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# Editorial Board

# Editorial Board

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*Full Length Research Paper*

# Context-specific inclusive education: A local perspective on the enterprise

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**Inclusive education is moulded by local factors. A qualitative case study was used to explore professionals' perceptions of inclusive education (IE) practice in local schools along with interventions for a support model in the schools. Observations, focus group interviews and individual interviews were used to collect data from teachers, school principals, curriculum advisors and psychologists in Capricorn South District of Limpopo Province. Data analysis revealed five themes in terms of factors impacting on IE practice in the local schools and proposed actions to address the factors. The themes were discussed and recommendations were made for a sustainable support model in the local schools.**

**Key words:** Context-specific inclusive education, perceptions of inclusive education practice.

## INTRODUCTION

Inclusive education is simply the totality of educational activities engaged to increase access, participation and progress of all learners in local mainstream schools. The local perspective on inclusive education (IE) is founded on the strongly localised interpretation of the concept and its implementation that varies according to countries, local contexts and organisational interest (Schmidt and Vrhovnik, 2015: 6). Stubbs (2008: 52) insists that IE interventions are sustainable when developed locally, using local resources. Recent global calls for decolonisation of IE are reminiscent of the context-specificity of IE albeit from an international perspective (Walton cited in Muthukrishna and Engelbrecht, 2018: 1). Current studies on IE identified key elements in successful inclusive education (Pappas et al., 2018: 8). However, few of these studies concentrated on IE in rural mainstream secondary schools from an international perspective with little attention to a local perspective (Engelbrecht et al., 2015:1; Dreyer, 2017:5; Shanda et al., 2018:20). This is despite the localised nature of IE implementation. Therefore, the research problem is a paucity of studies on IE from a local perspective. To address this problem, the paper aims to explore perceptions of IE practice from a local perspective.

## METHODOLOGY

Features of qualitative case study approach were used in the study (Creswell and Creswell 2018: 296). Constructivism and ecological systems theory (EST) underpinned the approach as participants constructed forms of knowledge about IE which specific research methods could recreate into scientific knowledge (Gelo et

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al., 2008: 269). Exploration of IE in ecological system levels of real-life context enhances understanding of IE practice (Kamenopoulou, 2016: 517). Two rural mainstream secondary schools (A and B) in Capricorn South District of Limpopo province of SA and twenty-two participants were purposefully selected in Lebowakgomo District of Limpopo province of SA. IE was implemented by nine teachers and one principal in each school. Two curriculum advisors supported the teachers. One hospital psychologist offered specialist support to the schools. The researcher was a subject advisor servicing the two schools. Prior to interviews, information about research purpose, mutual benefits, departmental permission to conduct research and non-comparison of the schools was shared in meetings with participants in research sites to encourage honest responses. In the same meetings, protection against harm was ensured by highlighting avoidance of disclosure to third parties and use of names in findings for confidentiality and anonymity and signing of consent form with freedom to withdraw at any stage of the process for voluntary participation. School observation with video camera, lesson observations and focus group as well as individual interviews using voice recorder were used for data collection. Collected data was analysed using the thematic method. Multiple methods, results confirmation with participants, clarification of researcher bias, and, description of settings with use of verbatim statements ensured trustworthiness of the results (Creswell and Creswell, 2018:314).

## RESULTS AND DISCUSSION

Inadequate inclusion in rural mainstream secondary schools in Lebowakgomo District of Limpopo province of SA prompted exploration of IE practice that would contribute to a locally-based sustainable support model. Five questions in two settings (A & B) produced results analysed into themes. The themes were subsequently integrated into five themes simultaneously presented and interpreted in accordance with research questions and ecological system levels in real-life context.

### School related factors: What physical and social conditions are there in the school to enable inclusion?

Generally, gravel paths, inadequate ramps, lack of adapted toilets and inadequate facilities characterised the schools. For example, those on wheel-chairs and others with specific disabilities were excluded. Only soccer and netball facilities and poorly resourced laboratories and libraries frustrated the quality of education provided for all (Ainscow et al., 2013, 4) as participation in sporting activities according to preferences was restricted and learning support materials were inadequate. Broken or missing window panes and general littering with over-grown premises violated the principle of cleanliness and orderliness of inclusive schools. Participants' voices corroborated implications: "Some children use wheel chairs. They cannot use our stoops. They will need stoops with ramps." "Yes, we say the school is an inclusive school but you can see that even the infrastructure does not allow it." Summarily, school conditions countered access to educative learning which was described by Slee (2018: 8) as a priority in inclusion initiatives. It also meant State's failure to ensure adequate, available and adaptable education for all (South African Human Rights Commission, 2012: 15).

### Classroom related conditions: What do the teachers and the principal in the school do to achieve inclusivity in the classrooms?

Mostly, physical conditions and curriculum delivery methods were basically deficient of inclusion. Littering, damaged electric plugs with hanging wires and broken, dilapidated furniture created an atmosphere not conducive for learning. Lesson presentation was not better. Non-statement of lesson objectives did not enhance learner engagement and learner achievement (Milkova, 2012:4) included in key elements in defining IE. Mainly, lecturing and only verbal and individual learner activities lacked flexibility as one of the principles of inclusive teaching meant one-size -fit all curriculum delivery (Meo, 2008: 3). Participants' comments validated foregoing interpretations: "You know why we cannot just tell you clearly how we are supporting these learners…….is just because even ourselves as teachers we ……do it by default……..."

### Teacher related factors: What do the teachers in the schools know about IE?

Teachers' knowledge about IE was satisfactory as their responses in focus group interviews were suggestive of presence, access, participation and achievement itemised in the definition of IE: "It (IE) means we must include all learners irrespective of their disabilities"; "We can include learners in both planning and teaching"; and "We can even include them in other activities like extramural activities". "IE is about mixing learners of all.....…learning abilities and disabilities. Let them learn together without segregation of any sort." However, other participants in individual interviews hinted that only recently trained teachers seemed knowledgeable about IE. For example, one participant said: "No, actually I don't think they have any knowledge." Another said: *"Generally, recently trained teachers have knowledge about inclusivity. Others' knowledge needs to be developed."* Still another said: *"I cannot say they are knowledgeable about inclusivity because sometimes when you go there you do not find anything there……"* The connotation was that young teachers have some knowledge about IE because IE was recently incorporated in teacher training programmes since the world declaration of IE. Further, deficient inclusion in the schools inferred inadequate in-service training on Curriculum and Assessment Policy Statements in South Africa.

**Departmental factors: What do the departmental officials do to support inclusivity in the classrooms?**

Predominantly, education officials were disobliging in offering support to teachers or offered segregating support to types of schools. This was apparent from provincial curriculum coordinator's response: *"We do not support IE in the schools…. We push curriculum issues……...Inclusivity is an add-on. If those guys dealing with inclusive education call us to their meetings we are reluctant to go there because we know it is a waste of our curriculum time."* Non-support of IE and perception of IE as an add-on that interfered with curriculum issues denoted either ignorance or misconception about the role of inclusion in facilitating access to curriculum in inclusive. For instance, IE improved achievement by learners with disabilities and their counterparts (Hehir et al., 2016) provided that teachers infused curriculum differentiation in traditional teaching methods (Suleymanov, 2014:69). IE district coordinator's response insinuated segregation of in-service teacher training and supports IE: *"I support IE by training and school visits to……...our pilot schools. I am very much disappointed with what is happening in the ordinary schools…… when I asked them if they have ever seen the EWP6 policy document. You find that they have not seen it. "*This meant lack of training on IE in ordinary secondary schools. Notwithstanding, unhelpful and isolated support by education officials, support specialists from other departments than education were surprisingly obliging. For example, the hospital psychologist said: "*Basically, when we go to schools to help teachers identify learners having barriers to learning…….. And, ……. recommend programmes to teachers and parents to assist the learners. That is what we do".* Ostensibly, education department has relegated its responsibility to other departments.

**Proposed interventions: What do the teachers, school principals and departmental officials suggest should be done to improve IE practice?**

Teacher training and support, parental engagement, and specialist resources were highlighted. Responses in all interview sessions alluded to need for training and support. For example, teachers declared: "We need training on how to accommodate learners with different abilities in our classes." Provincial curriculum coordinator retorted: "Well, the first one is that teachers should be addressed…..." Hospital psychologist supported teachers' lament for training: "Teachers must be remediated……...to mix methods and not use the lecture method only……. there must be support structures in the schools." Continuing training and support is a high-leverage practice (McLeskey et al., 2017: 17) and is therefore likely to enhance inclusion. Parental engagement too, featured in responses. Teacher's comment: "……parents are not supporting", was furthered by the psychologist: Especially in the rural schools, parents feel that it is the responsibility of the school alone to educate their children. There is no support from home". Positive parents' views and actions enhance learner achievement (National Education Collaboration Trust, 2016: 11). Provision of specialist resources was another prominent proposition. For instance, a school principal was unequivocal: *"The system must make sure specialised resources are there……"Teachers went further: "……. the department can help by having enough school psychologists ……to help us……."* District IE coordinator was even more explicit: "The policy says we should have psychologists, social workers, occupational therapists and speech therapists on our payroll." By underscoring teacher training and support, parental engagement and specialist resources amidst other potentially viable interventions implied what participants viewed as first steps towards geographically sound and enriched IE. This is concomitant with the argument that IE interventions are sustainable when developed locally, using local resources and therefore the relevance of the local perspective on IE.

Despite generally prevailing limitations, exploitable opportunities were noted to enhance IE practice from a local perspective: Parents were readily available to engage through in dunas (local chiefs); qualified teachers (all had teaching diplomas) along with their satisfactory awareness of IE were predisposed to development through in-service training on inclusive approaches and classroom techniques. Schools' proximity to health centres (schools within less than a kilometre from clinics) made it easy to access specialist support services. Adequate basic water and electricity in all schools already ungraded to a full-service school (in terms of unfortunately abused administration offices, sick rooms and washbasins) were further prospects.

Results described and discussed in this paper are comparable with findings established in South Africa and other countries. Teacher training and support, infrastructure and facilities, material and human resources and stakeholder participation including parental involvement were similarly linked to successful IE implementation (Engelbrecht et al., 2015: 1; Schmidt and Vrhovnik, 2015: 16; Pappas et al., 2018: 8).

## CONCLUSION AND RECOMMENDATIONS

This paper aimed to explore and describe IE practice in rural secondary schools in the Capricorn South District of Limpopo province. Based on the identified limitations and strengths, recommendations are made for what Price (2018:16) described as locally driven IE that will contribute significantly to sustainable support model to move IE practice forward: Teacher training on IE preceded

by awareness campaign targeting local stakeholders especially traditional leaders, parents, teachers, school principals, subject advisors, learner representatives and circuit managers. This will enable them to have a common understanding of IE, which according to Ainscow et al. (2013: 6) is a strong lever for change; Flexibility in curriculum content, process and product (Meo 2008: 3) in particular lesson planning, instruction and assessment to proactively address learner diversity; Clear and specific learning goals and objectives expressly stated at start of lesson presentations to promote learner participation (Price 2018:8); and adaptation of both new and existing schools to include all learners, by capacitating the schools in terms of stakeholders' propositions. Finally, the local perspective with need to engage local resources for sustainable IE interventions ostensibly contributes to global IE decolonisation movement and context-specific interpretation of IE implementation.

## Limitation of the study

Nevertheless, certain limitations have to be acknowledged in respect of the findings in this article. First, the results might not be generalizable due to limited scope (only two rural secondary schools in only one district and province), some participants refused lesson observation and not all participants have verified the results. Second, participants might have responded in a way to satisfy the researcher as subject advisor servicing the schools. Finally, since the researcher completed primary and high school education in a deep rural area, this might have resulted in emphasis on rural contextual factors. Nevertheless, limited scope of the foundation research and general classroom inclusion inadequacies, suggest need for further research, in particular, participatory action research with wider scope for focused understanding of teacher training needs and improved inclusive lesson design and delivery. However, prior sharing and results consistency along with different methods, clarification of bias, result confirmation and verbatim statements were trustworthiness strategies (Creswell and Creswell 2018: 314) for validity and credibility in the qualitative research.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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# Non-routine problem solving performances of mathematics teacher candidates

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**The aim of this study is to determine the non-routine problem solving performances of mathematics teacher candidates. A descriptive survey model was used for this work and it was conducted with 50 teacher candidates studying elementary mathematics teaching in a medium-sized university in Turkey. To determine the non-routine problem solving performance of the teacher candidates, open ended non-routine problems were prepared according to an expert's opinion. Firstly, the data obtained were examined with a holistic rubric to know the problem solving levels of the teacher candidates and secondly the levels of the teacher candidates for each problem solving step of Polya were evaluated with a two point scale. When the problem solving performances of the teacher candidates were examined in a holistic manner, it was concluded that their performance is low when the difficult level of problem is raised. From the results, it was determined that teacher candidates mostly tended to go through a solution by trying to use arithmetic operations to solve non-routine problems. As a result, it was suggested to examine teacher candidates' problem solving knowledge and pedagogical content knowledge and to re-evaluate the results of the research with different question types.**

**Key words:** Non-routine problem, Mathematics teacher candidates, Mathematics education.

## INTRODUCTION

Solving mathematical problem has been one of the key points in research in mathematics education for several decades. It is an advanced thinking ability and consists of different thinking processes (Codina et al., 2015). It is also a decision-making process which involves goal-oriented studies that require the recognition of the nature of the problem, the creation of a strategy and the implementation of the strategy (Hayes, 1989). The main focus point is being able to solve problems in a wide array of issues in science, technology, business, science, finance, medicine and daily life.

