaching innovative solutions (Mayer, 1989). Thus, real problem-based learning may represent a supportive context to stimulate and excite students, providing an appropriate environment for creativity to emerge, especially when supported by quick response code. The use of technological techniques can assist in stimulating children and uncovering their creativity (Resnick, 2007).

**The importance of supporting student learning with Quick Response (QR) Codes**

QR code is considered one of the innovative digital technology-based learning tools, which is a type of two-dimensional barcode easily readable by smartphones via a scanner. QR codes facilitate connecting real-world objects with any web content or additional resources that enrich the learning process (Leshchenko, et. al, 2022; Serevina, et. al, 2022).

The QR code technology provides a new method for integrating children, especially in the era where young learners are increasingly ready for mobile learning, using laptops, tablets, or smartphones. (Libriani et al., 2023). Using QR codes helps to enhance trust between teachers and students by directing them to reliable and teacher-directed resources. Additionally, it aids in focused learning, where students receive only relevant information and messages related to their current subjects (Shahril, et. al, 2019). Moreover, the use of QR codes promotes flexibility in innovative teaching and learning (Shahril, et. al, 2019), facilitates self-learning and assessment, and prevents students from feeling bored (Wulandari, et. al, 2020).

One of the significant advantages of using QR code-based learning media is that it does not require every student to possess educational tool or device, as they can be used in groups, making learning time efficient for everyone (Libriani, et. al, 2023). QR code has positive impact on achieving clear and effective educational outcomes (Serevina, et. al, 2022), especially in science learning (Libriani et al., 2023), reading comprehension and language learning (Leshchenko, et. al, 2022), making the learning process interesting, and diverse. (Leshchenko, et. al, 2022).

Furthermore, scanning QR codes serves as a versatile tool for stimulating and supporting active learning among children in informal learning environments such as museums, outdoor facilities, or shopping centers, allowing information to be displayed at the right time leading to attract children's interest. (Chung, et .al, 2019). From this, it is seem that there are no experimental studies that have addressed the use of QR codes in problem-based learning, especially when implemented collaboratively, and studied their impact on stimulating learners and enhancing their creative thinking skills. Therefore, the current study aimed to investigate the impact of integrating students into problem-based activities that are interresting for them. This was done by dividing the activities into complementary parts, encoding each part into a QR code, and assigning students to collaboratively scan their designated code and complete the task specified for their group. Then examined the effect of this approach on the level of intellectual over excitability and creative thinking skills.

## METHOD

**To measure intellectual over-excitability, the following tools were prepared**

Classroom teacher's observation card: This card consists of 18 items divided into three dimensions (intense and sharp mental activity, passion for answering questions and solving problems, and reflective thinking). The score ranges from (18 to 54), additionally, the observation card includes an open-ended question for any further comments or additional information regarding the child's intellectual over-excitability.

Situational Test to measure Intellectual over-excitability: it consists of ten scenarios, each containing three different responses representing varying levels (low, medium, high) of intellectual over-excitability. The score ranges from (10 to 30).

Both tools were presented to a group of experts in the field to verify their validity. The items were then modified in light of the study's objectives. The observation card was applied by the classroom teacher to a pilot sample of 20 sixth-grade students, followed by the administration of the test to the students. One month after the first application, the tools were reapplied to calculate reliability, with the correlation coefficients between the two applications being 0.813 and 0.875, respectively.

**To assess creative thinking during problem solving**, a specific test was developed. This test consists of four activities designed to measure various creative thinking skills.

Fluency and flexibility measured through the first and second activities. Fluency is measured by counting the number of possible ideas and responses, Flexibility assessed by the ability to think in multiple directions and generate a variety of ideas; this is measured by grouping similar ideas for each individual, with the score for flexibility being the number of different groups.

Originality and details measured through the third and fourth activities. Originality is the ability to produce unusual ideas, so a response that is different from peers receives the highest score, while a response that is common among all students receives a score of zero. Details assessed by the ability to add new and diverse details to an idea or solution, which helps develop and enrich it. Each detail added to the idea distinguishing and enriching it to make it unique earns a score.