Problem solving is also a powerful and effective tool for learning, which is also mentioned in the publication of NCTM (2000) standards. When the principles and standards are examined, problem solving is seen not only as a goal of learning mathematics but also as a basic tool of teaching mathematics. Therefore, problem solving is an essential part of learning mathematics and should not be considered separately from mathematics programs. One of the important topics that should be considered

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here is the improvement of the problem solving skills of the students. As skill development is a process, problem-solving skills should be acquired in school and the level of the problem contents and their complexity should be increased as the students' grade level and age increase. Considering that the definition of the problem is a situation that can be solved by analyzing and synthesizing previously acquired information, problem solving requires higher level thinking skills. In this context, the problems can be categorized into different groups with respect to their level of complexity. Altun (1998) categorizes problems into two groups. First group includes the routine problems, which are mostly seen in textbooks and can be solved through the basic operations. Second group consists of non-routine problems which require different skills such as organizing and classifying data, discovering the relations, determining the rules and generalities. Similarly, problems were categorized by Jonassen (1997) into two types: (i) a well-structured problem where all the information needed for the solution is provided; and (ii) an unstructured problem with multiple unknown and multiple states. Well-structured problems are an example of the questions used in school lessons. Problems which are suitable for real world situations are regarded as second type problems. Real life math problems are important to help students, where their previous knowledge is required to find a solution. The problems that students may encounter at school vary because of the different mathematical structures they contain and the differences in their solution purposes. For example, when students move from primary to secondary education, the acquisition of the problem solving method with algebraic reasoning becomes one of the most important tasks (Schmidt and Bednarz, 1997). In secondary education, they are introduced with more advanced methods of algebraic thinking and problem solving. Equations and the symbols representing the unknown become an important part of the solution process in the problem solving approach. Problem solving is used both to reveal the algebraic characters of arithmetic activities, and to provide development on students' algebraic skills with arithmetic thinking used in problem solving process (Van Dooren et al., 2002). Until the twentieth century, the most important reason behind the problem solving, taking part in mathematics teaching programs, was that problem solving was seen as improving one's thinking. In this respect, mathematics education programs mostly included arithmetic operations or logic questions that required a certain solution method. Later, among mathematics educators, the idea that mathematics should include problems related to how to use mathematics in real life to increase the motivation of learning has gained importance (Bingölbali et al., 2016). In this context, non-routine problems and real-life problems were added to the curriculum and the meaning of the concept of problem and problem solving has changed.

Polya (1957), who is the pioneer of the research in mathematical problem solving, explains a guideline for problem solving and provides some necessary hints to implement it in his book *How to Solve It*. Schoenfeld (1987) states that Polya has a great influence on both mathematical thinking and productive thinking and in mathematics education, "problem solving" means "problem solving a la Polya". Polya identified a four-step process which is mostly used for learning problem solving and helps to become a better problem solver and develop problem-solving skills. According to Polya's work, these four steps of problem solving are (i) understanding the problem, (ii) devising a plan, (iii) carrying out the plan, and iv) looking back.

It is seen that an understanding of the aim to develop problem creating and solving skills which are important building blocks in the development of mathematical skills is established in mathematics curriculum. In this direction, it is accepted that one of the main objectives of mathematics education is to improve students' problem solving skills. Problem solving is considered as a basic skill which is expected to be developed for each subject within the curriculum. In the program, it is emphasized that a process including problem-creating should be included in the studies aiming at improving the problem solving skills of the students and related learning outcomes were included at each grade level (Ministry of Turkish National Education (MoNE), 2017). Besides its importance of being a skill that needs to be developed, problem solving is also an important teaching tool. Many of the important mathematical concepts and operations can be taught in the best possible way by problem solving (Van de Walle, 2007). In this context, teachers are the people who are one of the most important dynamo stones expected to improve problem solving skills of students.

The task of teachers, who can establish a strong relationship between mathematics education and problem solving and shape problem-based learning environments, is of great importance in this context. When the effect of a teacher on the quality of education is examined, many components such as subject matter knowledge and beliefs and attitudes of them related with education and subject area become more of an issue. As a result of the research studies carried out in the field of teacher education, besides the general pedagogical features, the competence of the teacher in the subject area that he / she is teaching comes into prominence. It is accepted with the definition of pedagogical content knowledge developed by Shulman (1987) that the teacher's knowledge should not be considered independent of the content he/she teaches. In this context, "General Qualifications of Teaching Profession" and "Subject Matter Knowledge Qualifications" which include the knowledge, skills and attitudes that the teacher should have in order to determine his / her own

area of development and to improve themselves in this field have been developed by the Ministry of Turkish National Education (MoNE, 2017), as in many other countries. When the subject matter knowledge is examined, it is seen that it covers the practices that aim to develop students' problem solving, reasoning, and communication skills. Within the scope of developing problem solving skills, teachers' competencies mentioned include understanding the contribution of problem solving ability to mathematics learning, organizing activities to provide development of problem solving skills and enabling students to question the problem-solving process and to verify the results (MoNE, 2018).

Examining the problem solving performances of the teacher candidates in the field of mathematics education and conducting researches for the solution processes they have applied in the process of problem solving may shed light on the knowledge level of the teacher candidates who will take part on this mission mentioned in the future. Although teacher educators generally acknowledge that teacher candidates require guidance in dealing with problems and to face problems, what is often overlooked is that their thought structures should be revealed. It is important not to evaluate the accuracy of the solution, but to examine the behavior of teacher candidates in the problem solving steps and to identify errors. Many research studies focus only on the performance and there is limited number of study which focus on the thinking process of teacher candidates. The goal of this study is to determine the non-routine problem solving performance of mathematics teacher candidates and to focus on their problem solving processes using Polya' problem solving steps. The research problems can be formulated as:

(1) What is the problem solving performance of teacher candidates in two different non routine problems at different difficulty levels?
(2) What is the problem solving performance of teacher candidates with respect to Polya's problem solving steps?
(3) What are the strategies that teacher candidates prefer in problem solving?

## METHODOLOGY

### Research model

In this study, a descriptive survey study was planned to meet the goal, which was to determine the problem solving performances of the mathematics teacher candidates in non-routine problems at different difficulty levels. The descriptive survey model was preferred because it can be used to summarize the characteristics (capabilities, preferences, behaviors, etc.) of the study group, as it is intended to describe a situation that exists in the past or still exists (Büyüköztürk et al., 2017).

### Sample

The study was conducted with 50 teacher candidates, who study elementary mathematics teaching in a medium-sized university in 2017-2018. They are from the third graders of 85 students. They were selected by random sampling method. 32 (64%) of the teacher candidates were females and 18 (36%) were males. The teacher candidates are students who completed compulsory mathematics, general education and teaching mathematics courses. The teacher candidates have the knowledge of Polya's problem solving steps from teaching mathematics courses.

### Data collection tools

Problem solving performance of teacher candidates was discussed in the context of non-routine problems. In order to determine the non-routine problem solving performance of the teacher candidates, two problems were used, which can be solved with different problem solving techniques, to make in-depth analysis of teacher candidates' problem solving processes. The problems were chosen at different difficulty levels to also examine whether the level of difiiculty of problem affects the results. The two problems used in this study are considered as non-routine problems, since there is not a ready algorithm to solve them at first glance. The problems were selected in line with an expert's opinion among the seven items that were prepared as open-ended problems. In order to determine the validity of the scale, the opinions of 2 mathematics educators and 3 primary mathematics teachers were consulted and their opinions were taken in terms of clarity of the questions, compliance with the Turkish spelling rules and their suitability for achievements. Each item was rated by experts as "The item measures the targeted structure", "The item associated with structure but unnecessary", "The item partially measures the targeted structure "and" The item does not measure targeted structure". Validity rates of each item were obtained according to expert opinions. The items with a validity ratio over 0.78 were included in the pilot scale (Veneziano and Hooper, 1997). It was applied to 14 teacher candidates who were not included in the study group, in order to evaluate the quality for the verbal and visual understandability and clarity of selected problems. The scale was finalized with the problems that did not have any problems in understanding, at different difficulty levels. In the study, teacher candidates were asked to answer the problems using Polya's problem solving steps.

P1. Kobe, the famous basketball player who played in the Lakers, scored 63 points in his last match. This score was scored by 29 shots each with two or three points. According to this, how many two -point and how many three-point baskets would Kobe have scored?
P2. Robi, Jane and Dan are playing a game with playing cards. At the end of each round, the losing player equally divides his money among the other two players. After three games are played, each player has lost once. At the end of these three games, Robi has $400, Jane has $1000 and Dan has no money. According to this who lost the first game and how much money did Robi, Jane and Dan start with at the beginning of the game?

### Data analysis

In order to evaluate the problem solving performances of the teacher candidates, firstly, the data obtained were examined with the "Holistic Rubric" for determining the problem solving scores of teacher candidates. It was chosen due to its focus on the whole process, rather than segmenting the problem-solving process and evaluating each skill or criterion independently. For this purpose, a five-point holistic rubric in Table 1 which was developed by Umay (2007) was used. Thus, a numerical score is given to the whole solution process of each problem in the test. In this context, scores

**Table 1.** Holistic rubric to evaluate problem solving performance.

| Description | Scores |
|---|---|
| Completely blank<br>Only data were written down, no attempt for solution<br>Wrong answer and indicators of an inappropriate reasoning were seen | 0 |
| Indicators of a correct strategy was written but no application<br>Not reached the aim, some unclear mathematical work, but no put-forth result<br>Correct answer but inappropriate reasoning | 1 |
| Correct strategy was found, but the student was not able to apply it or he/she has not tried hard enough<br>Correct answer was found, but there was no indicator as to how it was achieved | 2 |
| Correct strategy was found and applied, but there was no correct answer due to some calculation errors and misconceptions<br>Correct strategy was found and correct answer was present but some errors during the application were seen | 3 |
| Correct strategy was found and applied correctly, but because one or several of data were misevaluated, correct answer was not reached | 4 |
| Complete and appropriate solution and correct answer | 5 |

over 4 were considered as high performance and below 4 were considered as low performance. It was scored as 5, if there is complete solution and as 4, if the solution method and the operation were made correctly, only if the numbers in the problem were taken incorrectly but solved correctly regarding that number. Participants scored as 3 were also considered as having low performance because there were misconceptions or errors at mathematical level or the strategy was not used in a complete correct way. The participants got score 2 if there was no mentioned reasoning with correct answer or the correct solution method with respect to the mentioned strategy. The teacher candiadtes were scored as 1 if there is no correct reasoning and unclear mathematical work and 0 if there is no answer or indicator of appropriate reasoning.

Secondly, the solution processes of teacher candidates were analyzed with a two-point (0-1) scale by taking into consideration the expected indicators within the scope of Polya's problem solving steps. 0 point was given to the teacher candidates who cannot answer the problem, 1 point was given to the teacher candidates who correctly answered and used the related strategy. In addition, strategies that the teacher candidates prefer to use were determined, and examples from the analysis and mistakes in the problem solving steps are presented descriptively with the quantitative data.

## FINDINGS

The data obtained from the holistic rubric related with the problem solving performance of the teacher candidates are given in Table 2 and the descriptive statistics about the problem solving performance scores are given in Table 3.

When the non-routine problem solving performances of the teacher candidates were examined in a holistic way, it can be said that they perform low especially as the difficulty level of the problem was raised. When the descriptive results of the problem solving performances of the teacher candidates for the problem types were examined, it was seen that the mean score obtained for the first problem ($\bar{X}$ = 4.02) was almost twice as much as the average score ($\bar{X}$ = 1.74) obtained for the second question. 31 teacher candidates' solution had no or inappropriate reasoning. When the solutions of the participants about the first problem were examined, it was seen that they used guess and check strategy predominantly and they answered the first problem correctly. In the second problem, the teacher candidates who preferred the strategy of using equation could not solve the problem; candidates who used the strategy of working backwards are successful in finding the answer to the problem. The difficulty level of the problem led to a decrease in the performances of teacher candidates. Although 36 teacher candidates answered the first problem completely, the fact that this number remains at 9 in the second problem supports this idea. Although 11 teacher candidates chose the right strategy in the first problem, a correct solution was not reached, due to the calculation error or wrong evaluation correct answer was not revealed. This situation was encountered in greater proportion in the second problem.

Teacher candidates were asked to explain their problem solving steps with respect to Polya, namely understanding the problem, devising a plan related to the solution, carrying out the plan and looking back. The solutions of the teacher candidates were evaluated separately for the solution steps and the steps were scored as 1 and 0 for each problem based on the indicators in the problem solving steps of Polya. This gives the potential to analyze why teacher candidates had difficulty in the second problem. Descriptive statistics of the data obtained in this direction are presented in Table 4.

When Table 4 is examined, it was determined that 94% of the teacher candidates had the first problem, 96% of them had the second problem answered by writing the expected sentences in their own words or stated that they made the correct association and explanation about the events and relations that were asked in the problems.

Only 3 teacher candidates had issues related with

**Table 2.** Problem solving performances of teacher candidates.

| | | Problem 1 | | Problem 2 | |
|---|---|---|---|---|---|
| | | f | % | f | % |
| Complete blank answers<br>Writing only data, not attempting to solve<br>Wrong answer and an indication of inappropriate reasoning | 0 | 3 | 6 | 15 | 30 |
| The strategy was chosen correctly but the strategy was not implemented.<br>Some ambiguous mathematical studies have been conducted, but the result is not revealed.<br>Correct answer but inappropriate reasoning | 1 | 5 | 10 | 16 | 32 |
| The strategy was chosen correctly, but the strategy could not be implemented or not enough.<br>The correct answer was found, but there is no indication of how it was found. | 2 | 4 | 8 | 7 | 14 |
| The correct strategy has been selected and implemented, but there is no exact right answer due to a calculation error or misconception.<br>The right strategy has been selected and the correct answer is present but some errors have been seen during the application. | 3 | - | - | - | - |
| The correct strategy was selected and applied correctly, but the correct answer could not be reached because one or more data were incorrectly evaluated. | 4 | 2 | 4 | 3 | 6 |
| Complete solution and correct answer. | 5 | 36 | 72 | 9 | 18 |
| Total | | 50 | 100 | 50 | 100 |

**Table 3.** Descriptive statistics about problem solving performance scores.

| | N | $\bar{X}$ | Std. deviation |
|---|---|---|---|
| Problem 1 | 50 | 4.02 | 1.72 |
| Problem 2 | 50 | 1.74 | 1.83 |

**Table 4.** Achievements of teacher candidates in problem solving steps.

| Problem solving steps | Problem1 | | | | Problem 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | | 0 | | 1 | | 0 | |
| | f | % | f | % | f | % | f | % |
| Understanding the problem | 47 | 94 | 3 | 6 | 48 | 96 | 2 | 4 |
| Devising a plan | 46 | 92 | 4 | 8 | 37 | 74 | 13 | 26 |
| Carrying out the plan | 36 | 72 | 14 | 28 | 9 | 18 | 41 | 82 |
| Looking back | 19 | 38 | 31 | 62 | 2 | 4 | 48 | 96 |

understanding the first problem and 2 teacher candidates had issues in understanding the second problem and they left the answers blank or just copied the problems in the same way. It was observed that teacher candidates chose the right strategy for the first problem with the rate of 92% and for the second problem with the rate of 74%. On the other hand, it was determined that 8% of teacher candidates for the first problem and 26% for the second problem chose inappropriate strategy or could not choose any strategy. It was determined that teacher candidates found a complete and correct solution by using the strategy they chose with the rate of 72% for the first problem and with the rate of 18% for the second problem. However, it was determined that 28% of the teacher

**Table 5.** Problem solving strategies preferred by the teacher candidates.

| Strategies | Problem 1 | | Problem 2 | |
|---|---|---|---|---|
| | f | % | f | % |
| Guess and check | 17 | 34 | 8 | 16 |
| Making a table | 13 | 26 | 2 | 4 |
| Using an equation | 10 | 20 | 12 | 24 |
| Drawing a diagram | 1 | 2 | 2 | 4 |
| Looking for a pattern | 5 | 10 | - | - |
| Eliminating possibilities | 1 | 2 | - | - |
| Working backwards | - | - | 10 | 20 |
| Making a systematic list | - | - | 3 | 6 |
| Not being able to select strategy or blank answers | 3 | 6 | 13 | 26 |
| Total | 50 | 100 | 50 | 100 |

candidates did not apply or could not find a correct solution for the first problem and 82% of the teacher candidates did not apply or could not find a correct solution for the second problem. In particular, a high failure is considered in the second problem. For the looking back step of the solutions to the problems, it was observed that the teacher candidates have controlled the correctness of the solution they made and created similar problems for the first problem with the rate of 38% and for the second problem with the rate of 4%. In addition, another finding is that there were no teacher candidates seeking to make logical verification. 38% of the teacher candidates have only created the wrong problems in the problem solving step for the first problem and 96% of the teacher candidates for the second problem or in the evaluation of the solution, they have not done any study. In the problem solving process, teacher candidates were asked to name the strategy they used in “devising a plan” step. Table 5 presents the frequency percentage distribution of the teacher candidates about their preferred strategies of problem solving.

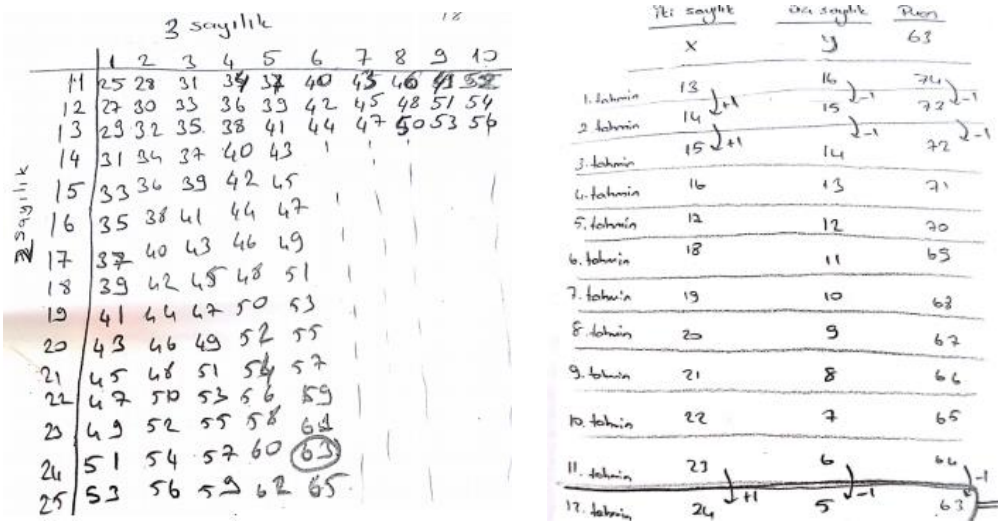
When Table 5 is examined, it is seen that teacher candidates prefer to use guess and check strategy with 34%, making a table with 26%, using an equation with 20%, looking for a pattern with 10%, drawing a diagram and eliminating possibilities with 2% in the first problem. In the second problem it is seen that they prefer to use equation with 24%, working backwards with 20%, guess and check with 16%, making a systematic list with 6%, making a table and drawing a diagram with 4%. However, while 92% of the teacher candidates could choose the right strategy for the first problem, only 72% of them have ended up with the solution by using the strategy correctly. This ratio results in an even greater difference in problem 2; while the percentage of teacher candidates who chose the right strategy was 74%, the number of teacher candidates who achieved the result by applying the chosen strategy remained at 18%. This is due to some of the mistakes students make while implementing the strategy. The responses of T8 and T16 using the table making strategy and guess and check strategy for the first problem are given in Figure 1. As shown in the figure, T8 and T16 preferred to use guess and check and making a table strategy to reach the solution of the problem correctly. T20 preferred the strategy of making a table for the first problem. The solution that has been realized in this direction is presented in Figure 2.

When Figure 2 is examined, it is seen that teacher candidate understood 2 and 3-point shooting giving a total number of 63; however, it is ignored that this number was obtained with 29 shots. In addition, the solution he implemented with the strategy that he considered to be used is not compatible with each other. He did not understand the strategy of making tables and problem.

In the second problem, 20% of the teacher candidates used the strategy of studying backwards. The response of T5 and T2 is given in Figure 3. When the responses of T5 and T2 are examined, with the reference of Robi has $400, Jane has $1000 and Dan has no money at the end of three games, they carried out the backward studying and reached the correct result.

Although 82% of teacher candidates chose the right strategy, 32% of teacher candidates did not apply correct study according to the strategy, 14% of the candidates chose the right strategy but did not apply the strategy and 6% of them chose the right strategy, and applied it correctly; however because of wrong evaluation of some data they could not get the right answer.

In addition, it is determined that some of the teachers did not know the names of the strategies they preferred to use correctly. For example, T7 realized the solution of Figure 4 for the first problem. As shown in Figure 4, T7 decided to use the "Pattern Search” strategy for the first problem, but by using the equation with two unknowns, he valued the variables and used the guess and check strategy. The responses of T23, T40 and T32 for the first problem are given in Figure 5. When Figure 5 is examined, it indicates that T23 preferred the making a table strategy but used the guess and check strategy, T32 preferred the making a table strategy, but




T8: Creating Table T16: Guess and check strategy

**Figure 1.** Making a table and Guess and check strategies for the first problem.

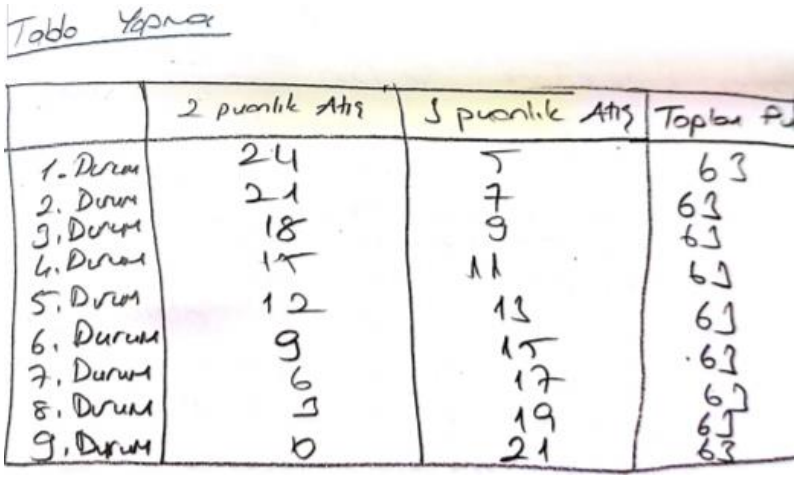
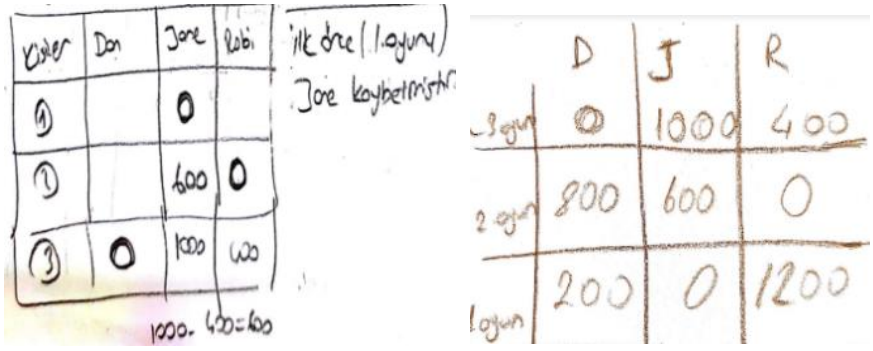



**Figure 2.** Solution of T20 for the first problem.




T5 T2

**Figure 3.** Responses for the use of the working backwards strategy for the second problem.

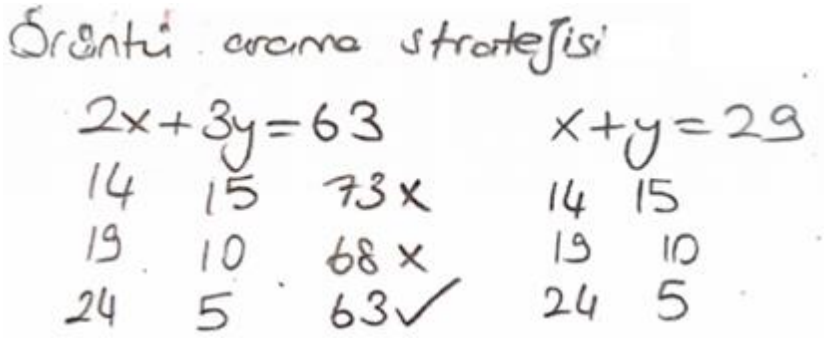
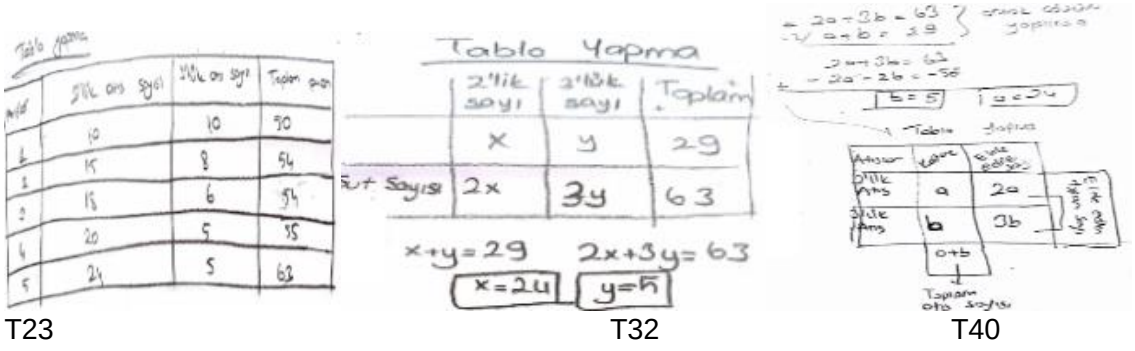



**Figure 4.** Solution of T7 for the first problem.




T23 T32 T40

**Figure 5.** Responses of teacher candidates using the making a table strategy for the first problem.

implemented using an equation strategy by placing the variables of two equation into the table and solving the equation, T40, firstly, solved the system of equations with two unknowns and placed the variables into the table and called this study as the strategy of making a table. The solutions of the teacher candidates T37, T41 and T28 for the first and second problems are given in Figure 6. When Figure 6 is examined, it is seen that T37 named the drawings he used to visualize the data of the problem as drawing a diagram strategy and could not solve the problem correctly. T41 used the expression "we can solve by establishing equation and connecting the variables with diagram". T41, who formed a structure with three unknowns, had drawn arrows in each game according to their lost situation and named them as drawing a diagram strategy and could not reach the correct answer. T28 used the following expression while solving the first problem: "First, we use a diagram drawing strategy, then we use equation using and guess and check strategies". He evaluated the different images he drew concerning the variables as a diagram strategy, solved the question by using two unknown system of equations and determined the operations he performed while checking the accuracy of the response as guess and check strategy. The responses of T48 and T9, who mentioned that they use guess and check strategy and making a systematic list strategy in the second problem, are presented in Figure 7. When Figure 7 is examined, it is seen that, although T48 preferred the strategy of guess and check, he used the strategy of using a variable and working backwards, T9 preferred to use the making a systematic list strategy, but used variable and could not reach the result.

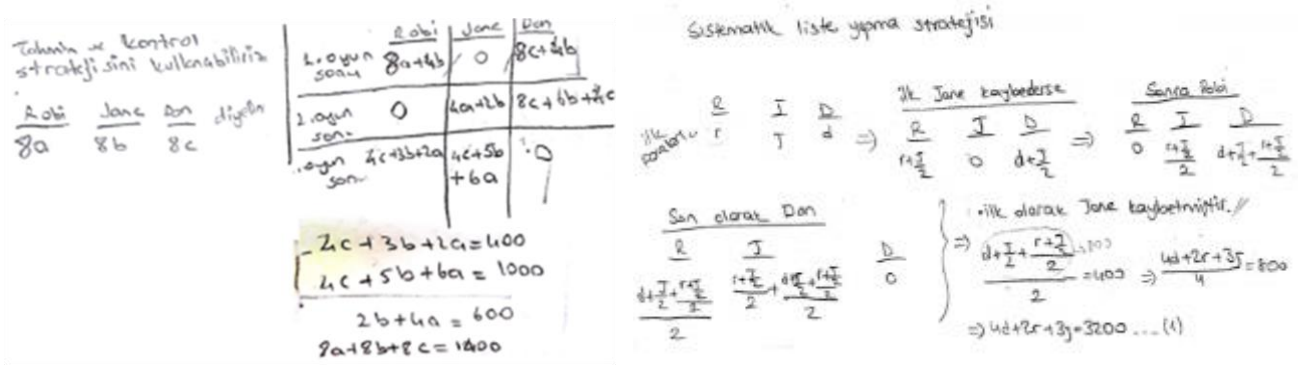
## DISCUSSION

In this study, which was conducted to determine non-routine problem solving performances of mathematics teacher candidates, problem solving performances were discussed in the context of non-routine problems. Problem solving scale was prepared in order to determine non-routine problem solving performance of teacher candidates and firstly the responses were evaluated with the holistic rubric and a two-point scale for evaluating the problem solving steps. Although the results based on two problems with different solution strategies and difficulty levels, it provides valuable information about teacher candidates' problem solving skills.

As a result, it is seen that 94% of the teacher candidates for the first problem, 96% of them for the


T37 T41 T28

**Figure 6.** Responses of teacher candidates using drawing a diagram strategy for first and second problem.




T48 T9

**Figure 7.** The responses of the teacher candidates used guess and check strategy and making a systematic list strategy in the second problem.

second problem expressed what was asked in the problem in their own words and made the correct relation and explanation about the events and relationships; 92% of teacher candidates chose the right strategy for the first problem and 74% teacher candidates chose the right strategy for the second problem. They made a complete and accurate solution using the strategy they choose for the first problem as 72% and for the second problem as 18%. In the first problem 38%, in the second problem 4% of the candidates controlled the accuracy of the solution they made completely and established similar problems. In addition, 38% of the teacher candidates for the first problem, 96% of them for the second problem established only incorrect problems or have not done any study in evaluation of the solution step.