The test was reviewed by several experts on creativity and talent measurement, and the agreement rates that the four activities measure creative thinking skills ranged from 80% to 96%. The test was administered to the pilot sample, and students' scores were recorded. One month after the first application, the test was re-administered to calculate its reliability, with the correlation coefficients for fluency, flexibility, originality, details, and the total score being 0.885, 0.841, 0.860, 0.792, and 0.744, respectively.

The test was reviewed by number of experts, and the agreement rates ranged from (80% to 96%) for the four activities. The reliability of the test was calculated using the test-retest method on the pilot sample, with correlation coefficients for fluency, flexibility, originality, details, and the total score being (0.885, 0.841, 0.860, 0.792, and 0.744), respectively.

**The study procedures were as following**

Study sample consisted of (40) sixth-grade students. The study tools were administered, and the scores were used to randomly divide the students into two groups of (20) each. The equivalence of the two groups was verified using the independent samples t-test to detect differences in the mean scores of over-excitability as measured by the test and observation card, as well as creative thinking skills. The t-values were (1.644, 0.137, 0.119) , respectively, which are not statistically significant.

Implement PBL with QR codes on the experimental group during the designated sessions, while the control group received the same content through traditional teaching methods by the classroom teacher. The procedures for the experimental group were as follows:

The researcher prepared (10) training sessions, each including one complex and stimulating problem affecting human life, such as environmental issues (water pollution, air pollution, soil pollution, desertification, overfishing…). Each session's training content was divided into five separate parts each part include activities related to (understanding the problem, the causes of the problem, the consequences of the problem, solutions for the problem, and the individual's role in mitigating the problem). The activities in each part were encoded into specific QR codes, these activities varied between engaging videos related to the content, attractive images for discussion, or tasks to be completed to achieve the activity's goal.

The experimental group was randomly divided into five subgroups, each consisting of five students. These subgroups were rotated in each session. They were instructed to bring a smartphone or tablet with a QR code scanner app installed.

The five QR codes were either displayed on the board or printed out depending on the session location. Each group was assigned to access their designated activities via the specific QR code. Each group concluded their activity with a report on what they learned, with each member becoming an expert on this part.

The groups were then reorganized into four new groups, each consisting of five experts on the five parts, to achieve a comprehensive understanding, analysis of each problem's elements and causes, and propose the best solutions. Figure (1) illustrates the procedures of the session with the experimental group."

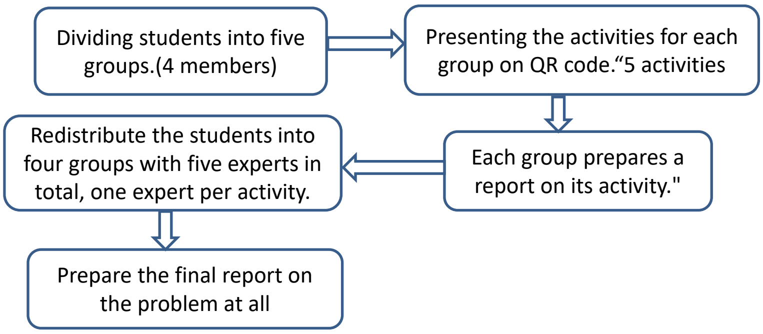


Figure 1
The procedures of the session with the experimental group

After completing the ten sessions, both the experimental and control groups were given an individual assignment. They were informed that their performance would be evaluated by experts to determine their creativity level, encouraging them to showcase their capabilities. The students' responses were then reviewed by three experts on creativity and talent measurement, and each student's creative performance was scored based on the average of the expert evaluations. The study tools were administered again to both the experimental and control groups.

## FINDINGS

**The first question: What is the effectiveness of problem-based learning supported by QR codes in activating intellectual over excitability in the study sample?**

Independent samples t-test was used to calculate the differences between the mean scores of the experimental and control groups in intellectual over-excitability, as measured by the observation card including its sub-dimensions and the situational test, the results are presented in table (1).

Table 1
Differences in intellectual over-excitability between groups

| | Experiment group | | Control group | | (T) value |
|---|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation | |
| Intensive intellectual activity | 13.05 | 1.820 | 11.25 | 2.359 | 2.702** |
| Problem solving desire | 10.60 | 1.188 | 9.25 | 2.359 | 2.286* |
| Reflective thinking | 14.80 | 1.542 | 12.90 | 3.432 | 2.258* |
| Total | 38.45 | 4.478 | 33.40 | 8.146 | 2.430* |
| Situation Test | 22.65 | 3.150 | 19.95 | 3.546 | 2.546** |

Table (1) shows that there are statistically significant differences between the experimental and control groups in the level of intellectual over-excitability in favor of the experimental group at( 0.01) level as measured by the situational test, the means were 22.65 for the experimental group and 19.95 for the control group, and at (0.05) level as measured by the observation card, the means were 38.45 for the experimental group and 33.40 for the control group, This indicates the effectiveness of problem-based learning in activating intellectual over-excitability among the study sample.

**The second question: What is the effectiveness of problem-based learning supported by QR codes in developing creative thinking skills in the study sample?**

Independent samples t-test was used to calculate the differences between the mean scores of the experimental and control groups in creative thinking skills, in addition to creative performance as evaluated by experts. Table (2) shows the results obtained.

Table 2

Differences in creative thinking and creative performance between groups

| | Experiment group | | Control group | | |
|---|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation | (T) value |
| Fluency | 10.25 | 1.650 | 10.35 | 1.424 | 0.205 |
| Flexibility | 4.45 | 0.759 | 3.55 | 1.468 | 2.435* |
| Originality | 4.85 | 0.366 | 4.20 | 1.361 | 2.062* |
| Details | 4.15 | 0.813 | 3.70 | 1.418 | 1.231 |
| Sum | 23.70 | 2.886 | 21.80 | 4.408 | 1.613 |
| Creative performance | 16.50 | 4.085 | 12.10 | 5.025 | 3.039** |

Table (2) shows that there were no statistically significant differences between the mean scores of the experimental and control groups in overall creative thinking skills, with the means being (23.70 and 21.80), respectively.

At the level of sub-skills, there were statistically significant differences between the mean scores of the experimental and control groups in the skills of flexibility and originality at (0.05) level in favor of the experimental group. The means for flexibility were (4.45 and 3.55), respectively, and for originality were (4.85 and 4.20), respectively. However, there were no significant differences in the skills of fluency and details, with the means for fluency being (10.25 and 10.35), respectively, and for details being (4.15 and 3.70), respectively.

There were statistically significant differences between the mean scores of the experimental and control groups in creative performance on the assigned task at (0.01) level in favor of the experimental group, with the means being (16.50 and 12.10), respectively.The results are summarized in Figure (2)

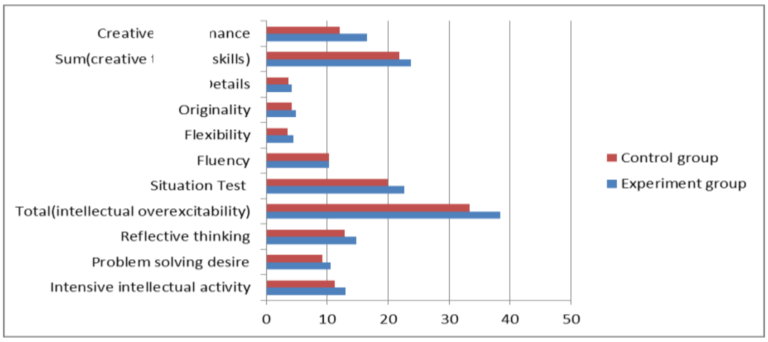


Figure 2
Differences in intellectual over-excitability ,creative thinking and creative performance between groups

**DISCUSSION**

Table (1) illustrates the effectiveness of PBL supported by QR codes, used in the current study, in stimulating intellectual over excitability. This can be explained by the context used in the current study is based on real-world problems, which are considered a stimulating environment for students, representing rich knowledge (Ericsson, et. al, 2006; Finke, et. al, 1992). This leads them to meaningful learning (Mayer &Wittrock, 1996) that increases their curiosity and desire to learn and stimulates their minds to know more and explore the unknown, reflecting a higher level of intellectual over excitability (Miller, et. al, 2009; Rinn & Reynolds, 2012).

The importance of the problems in the current study is further enhanced because they touch on everyone’s lives and their field of study. These include problems in the natural sciences related to climate change issues such as air pollution, desertification, and more. This context is suitable for motivating students to learn natural sciences as it supports them in exploration and discovery (Young, et. al, 2018).