Secondly, it was determined that teacher candidates preferred mostly guess and check strategy (34%) in the first problem and using an equation (24%) strategy in the second problem. However, 92% of the teacher candidates chose the right strategy for the first problem, while only 72% of them applied the chosen strategy correctly and reached the solution. This ratio resulted in even greater differences in problem 2; while the percentage of teacher candidates who chose the right strategy was 74%, the number of teacher candidates who achieved the result by applying the chosen strategy remained at 18%. This is due to some of the mistakes students make while implementing the strategy.

When the problem solving performances of the teacher candidates are examined in a holistic way, it can be said that they perform low. When the descriptive results of the problem solving performances of the teacher candidates for the problem types are examined, it is seen that the mean score obtained for the first problem ($\bar{X}$ = 4.02) is almost twice as much as the average score ($\bar{X}$ = 1.74) obtained for the second problem. The difficulty, which was created in problem quality, led to a decrease in the performances of the teacher candidates. Although 36 teacher candidates answered the first problem fully and completely, the fact that this number remains at 9 in the

second problem supports this idea. The main reason why the level of performance was low is that teacher candidates mostly prefer using equation and guess and check strategy. These are also very common problem solving strategies used in routine problem solving. Although the teacher candidates knew the theoretical knowledge about the strategies, it was observed that they had difficulty in applying the strategies other than using equations and guess and check. Some of the teacher candidates could name the correct strategy but could not reach the correct answer due to misapplication of the strategy or could reach the correct result but the name provided for strategy was not compatible with what they carried out. This is because they do not encounter problems that require different strategies. In their study, Kaya and Kablan (2018) mentioned that the success in using more than one solutions for non-routine questions is low. They concluded that difficulties mostly arise from using multiple strategies and everyday experiences when solving especially non- routine problems.

The results show that the problem-solving performance of teacher candidates decreased when the difficulty level of the problem increased; also, it is seen that the strategies they use for the solution did not correspond to the strategies they wrote. It was determined that the teacher candidates were quite inadequate in the evaluation of the solution. These results indicate that teacher candidates' problem solving skills are not sufficient and therefore they perform poorly. Sufficient knowledge of the problem solving skills of the teachers who are responsible for developing their students' problem solving skills is related to the knowledge of the field.

The primary objective of the curriculum is to improve the mathematical problem-solving skills, to develop reasoning skills and to develop the ability to use these skills in solving problems encountered in real life. It is also declared that problem solving facilitates mathematics learning and affects mathematical thinking (Verschaffel et al., 1999). However, when the results and different studies were examined, it was seen that teacher candidates showed low success in problems involving non-routine problems (Dündar, 2014; Akgün et al., 2012); they tend to use the arithmetic operation to solve non-routine problems (Dündar, 2014; Lawrence, 1977). However, the program does not provide sufficient support for the development of professional skills and accomplishments. Therefore, there is a big gap between theoretical preparation and school experience (Orgoványi -Gajdos, 2016). Shulman (1987) defined teachers' knowledge on the pedagogical content knowledge model. In this model, he emphasized that the defined content knowledge is related to the teacher's own field. He also emphasized that content knowledge should not be considered separately from mathematics teaching knowledge. There are many mathematics educators who suggest that the inclusion of problem solving and problem formation in mathematics lessons can have a positive effect on students' mathematical thinking (Abu-Elwan, 1999; Kilpatrick, 1987).

## Conclusion

In this case, it is recommended that a more effective teaching process and practices of different models should be included in teacher education in order to increase the performance of teacher candidates for problem solving. Practical work should be included in all the courses in the curriculum of mathematics teacher education programs. Both the content courses related to mathematics and the pedagogical content courses should be implemented in a problem solving environment. Teacher candidates should be encouraged to encounter different types of problems both in their courses and out-of-school activities through mathematics clubs and competetions arranged in the faculty or university. In this context, it is recommended to examine the problem solving knowledge and pedagogical content knowledge of the teacher candidates, and to re-evaluate the results of the study with different question types.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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# Adaptation of quantitative measurement tools to quantitative measurement of possibility

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**When correlation between variables is not explicit, data can be collected by adapting the quantitative measurement tools in use for quantitative measurement of possibility, a nonlinear measurement. This adaptation is possible because measurement data can be evaluated more qualitatively using parameters for possibility. These can be defined as regular-symmetric, irregular-symmetric, symmetric with regard to situation at which the distribution begins, event-based symmetric, symmetrical-contiguous, and of symmetrical discrimination, all available using possibility measurement tools. Without modifying the structure of conventional quantitative measurement tools, their pre-measurement adaptation can be carried out, making quantitative possibility measurement tools. This is made possible by converting scale values and scale options of each measurement tool to situation numbers and event numbers. Post-measurement adaptation can be carried out by converting the value measured to a symmetrical situation number. In this study, adaptation techniques and principles will be provided, for conventional quantitative measurement tools which will be classified according to their scale indicators and then used for quantitative measurements of possibility.**

**Key words:** Adaptation of measurement tools, adaptation over scale indicator technique, adaptation over items technique.

## INTRODUCTION

With the increase in the importance of possibility within the measurement process, the use of possibility measurement tools started to expand into different disciplines, as well (Mauris, 2013; Ryguła et al., 2018; Hou et al., 2016). To give an example, the possibility measurement tools are used for identifying the lipid markers in medicine (Sumino et al., 2016). Use of possibility in measurement may bring new perspectives into measurement. Use of probability in the evaluation, on the other hand, has the ability to do the same within the scope of evaluation. However, there are various uncertainties and challenges experienced within the scope of using the possibility theories in measurement and evaluation (Ferrero et al., 2014). Some of these challenges are stated as follows, quoted from the study carried out by Ferrero et al. (2014):

"The evaluation and expression of uncertainty in

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> measurement is one of the fundamental issues in measurement science and challenges measurement experts especially when the combined uncertainty has to be evaluated. Recently, a new approach, within the framework of possibility theory, has been proposed to generalize the currently followed probabilistic approach. When possibility distributions are employed to represent random contribution to measurement uncertainty, their combination is still an open problem. This combination is directly related to the construction of the joint possibility distribution, generally performed by means of t-norms."

The first thing to do for eliminating the uncertainties and challenges stated in the respective literature within the scope of possibility measurement and evaluation is the correlation of possibility with measurement and probability with evaluation. In that, since the probability is the ratio of possibilities, it can be identified as the evaluation of measured data. In this case, the probability calculation in education provides us with the "level" within the scope of evaluation on success level or knowledge level.

The second thing to do for eliminating the uncertainties and challenges in measurement and evaluation within the scope of education is to develop measurement tools and evaluation methods with the rules that comply with the possibility theories. The third thing to do for eliminating the uncertainties and challenges in the possibility measurement within education is to carry out measurements by means of adaptation of existing measurement tools with the possibility measurement tools based on the rules that comply with the possibility theories.

In many disciplines, quantitative measurement tools are conventional for the measurement of variables whose correlation is not known. More specifically, when the correlation between dependent and independent variables is unknown, the measurement can be carried out via possibility measurement tools. For this purpose, conventional, linear, quantitative measurement tools whose main use consists simply in the correlation of variables can be applied when converted to nonlinear tools for the quantitative measurement of possibility. This adaptation can be carried out by applying the principles of possibility distribution and of symmetrical possibility.

There are rules and computable equations of symmetrical, regular-symmetrical, and irregular-symmetrical possibilities, along with those for symmetrical possibility regarding the situation at which a distribution begins, and event-based symmetrical possibility. Using these as well as dependent possibility distributions, with and without different arrays, conventional quantitative measurement tools can be adapted, deriving special possibility distributions as described by Yılmaz (2018). Possibility distributions can be obtained with reference to the number of items (or questions) of a measurement tool, its scale options, or its scale value. Probabilities are calculated according to the number of distributions involved, and to the possibility distribution number and the results to be obtained from the measurement. Conventional quantitative measurement tools can be adapted to quantitative possibility measurement tools by obtaining the possibility distributions of measurement results. These possibility distributions can be obtained by correlating the values determined at length of conventional quantitative measurement with symmetrical situation numbers (independent variables of symmetry).

In this study, techniques and principles will be provided for the adaptation of conventional quantitative measurement tools for use in possibility measurement; in particular, techniques and principles which do not require modification in the structure of measurement tools. With these adaptation techniques and principles, both pre-post-adaptation of a measurement tool, and of the measurement results, can be achieved. Adapted measurement tools can be evaluated by information theories or VDOIHI methods (Yılmaz, 2011; Yılmaz and Yalçın, 2011).

## ADAPTATION TECHNIQUES AND PRINCIPLES

In different disciplines and according to their preparation style, quantitative measurement tools can be divided into four groups by scale indicators (response options). Their adaptation into quantitative possibility measurement tools can be carried out over the scale indicators and items /questions of these four groups. The four groups are as follows: (1) optional by two situations, (2) multiple-choice, (2) optional from lower limit (0 ≤) to upper limit, and (4) optional from negative limit to positive limit. Values cannot be attributed to some variables (e.g., gender) registered via certain measurement tools: these values indicate the aims or targets of measurement. In cases where values may be attributed to variables (e.g. educational level) measured by certain tools, these tools can be applied for the second group, "optional from lower limit to upper limit", using the measurement scale. There are options with measurement tools, such as those operating by two situations and those by multiple-choice, measuring for true and false. When the options are not appropriate for selection, as with true-false in multiple-choice measurement tools (MCMT), according to the answer options they may be used with either "optional from lower limit to upper limit" types or "optional from negative limit to positive limit" types.

Pre-adaptation of a measurement tool can be carried out by defining the possibility distribution number and independent variables (situation and event number) relative to the tool's item number or to its scale indicator.
Post-adaptation for quantitative possibility measurement

can be carried out by defining the independent variables of symmetry relative to the values obtained via conventional quantitative measurement. In this way, the structure of the conventional tool does not change because the adaptation for possibility measurement can be achieved without modifying items or the measurement scale. The scale indicator of the measurement tool may comprise numeral values or symbols (concepts). Any value on the scale will be termed a “scale value”. A symbol on the scale of the measurement tool will be termed a “scale option”. Without separating the scale value or scale option of the measurement tool, the term “scale indicator” can be used. There is a scale option or a scale value for each item on a measurement tool. This should be true for all the items of measurement tools with particular standards. A measurement tool can only have scale option or scale value. When there is scale option on a measurement tool, all items should have the same number of options. When there is scale value on a measurement tool, all items of the measurement tool should have the same values.

With scale option on a measurement tool, it can be adapted for possibility measurement by digitizing the options. In cases where the measurement tool requires digitizing, the “smallest significant piece (SSP)” method (Yılmaz, 2011) can be utilized. In this method, according to the purpose of the measurement, SSPs can be digitized by scoring. In a binary-basis digital system, the unit of measurement is one bit. In all bases, including binary base, the SSP can be used as a unit for possibility measurement.

Adaptation can be performed by two different techniques. The first of these is “adaptation over items”; the second is “adaptation over scale indicator”. The technique of converting a measurement tool’s item number to an event number will be termed “adaptation over items”. When a scale value is to be converted to an event number, this will be termed “adaptation over scale indicator”. Situation values are determined according to the measurement tool to be adapted, and the adaptation technique. Adaptation over items is performed in order to evaluate all items of a measurement tool together, converting to scale option or binary base. Adaptation over scale indicator is performed in order to evaluate each item of a measurement tool separately, using scale values. Both adaptations can be performed before or after measurement. In pre-measurement adaptation, event and situation numbers are determined for the adaptation to be carried out. Post-measurement adaptation can be performed after converting values to symmetrical situation numbers (that is, to independent variables of symmetry) and determining event and situation numbers. These pre- and post-measurement adaptations can be performed by means of adaptation over items technique or adaptation over scale indicator technique.

When a scale indicator comprises scale option, as when digitization is required, this can be done either by means of SSP or by application of SSP to those numerical values which are in accord with the measurement. Scale indicators from negative limit to positive limit can comprise verbal expressions, so this can be used as scale option in verbal expressions. For example, if such a scale option is to be digitized, there is mesoscale option, from negative limit to positive limit. According to SSP, the mesoscale option can be set at “0”, and each of the scale options to the right is then set at “1”, and each scale option to the left at “-1”. Scale option can be converted to scale value by taking of the scale option score together with the sum of scale options scores which fall between the scale option and the mesoscale option. In sensory analysis of foods, for example, the color of a food can be determined because the scale option can register different tones and /or colors. When such a measurement tool requires digitizing, it can be carried out by scoring tone and / or wavelength values (or ranges) for the colors at “1” and applying SSP.

When a scale indicator comprises scale values for conversion to scale options from lower limit to upper limit, those scale options having importance to each other, numerical values can be used, such as 0 or 1, 2,3, and so on, thus becoming scale values. In this type of conversion, no operations like addition, subtraction, multiplication, or division can be performed using the numeral values. These values may only relate the greatness of one scale option to the other options. If they show no significant correlation in the adaptation, the conversion to scale option can be done by assigning letters, such as a, b, c, and so on. In the conversion to scale option of values from negative limit to positive limit, if the scale options have importance to each other, scale values can be converted to scale options by assigning appropriate numerical values, e.g., -3, -2, -1, 0, 1, 2, 3.

The techniques and principles provided in this paper can be applied for conventional quantitative measurement in order to prepare tools quantitative measurement of possibility. Furthermore, they can be applied either to the measurement tool or to the results obtained. This paper does not provide for structural modification of quantitative tools. Such modifications can be performed by independent preparation (without modification), via principles of possibility, or by using the techniques and principles provided in this study. When a measurement tool has not been structurally modified, it allows pre-measurement adaptation.

## Adaptation of measurement tools (AMT): Those using two situations and those using multiple-choice

Since measurement tools using two or more options are prepared for base values equal at base to one true and false, they are binary-basis independent possibility

measurement tools. This applies to each item for such measurement tools. Each should have the same number of options within the scope of a given tool. Where the values are binary, such as true or false, no value or symbol affects the adaptation. These measurement tools are binary-based and can be converted to binary-basis independent possibility measurement tools wherein each item presents options such as true and false. Pre- and post-measurement adaptations of these tools can be performed by means of adaptation over items.