The effectiveness of the learning context in the current study may also be due to the active participation among students. The students were divided into groups, with each group assigned to study an aspect of the presented problem, making every member an expert in that aspect. In the next stage, the groups were divided again so that the new group consisted of experts in each aspect, resulting in an interactive and participatory context where every individual played their role without conflict.

Additionally, the PBL in the current study was supported by QR codes, allowing the combination of digital and physical information in real-time, which gives a realistic impression that increases students’ enthusiasm and motivation to learn (Pratiwi, et. al, 2020). This also increases their curiosity to know more without getting bored (Wulandari, et. al, 2020).

The use of QR codes facilitated the occurrence of interactive cognitive experiences that enhance positive learners’ behavior and increase their participation in the learning process, thereby enhancing learning experiences (Shahril, et. al, 2019). This aligns with the findings of Leshchenko, et. al ,(2022); Libriani, et. al, (2023) Serevina, et. al (2022), where the use of QR codes made the learning process progressively interesting, diverse, and motivating for learners, this will reflect directly on the level of intellectual over excitability among learners.

This was evident from the classroom teacher's comments on the observation card for students in the experimental group. She noted positive changes in the students' mental activity and their desire to learn after the experiment. Some students even requested the use of QR codes in all classes, as was done in the study experiment.

**Regarding question two**, Table (2) shows that the problem-based learning context used in the current study had an effect on both the flexibility skill, which relate to the ability to change the thinking angle and generate a variety of ideas, and originality skill, which relates to the ability to produce new and unfamiliar valid ideas. These two skills are particularly central in determining an individual’s creativity (Potur&Barkul, 2009).

The growth in flexibility skills may be attributed to the experiences of the experimental group students, as the ten sessions included a large number of collaborative experiences. The learner may start with an idea or propose a solution, and through discussions with peers, they find more valuable ideas. With a charter for each session that includes respecting and accepting ideas and discussing them without judgment, it helped grow the learners' ability to think in multiple ways, which reflected in the flexibility skill.

Additionally, the problem-based learning context involving active peer participation helps integrate individuals into the Creative Learning Spiral (CLS) proposed by Resnick, (2007), where they propose unconventional ideas, then invent ways to implement and test them, share them with others, and reflect on their reactions. Thus, they think a lot and develop new strategies based on all those interactions, facilitating the ease of changing thinking paths (flexibility).

The growth in originality skills may be attributed to PBL in the current study is supported by technology using QR codes, where the combination of digital and physical information leads to mastering and enhancing the experience (Pratiwi, et. al, 2020), This support innovation and the production of original ideas (Shahril, et. al, 2019).

The positive impact of PBL on these two skills may have been enhanced by the fact that the creative thinking test during problem-solving also related to real problems, which helped transfer the effect and increased the students' ability to shift their thinking and produce innovative original solutions. This corresponds with what Samson (2015) found, where training students through real-life experiences increased their motivation and was an effective way to transfer CTS in problem-solving to real-life environments.

The effect was not observed in fluency skill because they relate to the number of ideas that produced by the individual. Since both the experimental and control groups had the ability to produce a large number of ideas, so there were no differences between the groups in fluency, and they also had the ability to add many details, thus there were no differences between the groups in details, leading to no statistically significant differences at the overall level of the creative thinking skills test during problem-solving.

The appearance of differences in specific skills without others supports the idea that problem-based learning helps focus on the problem-solving process required for creativity, regardless of the overall level or final product (Mayer, 1989).

Table (2) shows that there are statistically significant differences between the mean scores of the experimental and control groups in the students' creative performance in favor of the experimental group. This can be explained by the fact that the creative performance was measured by a real task chosen by the students themselves, where they chose one of the environmental problems of their interest, analyzed its causes, implications, and severity, and how to tackle it in their own way, presenting their ideas in the way they preferred, "poster, presentation, or video... etc. as allowed by their abilities". This, in turn, increased the students' motivation and passion to complete the task and motivated them to come up with a new innovative way to present it, especially since the task instructions emphasized that their performance would be evaluated by experts, and they should make every possible effort to showcase their abilities in it.

Thus, the task was a challenge for the students to showcase their creative capabilities, especially after increasing their level of intellectual over-excitability compared to the control group, which directly affects the students' creative potentials by increasing their perceptual experiences (He, et. al, 2017). This result corresponds with the results of (Fung & Chung, 2022; Fung, et. al, 2021; Pethö, 2023).