### *Application of adaptation over items for binary basis*

Once adapted to binary-basis independent possibility distribution by means of adaptation over items, according to whether the same scale indicator has been measured in the items, post-measurement adaptation can be performed. The resulting binary-basis independent possibility measurement tool is adapted through multiple-choice items by using the obtained values (e.g. number of “trues”) as symmetrical situation values. The scale options selected are determined by means of the measurement in binary-basis independent possibility distributions, since all symmetrical possibilities with the same value are equal. In MCMTs, adaptation of options such as false can be carried out separately for each item. In the adaptation of these measurement tools, the event number is equal to the item number of the measurement tool; the situation number is two. By determining the event numbers, pre-measurement adaptation can be carried out with the same technique, yielding a binary-basis independent possibility measurement tool adapted through multiple-choice items.

After pre- or post-measurement adaptation has been performed for a possibility measurement tool, two different evaluations can be carried out. The first can be carried out via the Shannon Equation, and the second evaluation can be carried out by summing the symmetrical possibilities obtained for each symmetrical situation number, calculating the probabilities via this sum. With symmetrical situation numbers and/or events showing symmetrical situations, measurement data can be evaluated more qualitatively by means of possibility distributions. These include regular-symmetric, irregular-symmetric, symmetric with regard to situation at which the distribution begins, event-based symmetric, symmetrical-contiguous and symmetrical by discrimination. If required, values for probability can be converted to the desired value system (e.g., grades).

## AMTs: Those using lower limit and upper limit

Tools using lower limit and upper limit can be adapted to four different types of possibility distributions. These are distributions of independent possibility, binary-basis independent possibility, dependent possibility with or without different arrays (where that for dependent possibility with different arrays takes the number of situations as equal to the number of events). Pre- and post-measurement adaptation of these tools be carried out by means of adaptation over items or by adaptation over scale indicator technique.

### *Application of adaptation over items with upper and lower limits*

Measurement tools to which adaptation over items can be applied will be adapted either to independent possibility distribution or to binary-basis independent possibility distribution. If scale indicators for all items are to be evaluated together, the adaptation will be to independent possibility distribution, letting the event number be equal to the item number. In this kind of adaptation, scale values should be converted to scale option. After this conversion, situation number is equal to scale option number. A measurement tool adapted from use of upper and lower limits to independent possibility distribution can be termed a measurement tool for independent possibility adapted through optional items from lower limit to upper limit. Measurement is performed in order to evaluate all item and scale options together, with scale options selected for the items determined via measurement. With independent probability distributions, since all symmetrical possibilities given the same symmetrical situation number are equal to each other, the scale option numbers can be used as symmetrical situation numbers. Symmetrical possibilities are therefore calculated with symmetrical situation numbers, and evaluation with symmetrical possibilities can be carried out by calculating the probabilities. If the scale options for all items are determined in the measurement, the adaptation will be incorrect for evaluation as the symmetrical possibility will reduce to one.

If scale indicators for all items are to be evaluated separately, the adaptation over items should be to a binary-basis independent possibility distribution, according to whether or not the same scale indicator is measured following the evaluation. A measurement tool adapted from use of upper and lower limits to binary-basis independent possibility distribution can be termed a binary-basis independent possibility measurement tool adapted through optional items from lower limit to upper limit. When the same scale indicator has two situations, such as whether or not it has been measured, binary-basis independent possibility measurement is performed. In the adaptation of these measurement tools, the event number is equal to the item number of the measurement tool. On the other hand, the number of situations is two, determining whether or not the same scale indicator is measured. The same measurement is performed separately for each scale indicator. Since binary-basis

independent possibility measurement is performed, the number of items on which the same scale value is measured is equal to the symmetrical situation number. In this kind of measurement, therefore, the evaluation methods suggested for binary-basis independent possibility measurement tools adapted through multiple-choice items can be utilized separately for each scale indicator.

### *Application of adaptation over scale indicator*

Measurement tools can be adapted over scale indicator, to dependent possibility distribution, with or without different arrays, where the number of situations is equal to the number of events. An adaptation whose event number shows the maximum scale value, or its equivalent by scale option, can derive a dependent possibility distribution with different arrays where the number of situations is equal to the number of events. Where the event number will be equal to that of the scale values or of the scale options, it can present a dependent possibility distribution without different arrays.

A measurement tool adapted from use of upper and lower limits to a dependent possibility distribution with different arrays in which the number of situations equals the number of events can be termed a possibility measurement tool with different arrays adapted through optional scale indicators from lower limit to upper limit. The selected scale indicator value determined via measurement, and the scale indicator value to be measured equal to the symmetrical situation number, evaluations can be carried out. This is achieved by calculating symmetrical possibilities in dependent possibility distributions with different arrays where the number of situations equals the number of events.

A measurement tool adapted from use of from upper and lower limits to a dependent possibility distribution without different array can be termed a possibility measurement tool without different array adapted through optional scale indicators from lower limit to upper limit. The value selected for a scale indicator is determined via measurement, and that value is taken as equal to the symmetrical situation number. Evaluations can be carried out by calculating the symmetrical possibilities in distributions without different arrays using symmetrical situation numbers.

## AMTs: Those using negative and positive limits

Measurement tools with negative and positive limits can be adapted to four different types of possibility distribution. The distribution types to which this measurement tool can be adapted are independent possibility distribution, binary-basis independent possibility distribution, dependent possibility distribution without different array, and dependent possibility distribution with different array where the number of situations equals the number of events. Pre- and post-measurement adaptation of tools with negative and positive limits can be carried out by adaptation over items or by adaptation over scale indicator. Scale indicators in this kind of measurement tool have either a mesoscale value or a mesoscale option. The mesoscale value or option can be termed the mesoscale indicator. When adapting by means of either technique, the measurement tool can be divided into two halves using the mesoscale indicator. The half which has negative scale indicators can be termed the negative scale indicator, and the other half the positive scale indicator.

### *Application of adaptation over items*

Measurement tools can be adapted using adaptation over items, yielding either independent possibility distributions or binary-basis independent possibility distributions. If the scale indicators of all items are to be evaluated together, the adaptation to independent possibility distribution by means of adaptation over items can be carried out either for the entire scale indicator or for each half. When carried out for the entire scale, the scale indicator is converted to a scale indicator with upper and lower limits, and principles are applied for independent possibility measurement tools adapted through optional items from lower limit to upper limit. Such adapted tools can be termed independent possibility measurement tools adapted through optional items from negative limit to positive limit. In this adaptation, the conversion is done in such a way that the situation number is equal to the scale values number on the scale indicator, or scale options number.

In adaptations to be carried out for either half of a scale indicator, each half is converted separately to scale indicators as for a tool upper and lower limit to limits. Then, principles are applied for independent possibility measurement tools adapted through optional items from lower limit to upper limit. A measurement tool with adapted negative range can be termed an independent possibility measurement tool adapted through optional negative-half items from negative limit to positive limit. In this adaptation, the conversion is done in such a way that the situation number is equal to the scale values number, or to the scale options number on the negative-half scale indicator. Measurement tools with adapted positive ranges can be termed independent possibility measurement tools adapted through optional positive-half items from negative limit to positive limit. In this adaptation, the situation number is equal to the scale values number, or to the scale options number on the positive half scale indicator. As in the evaluation of negative-half measurement tools, evaluations of independent possibility measurement tools adapted

through optional items from lower limit to upper limit can be used.

If the scale indicators for all items on a measurement tool are to be evaluated separately, the adaptation is carried out by means of the principles of binary-basis independent possibility measurement tool adapted through optional items from lower limit to upper limit. Measurement tools thus adapted can be termed binary-basis independent possibility measurement tool adapted through optional items from negative limit to positive limit. Evaluation methods suggested for binary-basis independent possibility measurement tools adapted through multiple-choice items can be utilized separately for each scale indicator.

### *Application of adaptation over scale indicator*

The adaptation principles for tools with upper and lower limits by adaptation over scale indicator can be utilized via adaptation over scale indicator, yielding tools showing uniform possibility distribution. These adaptations are carried out either separately for each half or by uniting the scale indicator. If adaptations are to be carried out separately for each half of the scale indicator, each half is converted separately to a scale indicator for tools with upper and lower limits, after which the adaptation of each half is carried out separately. If adaptations are to be carried out by uniting scale indicators, the negative half is converted to scale indicator for optional measurement tools with upper and lower limits. The positive half is converted by uniting both halves of the scale indicator. Thus, in the adaptation of dependent possibility distribution without different arrays, the event number for the positive half is equal to the sum of both halves of the scale indicator, or to the scale values number, or to the scale options number. The situation number, on the other hand, is equal to the sum of maximum values for both halves of the scale indicator, with scale value or values for the scale option. In the adaptation of dependent possibility distributions with different arrays where number of situations equals number of events. For the positive half, the event number is equal to the sum of the maximum values for both halves of the scale indicator, with scale value or values for the scale option. The situation number, on the other hand, is equal to the event number.

Measurement tools whose negative half is adapted to dependent possibility distribution with different arrays where number of situations equals number of events via adaptation over scale indicator, like tools with different arrays adapted through optional scale indicator from lower limit to upper limit, can be termed negative-half possibility measurement tools with different arrays adapted through optional scale indicator from negative limit to positive limit. A measurement tool whose positive half is adapted can be termed a positive-half possibility measurement tool with different arrays adapted through optional scale indicator from negative limit to positive limit.

A measurement tool whose negative half is adapted by uniting its scale indicator to dependent possibility distribution with different arrays where number of situations equals number of events, via adaptation over scale indicator and principles of possibility measurement tools with different arrays adapted through optional scale indicators from lower limit to upper limit can be termed scale-combining negative-half possibility measurement tools with different arrays adapted through optional scale indicator from negative limit to positive limit. A measurement tool whose positive half is adapted by uniting its scale can similarly be termed a scale-combining positive-half possibility measurement tool with different arrays adapted through optional scale indicators from negative limit to positive limit.

A measurement tool whose negative half is adapted to dependent possibility distribution without different arrays via adaptation over scale indicator by means of principles for possibility measurement tools without different arrays adapted through optional scale indicators from lower limit to upper limit can be termed a negative-half possibility measurement tool without different arrays adapted through optional scale indicators from negative limit to positive limit. A tool whose positive half is adapted can likewise be termed a positive-half possibility measurement tool without different array adapted through optional scale indicator from negative limit to positive limit. A measurement tool whose negative half is adapted by uniting its scale indicators to a dependent possibility distribution without different arrays via adaptation over scale indicator by means of principles for possibility measurement tools without different arrays adapted through optional scale indicators from lower limit to upper limit can be termed a scale-combining negative-half possibility measurement tool without different arrays adapted through optional scale indicators from negative limit to positive limit. A measurement tool whose positive half is adapted by uniting its scale indicator can be termed a scale-combining positive-half possibility measurement tool without different arrays adapted through optional scale indicators from negative limit to positive limit.

## DISCUSSION

Workers in different disciplines can more easily interpret measurement results as provided by re-classifying measurement tools and adapting them for possibility measurement by means of two techniques. Better interdisciplinary interaction may thus be positively established. Conventional quantitative measurement tools can be adapted for measurement of possibility by means of techniques and principles provided in this

study. Quantitative possibility measurement tools can be used with every measurement available via conventional quantitative measurement tools. In areas where correlations and/or equations between dependent and independent variables are not explicit, possibility measurement tools can be utilized as well as other measurement methods and tools. Quantitative possibility measurement tools can be used, above all, in measurements featuring nonlinear expectation of correlations and/or equations between dependent and independent variables.

Depending which possibility distribution type which the measurement tool will be adapted to, items or scale value/ scale options of conventional quantitative measurement tools are adapted to the event and situation number and to the independent variables of symmetry. Being at measured values of the tool, no structural modification of the conventional quantitative measurement tools is required. Therefore, without modifying their structure, conventional quantitative measurement tools can be adapted for quantitative possibility measurement. Measurement can be performed via possibility measurement tools after the measurement tool is adapted, and also the measurement tool and the results can be adapted after the measurement. Thus, nonlinear correlation between variables can be determined via probability measurement tools in fields where quantitative possibility measurement tools are used. Two different evaluation methods can be used in quantitative possibility measurement tools. The first of these; is a two-way probabilistic evaluation method classified VDOIHI (Yılmaz, 2011; Yılmaz and Yalçın, 2011). In the other evaluation method, the information contents can be determined by means of the Shannon equation. Different measurement tools can provide a new dimension to both measurement and evaluation. These new dimensions play a role in qualifying education and training. Individual-centered and knowledge-centered evaluations can be made with different measurement tools. Possibility measurement tools provide knowledge - centered evaluations due to their nature.

Measurement tools with the same structure can be named differently in different disciplines. Thanks to the re-classification of those used under different names in different disciplines by means of scale indicators, measurement results can be interpreted more easily by workers in different disciplines. The names provided in this study can be used for this classification of measurement tools of the same structure. Accordingly, interdisciplinary interaction can be improved.

Quantitative possibility measurement tools can be utilized in disciplines where problems and uncertainties occur in the course of measurement. Although nonlinear correlations can be determined via quantitative possibility measurement tools obtained by means of adaptation, certain problems with a conventional quantitative measurement tools can be transferred to its corresponding possibility measurement tool. For example, with multiple-choice tools, all the other options apart a correct option have one meaning for the measurement. In quantitative measurements, the interpretation of all options of a MCMT can be done using quantitative possibility measurement tools prepared without adaptation.

Whether dependent or independent variables will be measured determines the proper methods and tools of measurement. Therefore, the variables to be measured should be determined before initiating the measurement. In the measurement of variables, linear or nonlinear measurement tool selection is important. The same variable can be measured via linear measurement tools or nonlinear tools. Tool selection depends on measurement purpose. The proper measurement tool should be used for a purpose.

In the evaluation of measurements performed for individual items, items can be united in the sum of probabilities, and the distributions of the items can be united as well. These operations are carried out by means of evaluation techniques. Use of possibility measurement tools in education may bring new perspectives into measurement in education. Use of probability methods in the evaluation, on the other hand, has the ability to do the same in education within the scope of evaluation process. Measurement and evaluation methods that comply with the possibility and probability theories can also bring new perspectives into the teaching methods. Utilizing the Shannon equations with regards to probability calculations, new methods can be developed for data identification (Chen et al., 2019; Elerman, 2018). However, the Shannon equation can be used for identification of two-possibility data. Possibility theories of bases larger than two for identifying the data in bases bigger than two-possibility basis. New perspectives can also be brought for education teaching methods using the data to be collected through possibility measurement tools which can be developed using the rules of possibility theories of bases bigger than two. Through the adaptation rules of quantitative measurement tools in this study into the possibility measurement tools, the uncertainties and challenges experienced in possibility measurement tools can be minimized. Through the data to be obtained with the possibility measurement tools which are projected to be established with the rules in this study, new perspectives can be brought into the teaching methods.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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# Examining internet addiction levels of high school last-grade students

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**Technological developments in the 21th century have enabled the emergence of tools that enable mass communication. This communication environment has brought about a continuing passion for technology in individuals and, with this passion, a communication pollution and addiction have begun to emerge. In this study, Internet addiction of high school last-grade students studying in Yeşilyurt district of Malatya city was analyzed and investigated according to gender and family monthly income. The population of the study consisted of 3442 last-grade students studying in 37 public high schools located in Yeşilyurt district of Malatya city in 2016 to 2017 academic year. The sample of the study was composed of 606 last-grade students from 17 high schools randomly selected from the schools in the population. The study model was the survey model. In the study, "Internet Addiction Scale" developed by Günüç (2009) was used to determine the Internet addiction levels of the students. This scale is composed of "withdrawal", "controlling difficulty", "disorder in functionality", and "social isolation" subscales. In the analysis of the data, arithmetic mean ($\bar{x}$) frequency (f), standard deviation (sd), k-mean set method, t-test and one-way ANOVA test were used. When these results were taken into consideration, it was observed that majority of the students in the sample were in the non-addicted group (43.3%). A significant difference was determined between gender and Internet addiction mean scores of the students. On the other hand, no significant difference was found between family monthly income and the internet addiction mean scores of the students.**

**Key words:** Internet, Internet addiction, addiction, technology, technology dependence.

## INTRODUCTION

The Internet, which has been developing and changing rapidly globally since its emergence, has greatly affected our lives and paved the way for advances in many areas. Internet has influentially shown its existence in many fields such as economy, education, art, science, and daily life and even today it has become a must. The benefits of the Internet and its reflections on our daily lives are of course beyond measure. In addition, it has also led to the

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development of some negative behaviors. Internet addiction is the first of these. In general, addiction and substance use are thought to fulfill the function of helping an individual to overcome difficulties in daily life (Flores, 2004: 1). Addiction, which often refers to repeated behavioral routines mostly to obtain chemical substance, sometimes without purpose, is a psychiatric disorder in which the individual exhibits repetitive obsessions or imperative behaviors (Marks, 1990, 1389). Although it is traditionally seen as a phenomenon caused by psychotropic substances affecting human behaviors such as alcohol or cocaine, studies conducted in the last 30 years have shown that individuals can get harmed due to their behaviors and habits showing addiction signs. Overeating, gambling, shopping, sex and Internet usage can create similar problems with psychotropic substances (Padwa and Cunningham, 2010: 1). Therefore, the concept of addiction has started to be increasingly used to explain the behavior of many people (Netherland, 2012: 11).

The technology dependence which was defined as a non-chemical addiction type involving human and machine communication in these times when computers started to be used extensively was first introduced by Griffiths (1995: 14,15). With the spread of the Internet around the world from the mid-90s, Internet addiction has been defined as an important legal psychological disorder affecting cognitive, emotional, and social development of individuals (Price, 2011: 7). It was found that 6% of online users in America in 1998 are faced with this problem (Brenner, 2000: 452). However, unlike chemical dependency, excessive internet use has come to the forefront with some technological benefits that it provides to society rather than being criticized as addictive (Young, 2009: 217). When the first signs of Internet addiction appeared, it led to discussions among clinicians and academicians. Excessive Internet use has been considered by some as a type of pathological, addictive and technological addiction (Widyanto and Griffiths, 2006: 31).

The Internet use, one of the realities of the information age, has affected not only almost every field of life but also significantly the structure and presentation of education programs in education and school system. The Internet has made not only access to information easier, but also information independent of time and space. As a natural result of this situation, access to information seems to have ceased to be a problem (Aydemir et al., 2013: 1073). Proper definition of the concept of Internet addiction has shown variation depending on the perspectives. It is generally characterized by impulses or behaviors related to computer and Internet use which lead to distortion and distress along with uncontrollable engagement (Shaw and Black, 2008: 353). While some researchers have associated Internet addiction with dependencies including alcohol and substance use (Griffiths, 1999: 246), some others have associated it with recurrent obsessions or compulsive (impulse) control disorders (Belsare et al., 1997). The expressions of pathological Internet use (Davis, 2001:187) and problematic Internet use (Caplan, 2003: 625) have also been used to describe this problem.

The concept of Internet addiction, the last link of technological dependence, was first mentioned by Ivan (Goldberg, 1996; Suler, 1999). Internet addiction is an uncontrollable, significantly time-consuming process resulting in problematic or social and professional difficulties (Shapira et al., 2000. s. 268). According to Young (2004),Internet addiction as a rapidly growing phenomenon is a concept including a wide range of behavior variety and impulse control disorder associated with gambling addiction (p. 402). Griffiths (1999) stated that Internet may not be an addiction for most of excessive users and other addictions can be a tool of satisfaction.

The number of Internet users which was 360 million people worldwide in 2000 (Internet World Status [IWS], 2019) exceeded 4.02 billion people in 2018 (Bayrak, 2018). According to data in 2018, the rate of Internet use among individuals in the age group of 16-74 years was 59.6 and 72.9%, respectively (Turkish Statistical Institute [TÜİK], 2018). The number of users was recorded as approximately 44 million people (IWS, 2019). This means that nearly one in two people is an active user. With such increase in the place of Internet in daily life, the relationship between many variables, especially psychological factors, andInternet addiction has been investigated. These studies have revealed that there was a correlation between problematic Internet use and psychological disorders such as attention deficit and hyperactivity disorder (Dalbudak and Evren, 2013; Ko, 2009; Öztürk et al., 2013; Yen et al., 2007), depression (Choi et al., 2014; Koronczai et al., 2013; Şahin et al., 2013; Şenormancı et al., 2014; Yang et al., 2014), loneliness (Yao and Zhong, 2014), neurotic personality (Tsai et al., 2009; Wang et al., 2011), low self-esteem (Armstrong et al., 2000; Aydın and Sarı, 2011; Sariyska et al., 2014), low self-control (Özdemir et al., 2014), academic failure (Stavropoulos et al., 2013), feelings of hostility (Koç, 2011) and insomnia (Anderson, 2001; Lam, 2014).

In this context, the aim of the study is to determine the Internet addiction status of the students with related literature and feedbacks from the students, identify the relationship of Internet addiction with the gender variable and family's monthly income, and to make contribution to the literature.

## METHODOLOGY

In this study, the survey model, which aims to describe the situation as it is, was used. The survey models are the survey conducted on the whole population or a group; example or sample to be taken from the population in order to make a general judgment about the population in a population composed of many elements (Karasar,

2011: 110).

**Study group**

While conducting the sampling, first, it is necessary to define the study population by limiting the population in which the results are intended to be generalized in line with the purposes of the study. There is a study population which is the most appropriate one according to the purposes of the The population of the study consisted of 3442 students studying in the 4th grade in 37 high schools in Yeşilyurt District of Malatya city in the 2016-2017 academic year.

According to certain rules, the sample is a small cluster selected from a certain population and accepted as a adequacy of representation of the population in which it was selected. Studies are mostly carried out on sample sets and the obtained results are generalized to relevant populations (Karasar, 2011). The sample of the study consisted of 606 last-grade students who were randomly selected from 17 high schools.

**Data collection tool**

In order to determine the Internet addiction levels of the students in the study, "Internet Addiction Scale" developed by Günüç (2009) was used. The scale consists of 35 items including "withdrawal", "controlling difficulty", "disorder in functionality" and "social isolation" subscales.

**Data analysis**

In the study, the data related to the participants were analyzed by using The Statistical Package for Social Sciences(SPSS) 22.0 packaged software. After uploading the data obtained with scales into the computer environment, Test of Normality was conducted to determine whether they had normal distribution or not. In a statistical study, the distribution should be normal or close to normal for many tests to be performed (Kalaycı, 2006). While many features show a normal distribution in the population, deviations from the normal distribution will occur if the measurements of a property of interest are obtained from a small group (n<30). As the size of the group increases, the distribution will approach normal (cited by Büyüköztürk et al., 2014: 63 from Ravid, 1994). Tabachnick and Fidell (2005) have accepted that the distribution is normal when skewness and kurtosis values vary between +1.500 and -1.500 (p. 81). As a result of the applied test of normality, it can be asserted that the distribution in the study was normal since the skewness (0.762) and kurtosis (0.074) values of the scale items were between the values of +1.500 and -1.500. For this reason, arithmetic mean ($\overline{X}$), frequency (f), standard deviation (sd), k-mean set method, t-test and one-way ANOVA test were used to analyze the data in the study. The significance value was taken as (p<0.05) in the data analysis.

## RESULTS

Information related to the distribution of the students in terms of their demographic characteristics are given in frequency and percentage in Table 1. As seen in Table 1, 52% (51.6%) of the students in the sample group were female and 48% (48.4%) were male students. Besides, it was found that the monthly income of the families of the students was mostly (39.2%) between 1501-3000 TL.

The score distribution of the students from their answers to the scale was examined and Table 2 shows the analysis results.

As seen in Table 2, the lowest mean score of the participants from Internet Addiction Scale was 1.00 and their highest mean score was 4.94. The arithmetic mean obtained from the scale was $\bar{X}$= 2.37 and standard deviation was sd= 0.89.

In order to determine the group with or without Internet addiction and to obtain more detailed results about the addiction statuses of the individuals, "clustering analysis" technique from sample classification techniques was applied. The general purpose of the clustering analysis is to reveal the similarities of the units according to their certain characteristics and to classify the units into the correct categories based on these similarities (Çokluk et al., 2014: 139). This method has also allowed to reveal some extreme values found to be implicit in the sample. With this clustering method, addiction levels of individuals can be classified in a healthier way (Günüç and Kayri, 2009: 171).

In order to determine a more detailed result in the determination of the addiction statuses of individuals, the clustering analysis was applied and it was observed to consist of three sub-clusters. Accordingly, as seen in Table 2, "addicted group" was in the first cluster, "group with the addiction risk" was in the second cluster and "non-addicted group" was in the third cluster. In the naming of clusters, Günüç (2009)'s classification was taken as an example. Table 3 shows frequency and percentage distributions of the Internet addiction scores of students by considering the students' scores obtained from the scale total related to their Internet addiction levels.

In Table 3, the majority (43.3%) of 606 high school fourth-grade students participating in the study were seen to be in non-addicted group. This was followed by Risk Group (42.6%) and Addicted Group (14.1%), respectively. In the literature review conducted based on these data, it was observed in the study by Özdemir (2016) that 1.5% of the sample were addicted Internet users. Addicted group forms 7% of the sample in the study by İşleyen (2013), 10.1% in the study by Günüç (2009), 0.4% of the study by İnan (2010), 0.2% in the study by Çalışgan (2013), 23.2% in the study by Balcı and Gülnar (2009), 17% in the study by Durualp and Çiçekçioğlu (2013) and there was no addicted group in the studies by Yücelten (2016) and Döner (2011). These rates were found in some other studies as 4% (Wang et al., 2011), 1.1% (Bayraktar, 2001), 3.1% (Kaltiala-Heino et al., 2004), 2% (Johansson and Götestam, 2004), 20.7% (Yen et al., 2007), 2.4% (Cao and Su, 2007), 8% (Elizabeth and Tee, 2007), and 4.3% (Jang et al., 2008) (Cited., by Günüç, 2009; p. 89). It was observed that 14% of the sample in the study by Özdemir (2016) were risky Internet users, 9% of the sample in the study by İnan (2010) were the group showing Internet addiction

**Table 1.** Demographic characteristics of the students.

| Variable | Options | Frequency | Percentage |
|---|---|---|---|
| Gender | Female | 313 | 51.6 |
| | Male | 293 | 48.4 |
| | Total | 606 | 100 |
| Family monthly income | 0-1500 | 137 | 22.6 |
| | 1501-3000 | 238 | 39.2 |
| | 3001-4500 | 141 | 23.2 |
| | 4501 and higher | 90 | 15.0 |
| | Total | 606 | 100 |

**Table 2.** Distribution of the mean scores of the students from internet addiction scale.

| | Number of people (N) | Lowest score | Highest score | $\bar{X}$ | Standard deviation |
|---|---|---|---|---|---|
| Score Value | 606 | 1.00 | 4.94 | 2.37 | 0.89 |

**Table 3.** Frequency and percentage distributions related to Internet addiction levels of the students.

| Clustering (k-mean) | f | Total (%) |
|---|---|---|
| 1 (Addicted Group) | 85 | 14.1 |
| 2 (Risk Group) | 258 | 42.6 |
| 3 (Non-addicted Group) | 262 | 43.3 |
| Total | 606 | 100 |

symptom, 28.4% of the sample in the study by Balcı and Gülnar (2009) were risky Internet users, 11% of the sample in the study by Yücelten (2016) were Internet addiction risk group, 9% in the study by Döner (2011) were those showing limited symptom, 23% of the sample in the study by İşleyen (2013) were risk group, 14% of the sample in the study by Şahin (2011) were those showing limited symptoms, 66% of the study of Durualp and Çiçekçioğlu (2013) were risk group, and 29% of the sample in the study by Günüç (2009) were risk group.

Table 4 shows the mean scores used in the determination of these three groups obtained as a result of the applied clustering analysis method. When Table 4 was examined, it was determined that the mean score of the students in the addicted group was 3.58, the mean score of the students in the risk group was 2.40 and the mean score of non-addict students was 1.51. Table 5 shows the results of "t-test" conducted to determine whether there is a significant difference between the Internet addiction scores of high school last-grade students by their gender. When Table 5 was examined, no differentiation was determined in withdrawal subscale of the Internet addiction scale of high school last-grade students based on gender variable 0.11 ($p>0.05$).