The study revealed interesting results for teachers, educators, and policymakers, especially concerning students in the early stages of education. It highlights the importance of designing learning situations based on real problems and supporting them with stimulating technological tools, such as QR codes. Additionally, creating a supportive context and encouraging collaborative participation can activate students' over excitability and enhance their skills and creativity.

However, it should be noted that there are some limitations in the current study that may affect the generalizability of the research results. The most significant of these are the small sample size and the nature of the study's sample. The sixth-grade students who participated in the experiment belong to a cohort whose curriculum had been entirely revised starting in the fourth grade, which makes them different from their predecessors in many characteristics and circumstances.

## CONCLUSION

The current study revealed that problem-based learning supported by QR codes and implemented collaboratively served as a motivating and stimulating context for sixth-grade students' intellectual over-excitability as measured by the situational test applied by the students and the observation card used by the classroom teacher for each student individually.

The teacher's comments on the open-ended question in the observation card revealed the growth in the students' level of intellectual over-excitability, increased desire to explore more and discover the unknown, and they expressed interest in using this method.

At the same time, the study revealed a positive impact of the context used in the current study on the students' creative performance, as reflected in the final product presented individually and evaluated by experts. The task assigned to them and the manner of presentation was chosen by the students according to their capabilities, which increased their engagement and passion for completing it, especially after their level of intellectual over-excitability increased.

The context used in the current study had a positive impact on the creative thinking skills of flexibility and originality but not on fluency and details, nor at the overall level. This was interpreted in light of the content of the creative thinking skills test and the method of grading each sub-skill.

This necessitates further research to explore and activate different patterns of over-excitabilities (as the current study focused only on intellectual over-excitability) and to study their impact on individuals' creativity across different ages. Additionally, it is important to explore methods of measuring creativity and understand why results may differ when assessing children's creative potentials using various methods.

**REFERENCES**

Carman, C. A. (2011). Adding personality to gifted identification: Relationships among traditional and personality-based constructs. *Journal of Advanced Academics, 22(*3), 412-446. http://dx.doi.org/10.1177/1932202X1102200303

Chang, H., & Kuo, C. (2013). Overexcitabilities: Empirical studies and application. *Learning and Individual Differences*, *23*(1), 53–63. http://dx.doi.org/10.1016/j.lindif.2012.10.010

Chung,T., Wilsey,S., Mykita,A., Lesgold,E.,& Bourne,J.(2019). Quick response code scanning for children's informal learning. *The International Journal of Information and Learning Technology*,*36*(1),38-51 http://dx.doi.org/10.1108/IJILT-04-2017-0026

Dai, D. Y., & Sternberg, R. J. (2004). *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development*. Lawrence Erlbaum.

De Bondt, N., Maeyer, S. D., Donche, V., & Van Petegem, P. (2019). A rationale for including overexcitability in talent research beyond the FFM-personality dimensions. *High Ability Studies,* 1–26. http://dx.doi.org/10.1080/13598139.2019.1668753

Ericsson, K. A., Charness, N., Feltovich, P. J., & Hoffman, R. R. (2006). *The Cambridge handbook of expertise and expert performance*. Cambridge University Press.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications.* The MIT Press.

Fung, W. K., Chung, K. K. H., & He, M. W. (2021). Association between children's imaginational overexcitability and parent-reported creative potential: Cognitive and affective play processes as potential mediators. *The Journal of Creative Behavior*, *55*(1), 962–969. http://dx.doi.org/10.1002/jocb.501

Fung,W.K.,&Chung,K.K.,(2022). Overexcitabilities and creative potential in the kindergarten context: The mediating role of children's playfulness. *Thinking Skills and Creativity*, *46*(101197), 1-11. https://doi.org/10.1016/j.tsc.2022.101197

Garces-Bacsal, R. M. (2011). Socioaffective issues and concerns among gifted Filipino children. *Roeper Review, 33*(4), 239-251. http://dx.doi.org/10.1080/02783193.2011.603112

Harrison, G. E., & Haneghan, J. P. V. (2011). The gifted and the shadow of the night: Dabrowski's overexcitabilities and their correlation to insomnia, death anxiety, and fear of the unknown. *Journal for the Education of the Gifted, 34*(4), 669-697. http://dx.doi.org/10.1177/016235321103400407