Internet addiction mean scores significantly differentiated in terms of gender at the value of $p<0.05$ in overall Internet addiction scale (p=0.04), controlling difficulty (p=0.00), disorder in functionality (p=0.03) and social isolation subscales (p=0.04). When the arithmetic means were examined, it was observed that the male students caused the significant difference. The study results revealed that male students were under more risk in terms of Internet addiction compared to female students. In the literature review conducted in this context, a large number of studies supporting the study results were found. The correlation between the Internet addiction and gender was examined in the study conducted by Usta (2016) and a significant correlation was found between Internet addiciton and gender variable. As a result of the analysis, it was concluded that male students showed more Internet addiction behavior than female students. Similarly, Gencer (2017) stated that male students showed more Internet addiction behaviors than female students. Ayaroğlu (2002) examined the correlation between Internet uses of the university students and their loneliness levels and concluded that men spend more time than women in the fields of surfing on web and file transfer. Scherer (1997) examined 531

**Table 4.** Group averages of the students related to their internet addiction statuses.

| Clustering (k-mean) | $\bar{X}$ |
|---|---|
| 1 (Addicted Group) | 3.58 |
| 2 (Risk Group) | 2.40 |
| 3 (Non-addicted Group) | 1.51 |

**Table 5.** Internet addiction levels of the students on the gender variable.

| Dimensions | Gender | N | $\bar{X}$ | sd | t |
|---|---|---|---|---|---|
| Withdrawal | Female | 313 | 2.57 | 0.97 | 4.27 |
| | Male | 293 | 2.58 | 1.07 | |
| Controlling difficulty | Female | 313 | 2.27 | 0.88 | 0.25 |
| | Male | 293 | 2.31 | 0.91 | |
| Disorder in functionality | Female | 313 | 2.22 | 0.94 | 0.28 |
| | Male | 293 | 2.26 | 0.96 | |
| Social isolation | Female | 313 | 2.31 | 0.88 | 3.52 |
| | Male | 293 | 2.41 | 0.92 | |
| Internet addiction scale (general) | Female | 313 | 2.36 | 0.80 | 1.22 |
| | Male | 293 | 2.37 | 0.85 | |

N=606, $p<0.05$.

students in terms of Internet usage and determined that the majority of students (71%) determined to be Internet addicts were male students. Similarly,Döner (2011) reached a total of 624 students including 282 females and 342 males in her study and, according to the results of the study, Internet addiction of the male students differed significantly compared to female students and this difference was observed in favor of men. Similarly, Morahan-Martin and Schumacher (2000), Chou and Hsiao (2000), Bayraktar (2001), Koch and Pratarelli (2004), Aktaş (2005), Yang and Tung (2007), Balta and Horzum (2008), Ögel and Cömert (2009), Günüç (2009), Kelleci et al. (2009), Tsai et al. (2009), Esen (2010), Gürcan (2010), Yıldız (2010), Taçyıldız (2010), Gençer (2011), Liberatore et al. (2011), Carli et al. (2012), Gökçearslan and Günbatar (2012), Yılmaz (2013), Zorbaz (2013), Türkoğlu (2013), Azher et al., (2014), Waldo (2014), Ceyhan (2016), İşsever (2016) and Ünsal (2016) also found that male students had higher Internet addiction levels than female students in terms of gender variable. These results support the data obtained concerning the variable of gender in the study.

It is also possible to find studies in the literature that show that there is no significant differentiation between Internet addiction and gender. Brenner (2000), Batıgün (2011), Kaya (2011), Jelenhick et al. (2012), Hawii (2012), Çalışgan (2013), Andreou and Svoli (2013), Dikme (2014), Dalgalı (2016), and Yücelten (2016) have also found that gender has no effect on Internet addiction. A limited number of studies have revealed that Internet addiction is in favor of female students (Beşaltı; 2016; Griffiths, 1995).

The differentiation between the gender variable and Internet addiction is thought to be caused by the measurement type of Internet addiction level in the studies or the cultural differences due to different countries (Balta and Horzum, 2008: 187-205). When the studies are examined in general, the reasons why men have higher Internet addiction level than women are that there is gender inequality in the society, men are left more comfortable and free in the society, and men can go Internet cafés more than women (Çavuş and Gökdaş, 2006: 57; Taşpınar and Gümüş, 2005: 80). On the other hand, female students can be deprived (Atlasma and Gökdaş, 2006), their spare time is taken away by taking many responsibilities at home or their areas of freedom is reduced by interfering (Cited, Yılmaz, 2013: 75).

In Turkish society, males can be more comfortable and free compared to females due to the reasons such as tendency of men to move away from family after a certain age, adolescent period syndromes and friend environment. Besides, the general family structure of the Malatya province may be one of the reasons of higher Internet addiction scores of men. Table 6 shows

**Table 6.** Variance analysis results of the students' internet addiction scores based on family monthly income.

| Dimensions | Income level | Sum of squares | Sd | Mean of squares | F |
|---|---|---|---|---|---|
| Withdrawal | Intergroup | 11.251 | 9 | 1.25 | 1.311 |
| | Intragroup | 567.497 | 595 | 0.95 | |
| | Total | 514.585 | 604 | | |
| Controlling difficulty | Intergroup | 9.828 | 9 | 1.09 | 1.123 |
| | Intragroup | 579.795 | 596 | 0.97 | |
| | Total | 589.624 | 605 | | |
| Disorder in functionality | Intergroup | 12.063 | 9 | 1.34 | 0.313 |
| | Intragroup | 608.200 | 596 | 1.02 | |
| | Total | 620.263 | 605 | | |
| Social Isolation | Intergroup | 14.582 | 9 | 1.62 | 0.403 |
| | Intragroup | 688.019 | 596 | 1.15 | |
| | Total | 702.601 | 605 | | |
| Internet Addiction Scale (General) | Intergroup | 9.274 | 9 | 1.03 | 1.295 |
| | Intragroup | 474.089 | 596 | 0.79 | |
| | Total | 483.363 | 605 | | |

$p<0.05$.

arithmetic mean and standard deviation of the students related to Internet addiction according to the family monthly income.

When Table 6 was examined, a significant difference was determined between Internet addiction status of the students and their family income level at the level of $p<0.05$ ($p=0.23$) for the overall Internet addiction scale. When the subscales of the scale were examined, no significant difference was observed in all of the subscales at the level of $p<0.05$. No significant difference was determined between Internet addiction of the students and the monthly income level of their families.

The fact that Internet access is cheap and comfortable for individuals from all socio-economic levels can be shown as the reason why there was no significant difference between Internet addiction and the families' monthly income levels. This result supports most of the results in the literature conducted in terms of the variable of family monthly income level. According to the study by Song (2003) and Balta and Horzum (2008), it was found that there was no correlation between the Internet addiction and socio-economic level. Bakken et al. (2009) also found no significant difference between the income level and Internet addiction. Esen (2010), İnan (2010), Gençer (2011), Beşaltı (2016), Ceyhan (2016) and Dalgalı (2016) have also found similar results.

In the literature, it is possible to see studies contrary to the findings from the present research. In the study by Yılmaz (2013) it was found that students with high economic level were more Internet addicted than the students with moderate economic level. According to Şahin (2011) as the families' income level increased, the students' tendency to Internet addiction increased. Similarly, Bayraktar (2001), Batıgün and Kılıç (2011), and Sevindik (2011) also found a significant and positive difference between economic level and Internet addiction. The study by Kayri and Günüç (2016) revelaed that "the children of families with high socioeconomic levels are more likely to have Internet addiction".

## Conclusion

Based on the results obtained from the study, the following conclusions were reached.

(i) As a result of the clustering analysis conducted to investigate the Internet addiction levels of high school last-grade students, 14% of the students were in addicted Group, 42% were in the group with addiction risk and 43% were in non-addicted group.
(ii) It was determined that the students' mean scores from Internet addiction scale differed according to the variable of gender. This differentiation was observed in favor of male students. The mean scores of male students were higher than the mean scores of female students.

(iii) The family's income levels of the students were found to be mostly between 1501-3000 TL and there was no significant correlation between their mean scores of Internet addiction scale.

The following recommendations may be given in accordance with the findings and results obtained from this study:

(i) When considering that 42% of the students were involved in the risk group, high school students should be informed about Internet addiction in both information courses and in other related courses and necessary contents can be added into these courses.
(ii) Families and children can be aware of addiction through various channels using the developing technological possibilities and mass media in order to stand out that the Internet addiction has an important place like other substance addiction.
(iii) Although high school students are open to new ideas and innovations, it is generally accepted that they do not have enough experience to question the validity of these ideas and innovations. Therefore, parents should limit and guide theInternet use of their children.
(iv) Parents should be informed about the family protection programs and the necessary support for the effective use of the program should be provided by the relevant institutions.
(v) This study was carried out with high school students studying in Yeşilyurt District of Malatya city and similar studies can be conducted in other regions with larger population and sample.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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# Investigation of the imagery and creativity of the 7th grade students using guided discovery method

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**The aim of this study is to investigate the imagery and creativity of the 7th grade students using guided discovery method. The research group was made 77 (age=12.7922+0.52158) 7th grade students, 37 females and 40 males studying in Imam Hatip Secondary School, Konya province, Ereğli county. To achieve the purpose of the research, adaptation-innovation inventory creativity scale and sport imagery questionnaire scale were used for data collection. Experimental design consisting of pre-test and post-test was used in the research during the research. Students were given experimental work for 10 weeks. In the analysis and assessment of the data, Kolmogorov Smirnov test, paried samples t test and two Way Anova for mixed measures test, were used and significance was taken as p<0.05. For the evaluation of the data and the determination of the calculated values, SPSS package program was used. As a result of this study; there was a significant difference between level for imagery and creativity of the 7th grade students in favor of the post-test according to the guided discovery method. It was found that the level of imagination and creativity of secondary school students participating in the experimental study showed a significant difference after the experiment; that is, in different treatment groups the repeated effects of the factors of repeated measures on imagination and creativity were meaningful.**

**Key words:** Guided discovery, creativity, imagery.

## INTRODUCTION

With the advances in technology as well as the rapid advances in science, the importance of physical education in human life has gradually increased and physical education has become an important area where the goals of physical education can be gained. Physical education is an important discipline within our education system that enables individuals to develop physically, mentally, emotionally and socially (Sunay and Tuncel, 1998). It is thought that physical education aims and achievements can be contributed to the individual's own life by using a good and effective teaching method. Büyükkaragöz and Çivi (1997) stated that non-methodical activities produce random and random results, but that if the appropriate and good method is chosen, it will be

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possible to reach the targets in a short time.

Tamer and Pulur (2001), stated that a good physical education and sports teaching method is a method that is suitable for the characteristics of teaching activity and enables all students to participate and move to the highest level of activity. It can be said that the directed invention method is one of these methods. Since with the directed invention method, students can perform mental activities in the analysis, synthesis and evaluation stages at the highest level (Temel and Avşar, 2008).

In this method, the teacher asks a variety of questions to guide students to a predetermined goal (movement, concept, principle, etc.). He asks them one after another, observing a meaningful sequence. Before the students answer one question, another question is not passed. Thus, the teacher guides the students patiently and skillfully in finding the right answer (Tamer and Pulur, 2001). The essence of this method is to create a cognitive discomfort in the student or athlete, and the student or athlete needs to get rid of this situation and find solutions (http://www.bedenegitimci.org).

According to Hançerlioğl (2000), it creates a form of creative thinking that brings new solutions to problems, seeks innovation, and creates inventive, original thoughts. Creativity, on the other hand, can be defined as creating new concepts or thoughts with our observations, knowledge, experience or thoughts from the relationships between the existing concepts (Yıldırım, 1998).

The process of creativity is evaluated as “making and being” by adding the new experiences to the old experiences and by using the information obtained previously (Sternberg, 2005). Creativity, in more detail, is to break down existing patterns, to be open to the lives of others, to go out of the ordinary, to take a step towards the unknown, to break the imposed line of thought and to create a new line of thought to provide a different alternative solutions to a problem, to follow the path of others to find something new that leads to other things, to establish a new relationship, to put forward a new idea, to invent an new technique or method, and to find a tool or device that is useful to people (Rıza, 1999).

Imagination, which is an event related to the will that is also used in the revitalization of a technique or the repetition of it, is also applied to sporting skills (White and Hardy, 1998, cited; Elçi, 2014). Imagination is a way of thinking and imagination has creativity. In the case of free thinking, images come to life in memory one after another.

Images or designs are further abstracted, joined together, subtracted, simulated, their qualities changed, new formations and syntheses occur, which is the event of creative thought. To achieve this, the stored information and wealth of life in the brain is used (Erkuş, 1994, cited; Ağılönü, 2014).

Parallel with the level of development of societies, there is a differentiation in the needs of individuals. Teaching programs is also a factor affected by this change.

Nowadays it is seen that the multi-faceted development of individuals is at the forefront of the teaching programs. In the restructured curricula, the students are expected to learn by doing, living and practicing (Şirinkan and Erciş, 2009). The participation of more sensory organs of the students in the learning process will increase the permanence and effect of learning at that rate. The active participation of students in physical education and sports courses in the curriculum, finding the applications by designing themselves, and the use of measurement and evaluation tests that can control themselves will increase the efficiency of the student in multidimensional development (Şirinkan and Erciş, 2009). In scientific studies, it was found that the methods in which the students were active are more effective. Significant results were obtained in determining the effect of student-centered methods on achievement and retention in Demirhan's skill learning in sports (Şenışık et al., 2007; cited; Şirinkan and Erciş, 2009).

Mosston and Ashworth (2008) conducted a number of international researches on teaching styles and compared these styles with each other. The findings of these studies have also produced various results (Papaioannou et al., 2012; Kolovelonis et al., 2011; Zeng, et al., 2009, cited in Saraç and Muştu, 2013). Other literatures from scientific studies, such as Böke (2016), were reviewed. As a result of the study on the effect of using different special teaching methods on the cognitive, affective and psychomotor behaviors of secondary school 7th grade students in physical education classes, it has been seen that the most effective method for psychomotor field development is exercise method. The most effective methods for cognitive field development are self directed methods and invention methods. And the most effective method for affective field development is participation method.

In her research, Yıldız stated that the methods that teachers prefer more in physical education classes are paired work, command and practice methods; while the least preferred methods of teachers were personal student design, directed invention and self-learning methods (Yıldız, 2012, cited in Böke, 2016).

Çelik (2011), in his study, investigated the effectiveness of different teaching methods in basketball teaching on the 6th grade students. The researcher examined the cognitive, affective and psychomotor scores of the students. When the research results were examined and the students' development in the cognitive field examined, it was revealed that the directed invention method shows a higher development than the command method (Sural, 2015). The method of invention, which is guided by the teaching methods used in physical education and sports, is seen as an important concept in the development of high-level mental skills of students and participation in high-level activities (Temel and Avşar, 2008). The aim of this study is to examine the effects of 7th grade students on the level of imagination and

creativity in revealing their high level cognitive skills.

## METHODOLOGY

### Research group

The research group comprised 77(age=12.7922+0.52158) 7th grade students studying in Imam Hatip Secondary School, Konya province, Ereğli county; 37 females and 40 males.

### Data collection tools

To achieve the purpose of the research, “Adaptation-Innovation Inventory Creativity Scale” developed by Kirton (1999) and “Sport Imagery Questionnaire Scale” developed By Hall and et al. (1999) adapted to Turkish by Kafkas (2011) were used for data collection.