He, W., Wong, W., & Chan, M. (2017). Overexcitabilities as important psychological attributes of creativity: A Dabrowskian perspective. *Thinking Skills and Creativity, 25*, 27–35. https://doi.org/10.1016/j.tsc.2017.06.006

Jaenudin,A.(2023).Factors influencing creative thinking in problem –solving. *Asian journal of engineering social and health, 2*(3),161-170). http://dx.doi.org/10.46799/ajesh.v2i3.47

Leshchenko, T., Zhovnir, M., Shevchenko, O.,& Grinko, N. (2022). The usage of quick response codes: evolution and integration in classroom activities in the context of language learning. ScienceRise: *Pedagogical Education, 4*(49), 52–58. doi: http://doi.org/10.15587/2519-4984.2022.261828

Libriani,P.W., Suarjana,M.,& Bayu,G.W. (2023). Quick Response Code-based Pop-Up Book Media: Plant Reproduction Systems Topic for Grade VI Elementary School. *Journal of Education Technology, 7*(2),381-389. https://doi.org/10.23887/jet.v7i2.60917

Limont, W., Dreszer-Drogorób, J., Bedyńska, S., Śliwińska, K.,& Jastrzębska, D. (2014). Old wine in new bottles? Relationship between overexcitabilities, the Big Five personality traits and giftedness in adolescents. *Personality and Individual Differences, 69*, 199–204. http://dx.doi.org/10.1016/j.paid.2014.06.003

Maharani, H. R., Sukestiyarno, S., & Waluya, B. (2017). Creative thinking process based on wallas model in solving a mathematics problem. *International Journal on Emerging Mathematics, 1*(2), 177–184. http://dx.doi.org/10.12928/ijeme.v1i2.5783

Martowska,K.,(2016). In search of the correlates of overexcitability. *Studia Psychologica ,16*(2) , 5–21. http://dx.doi.org/10.21697/sp.2016.16.2.01

Martowski, K., Matczak, A., & Jóźwik, K. (2018). Overexcitability in actors. Psychology of Aesthetics, *Psychology of Aesthetics Creativity and the Arts, 14*(1),1-6. http://dx.doi.org/10.1037/aca0000192

Mayer, R. E., & Wittrock, M. C. (1996). *Problem-solving transfer.* In D. C. Berlinert & R. C. Calfee (Eds.), Handbook of educational psychology (pp. 47–62). Macmillan.

Mayer, R.E.(1989). Cognitive views of creativity: Creative teaching for creative learning. Contemp. Educ. *Psychol. 14*(3), 203–211. http://dx.doi.org/10.1016/0361-476X(89)90010-6

Mendaglio, S., & Tillier, W. (2006). Dabrowski's theory of positive disintegration and giftedness: Overexcitability research findings. *Journal for the Education of the Gifted, 30*(1), 68-87. http://dx.doi.org/10.1177/016235320603000104

Miller, N. B., Falk, R. F., & Huang, Y. (2009). Gender identity and the overexcitability profiles of gifted college students. *Roeper Review, 31*(3), 161-169. http://dx.doi.org/10.1080/02783190902993920

Minister of Education(2021). *Pan-Canadian Systems-Level Framework on Global Competencies*. @. https://www.globalcompetencies.cmec.ca/global-competencies

Mofield, E., & Peters, M. P. (2015). The relationship between perfectionism and overexcitabilities in gifted adolescents. *Journal for the Education of the Gifted, 38*(4), 405-427. http://dx.doi.org/10.1177/0162353215607324

Mumford, M. D., & McIntosh, T. (2017). Creative thinking processes: The past and the future. *The Journal of Creative Behavior, 51*(4), 317–322. http://dx.doi.org/10.1002/jocb.197

Navarrete, C. C. (2013). Creative thinking in digital game design and development: A case study. *Computers & Education, 69,* 320–331. http://dx.doi.org/10.1016/j.compedu.2013.07.025

Papert, S.(1993). *The Children's Machine: Rethinking School in the Age of the Computer*; Basic Books: New York, NY, USA.

Pethö,T.(2023). Types of Overexcitability in Intellectually Gifted Adolescent Students in Slovakia. *Journal for general social issues, 31*(1), 1-18. http://dx.doi.org/10.5559/di.31.1.01

Piechowski, M. M. (1975). A theoretical and empirical approach to the study of development. *Genetic psychology monographs, 92,* 231-297. Piechowski1975a.pdf

Piechowski, M. M. (2017). Rethinking Dabrowski's theory II: It's not all flat here. *Roeper Review, 39*(2), 87-95. http://dx.doi.org/10.1080/02783193.2017.1289487

Piechowski, M.,&Chucker,J. (2011). *Overexcitabilities. Encyclopedia of Creativity*, 202-208. https://08101nto6-1104-y-https-doi-org.mplbci.ekb.eg/10.1016/B978-0-12-809324-5.06250-7

Potur, A. A., & Barkul, O. (2009). Gender and creative thinking in education: A theoretical and experimental overview. Journal of Faculty of Architecture, 6(2), 44–57. 05poturbarkul0602.pdf

Pratiwi, K. B., Sugito, & Subandowo, M. (2020). The Development Pop-Up Books To Improve Children's Language Skills. *Jurnal Kajian Teknologi Pendidikan, 3*(4), 408–414. https://doi.org/10.17977/um038v3i42020p408

Resnick, M.(2007). Sowing the seeds for a more creative society. *Learn. Lead. Technol. 35*, 18–22. http://dx.doi.org/10.1145/1518701.2167142

Rinn, A. N., & Reynolds, M. J. (2012). Overexcitabilities and ADHD in the gifted: An examination. *Roeper Review, 34(*1), 38-45. http://dx.doi.org/10.1080/02783193.2012.627551

Samson, P.L. (2015).Fostering student engagement: Creative problem-solving in small group facilitations. Collect. *Essays Learn. Teach. 8*, 153–164. http://dx.doi.org/10.22329/celt.v8i0.4227

Sari, Y. I., Sumarmi., Utomo, D. H., & Astina, I K. (2021). The Effect of Problem Based Learning on Problem Solving and Scientific Writing Skills. *International Journal of Instruction*, *14*(2), 11-26. https://doi.org/10.29333/iji.2021.1422a

Serevina,V., Nurhasanah,D.,& Shaladsha.(2022). Quick Response (QR) Code Assisted Learning Media on System Materials for Distance Learning Sky Coordinates. *Journal of Physics: Conference Series, 2309*(1), 1-7. http://dx.doi.org/10.1088/1742-6596/2309/1/012039

Shahril,A.M., Tarmudi,S., Hamid,R.,& Mohi,Z.(2019). Interactive Knowledge Experience: Encouraging Student Using Quick Response Code In Higher Learning Institution In Malaysia. *International Journal of Management Sciences and Business Research, 8*(5),72-78. https://www.researchgate.net/publication/334050256

Silver, E. A. (1994). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM*:*the international journal on mathematics*, *3*(29), 75–80. http://dx.doi.org/10.1007/s11858-997-0003-x

Sousa,R.A.,& Fleith,D.S.(2021). Emotional Development of Gifted Students: Comparative Study About Overexcitabilities. *Psico-USF*, *26*(4),733-743. http://dx.doi.org/10.1590/1413-82712021260411

Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal*, *18*(1), 87.

Suratno, Komaria, N., Yushardi, Dafik, & Wicaksono, I. (2019). The Effect of Using Synectics Model on Creative Thinking and Metacognition Skills of Junior High School Students. *International Journal of Instruction*, *12*(3), 133-150. https://doi.org/10.29333/iji.2019.1239a

Susilowati, W. W., & Suyatno, S. (2021). *Teacher competence in implementing higher-order thinking skills oriented learning in elementary schools. Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran*. https://doi.org/10.25273/pe.v11i1.7762.

Wulandari, N., Hendratno, H., & Indarti, T. (2020). Development of Pop-Up Book Media based on Balanced Literacy Approach to Improve Skills of Reading Class 1 Students Basic School. *International Journal of Multicultural and Multireligious Understanding, 7*(5), 619-627. https://doi.org/10.18415/ijmmu.v7i5.1693.

Young, T., Hazarika, D., Poria, S., & Cambria, E. (2018). Recent trends in deep learning based natural language processing. *Ieee Computational IntelligenCe Magazine*, *13*(3), 55–75. https://doi.org/10.1109/MCI.2018.2840738.