### Research model

Figure 1 shows that students were given experimental work for 10 weeks and Table 1 shows Experimental design used in the research. Experimental design consisting of pre-test and post-test was used in the research; students were given experimental work for 10 weeks. During this time, the subjects included at the annual plan on physical education course were processed by guided discovery method. Then post-test was applied to analyze the level of development of the students' creativity and imagery.

### Analysis of data

In the analysis and assessment of the data, Kolmogorov Smirnov test, Paried Samples T Test, Two Way Anova for mixed measures test, was used and significance was taken as P<0.05 and in the evaluation of the data and the determination of the calculated values, and SPSS package program was used.

## FINDINGS

The test results were examined in Table 2. It was found that the physical education courses according to the directed invention method showed a significant difference in the creativity levels of 7th grade students before and after the experiment (t:-11.211, p<0.05). As a result of this difference, the creativity pre-test score mean ($\bar{x}$=94.88), creativity post-test mean score ($\bar{x}$=131.25) were found.

If the test results are examined in Table 3, It was found that the physical education courses conducted according to the directed invention method showed a significant difference between the 7th grade students' specific cognitive sub-dimensions before and after the experiment (t:-11.604, p<0,05). As a result of this difference; While specific cognitive pre-test point mean ($\bar{x}$=25.54), specific cognitive post-test mean score ($\bar{x}$=34.14) was found.

If the test results are examined in Table 4; It was found that the physical education courses conducted according to the directed invention method showed a significant difference between the general cognitive sub-dimensions of 7th grade students before and after the experiment (t:-9.014, p<0.05). As a result of this difference, general cognitive pre-test point mean was ($\bar{x}$=8.96) and general cognitive post-test mean score ($\bar{x}$=12.10) were found. From the test results examined in Table 5, it was found that the physical education courses conducted according to the directed invention method showed a significant difference between the 7th grade students' pre-experiment and post-experiment motivation sub-dimensions (t:-11.863, p<0.05). As a result of this difference; motivation pre-test point mean ($\bar{x}$=12.02) and motivation post-test mean score ($\bar{x}$=17.09) were found.

According to the method of the invention, which is directed according to the gender variable, the mean creativity pre-test scores of 7th grade male students were 95,9000, while the average post-test scores were 136,8500. The mean score of creativity pre-test of female students was 93,7838 and the average score of post-test was 125.2162 (Table 6).

It was found that the physical education courses conducted according to the directed invention method showed a significant difference in the creativity levels of the students before and after the experiment. (F:2.181, p<0.05). According to the basic effect of the measurement, a significant difference was found in terms of gender variable according to the mean scores of creativity pre-test and post-test of 7th grade students (F:126.161, p<0.05) (Table 7). From Table 8, according to the method of the invention directed by gender variable, the mean of the 7th grade male students' specific cognitive pre-test scores was 25,6500; while the average of post-test scores was 34,8250. The mean score of creativity pre-test of female students was 25,4324 and the average of post-test was 33,4054.

From Table 9 it was found that the physical education courses conducted according to the directed invention method did not show a significant difference in the level of special cognitive subscales from the pre-experiment and post-experiment imagination levels of the students (F:0.654, p>0.05). According to the basic effect of the measurement, there was a significant difference between the level of imagination of 7th grade students in terms of gender variable according to the special cognitive subscale pre-test and post-test mean scores (F:133.101, p<0.05). From Table 10, using the method of the invention directed by gender variable, the mean cognitive pre-test scores of 7th grade male students were 9,5500; whereas the mean post-test scores was 12,4750. The mean score of general cognitive pre-test of female students was 8,3243, while the mean of post-test was 11,7027.

It was found that the physical education courses conducted according to the directed invention method did not show a significant difference in the general cognitive sub dimension levels of the students' imagination levels before and after the experiment (p> 0.05). According to the basic effect of the measurement, there was a significant difference between the level of imagination of

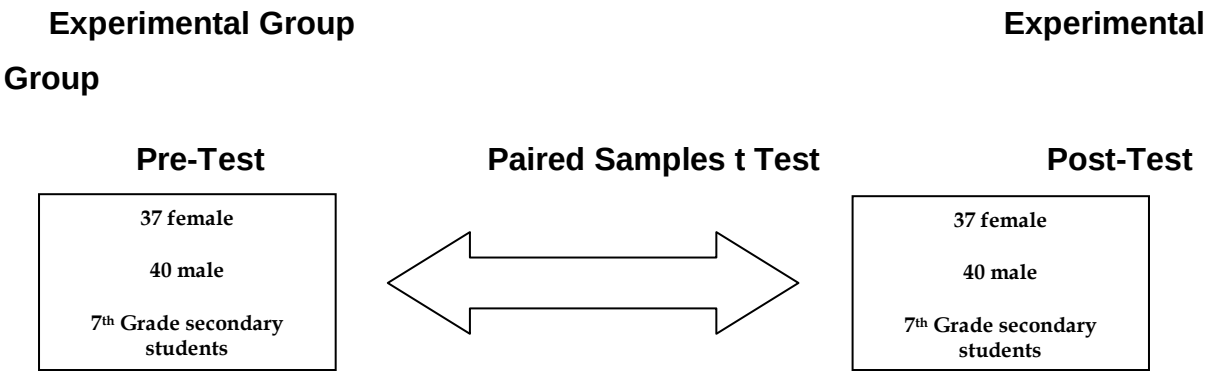


**Figure 1.** Students were given experimental work for 10 weekly.

**Table 1.** Experimental design used in research.

| Group | Pre-test | Experimental design | Post-test |
|---|---|---|---|
| Experimental group | T1<br>T2 | The subjects included at the annual plan on physical education course were processed by guided discovery method | T1<br>T2 |

T1: Kirton (1999) Adaptation-Innovation Inventory Creativity Scale; T2: Sport Imagery Questionnaire Scale.

**Table 2.** According to the guided discovery method of the 7th grade students; pre-test and post-test scores showing indicative creativity levels paired sample t test results.

| | N | Mean | Std. deviation | t | p |
|---|---|---|---|---|---|
| Creativity pre-test | 77 | 94,8831 | 24,47124 | -11.211 | 0.000 |
| Creativity post-test | 77 | 131,2597 | 18,59924 | | |

**Table 3.** According to the guided discovery method of the 7th grade students; pre-test and post-test scores showing indicative special the cognitive sub-dimension levels paired sample t test results.

| | N | Mean | Std. deviation | t | p |
|---|---|---|---|---|---|
| Special cognitive pre-test | 77 | 25,5455 | 6,02090 | -11.604 | 0.000 |
| Special cognitive post-test | 77 | 34,1429 | 4,17925 | | |

**Table 4.** According to the guided discovery method of the 7th grade students; pre-test and post-test scores showing general cognitive sub-dimension levels paired sample t test results.

| | N | Mean | Std.deviation | t | p |
|---|---|---|---|---|---|
| General cognitive pre-test | 77 | 8,9610 | 2,97994 | -9.014 | 0.000 |
| General cognitive post-test | 77 | 12,1039 | 2,11252 | | |

7th grade students in terms of gender and general cognitive sub-dimension pre-test and post-test scores (F:4.641, p<0.05) (Table 11).

In line with the invention method guided by gender variable, the mean motivation pre-test scores of 7th grade male students were 12,8000, while the average

**Table 5.** According to the guided discovery method of the 7th grade students; pre-test and post-test scores showing level of sub-dimension motivation paired sample t test results.

| | N | Mean | Std. deviation | t | p |
|---|---|---|---|---|---|
| Motivation pre-test | 77 | 12,0260 | 3,37940 | -11.863 | 0.000 |
| Motivation post-test | 77 | 17,0909 | 2,60153 | | |

**Table 6.** According to the gender variable, to the guided discovery method of the 7th grade students; descriptive statistical Analysis results about the level of creativity.

| | Gender | Mean | Std. deviation | N |
|---|---|---|---|---|
| Creativity pre-test | Male | 95,9000 | 27,90074 | 40 |
| | Female | 93,7838 | 20,45746 | 37 |
| Creativity post-test | Male | 136,8500 | 15,94791 | 40 |
| | Female | 125,2162 | 19,55780 | 37 |

**Table 7.** According to the gender variable, to the guided discovery Method of the 7th grade students; about the pre-test and post-test creativity level of two-way anova test results.

| Source | Sum of squares | df | Mean square | F | p |
|---|---|---|---|---|---|
| Between groups | 40999,714 | 76 | | | |
| Group(gender) | 1816,964 | 1 | 1816,964 | 3,478 | 0.046 |
| Error | 39182,750 | 75 | 522,437 | | |
| Within groups | 81153,951 | 77 | | | |
| Assumed pre-test and post test | 50350,912 | 1 | 50350,912 | 126,161 | 0.000 |
| Group* Assumed | 870,548 | 1 | 870,548 | 2,181 | 0.044 |
| Error | 29932,491 | 75 | 399,100 | | |
| Total | 122153.665 | 153 | | | |

**Table 8.** According to the gender variable, to the guided discovery method of the 7th grade students; descriptive statistical analysis results about the pre-test and post-test level of special cognitive subscales.

| | Gender | Mean | Std. deviation | N |
|---|---|---|---|---|
| Special cognitive pre-test | Male | 25,6500 | 5,79810 | 40 |
| | Female | 25,4324 | 6,33132 | 37 |
| Special cognitive post-test | Male | 34,8250 | 4,67337 | 40 |
| | Female | 33,4054 | 3,48377 | 37 |

post-test scores were 17,4250. On the other hand, the average pre-test score of female students was 11,1892 and the mean post-test score was 16,7297 (Table 12). From Table 13, it was found that there was a significant difference between the pre-test and post-test motivation scores of the 7th grade students of physical education courses according to the gender-directed invention method (F:1.150, $p<0.05$). There was a significant difference in the motivation subscale of the 7th grade students according to the gender variable according to the pre-test and post-test mean scores of the physical education course according to the directed invention

**Table 9.** According to the gender variable, to the guided discovery method of the 7th grade students; about the pre-test and post-test level of special cognitive subscales two-way ANOVA test results.

| Source | Sum of squares | df | Mean square | F | p |
|---|---|---|---|---|---|
| Between groups | 2476,291 | 76 | | | |
| Group(gender) | 25,759 | 1 | 25,759 | 0.788 | 0.377 |
| Error | 2450,501 | 75 | 32,673 | | |
| Within groups | 4432,224 | 77 | | | |
| Assumed pre-test and post test | 2825,964 | 1 | 2825,964 | 133,101 | 0.000 |
| Group* Assumed | 13,886 | 1 | 13,886 | 0.654 | 0.421 |
| Error | 1592,374 | 75 | 21,232 | | |
| Total | 6908.515 | 153 | | | |

**Table 10.** According to the gender variable, to the guided discovery method of the 7th grade students; descriptive statistical analysis results about the pre-test and post-test level of general cognitive subscales.

| | Gender | Mean | Std. deviation | N |
|---|---|---|---|---|
| General cognitive pre-test | Male | 9,5500 | 2,55152 | 40 |
| | Female | 8,3243 | 3,30029 | 37 |
| General cognitive post-test | Male | 12,4750 | 2,28695 | 40 |
| | Female | 11,7027 | 1,85390 | 37 |

**Table 11.** According to the gender variable, to the guided discovery method of the 7th grade students; about the pre-test and post-test level of general cognitive subscales two-way ANOVA test results.

| Source | Sum of squares | df | Mean square | F | P |
|---|---|---|---|---|---|
| Between groups | 658,338 | 76 | | | |
| Group(gender) | 38,364 | 1 | 38,364 | 4,641 | 0.034 |
| Error | 619,974 | 75 | 8,266 | | |
| Within groups | 737,56 | 77 | | | |
| Assumed pre-test and post test | 381,846 | 1 | 381,846 | 80,959 | 0.000 |
| Group* Assumed | 1,975 | 1 | 1,975 | 1,419 | 0.519 |
| Error | 353,739 | 75 | 4,717 | | |
| Total | 1395,898 | 153 | | | |

method (F:4.,804, p<0.05).

## DISCUSSION

In this study examined the effect of 7th grade students' level of imagination and creativity in revealing high level cognitive skills. It was found that the physical education courses according to the directed invention method showed a significant difference in the creativity levels of 7th grade students before and after the experiment. In the guided method of invention, the ability to direct the student to the correct answer by asking the questions prepared beforehand, from simple to complex can be discussed. It can be said that there is a problem in the minds of students in the face of the questions asked. In order to solve this problem, according to their readiness, the students can either explain an existing situation or create a new situation. It can be said that the creation of a new or different concept is related to creativity. When the related literature is examined, it is seen that there are many studies on creativity, and no studies dealing with creativity have been found with the directed invention method. For example, Kadayıfçı (2008), who conducts research on creativity, examines the effects of a teaching model that supports creative thinking on the conceptions, images, divergent thoughts and scientific creativity of 9th grade chemistry students in comparison to traditional teaching approach. It is stated that the average scores are in the range of 60-70 points (Kılıç and Tezel, 2012).

**Table 12.** According to the gender variable, to the guided discovery method of the 7th grade students; descriptive statistical analysis results about the pre-test and post-test level of general motivation subscales.

| | Gender | Mean | Std.deviation | N |
|---|---|---|---|---|
| General motivation pre- test | Male | 12,8000 | 3,12311 | 40 |
| | Female | 11,1892 | 3,48678 | 37 |
| General motivation post-test | Male | 17,4250 | 2,30815 | 40 |
| | Female | 16,7297 | 2,87372 | 37 |

**Table 13.** According to the Gender Variable, to the guided discovery method of the 7th grade students; about the pre-test and post-test level of general motivation subscales two-way ANOVA test results.

| Source | Sum of squares | df | Mean square | F | P |
|---|---|---|---|---|---|
| Between groups | 848,974 | 76 | | | |
| Group(gender) | 51,108 | 1 | 51,108 | 4,804 | 0.031 |
| Error | 797,866 | 75 | 10,638 | | |
| Within groups | 1526,459 | 77 | | | |
| Assumed pre-test and post test | 993,121 | 1 | 993,121 | 141,798 | 0.000 |
| Group* assumed | 8,056 | 1 | 8,056 | 1,150 | 0.287 |
| Error | 525,282 | 75 | 7,004 | | |
| Total | 2375.433 | 153 | | | |

This finding supports the research result. Again, Öztunç (1999), in his study, examined the relationship between the fifth grade students 'creative thinking abilities and their families' educational and economic status and their attitudes towards their children. It was concluded that the high level of parents' education was effective on the creative thinking of children. This study supports the research finding of others (Öztunç 1999; Kılıç and Tezel, 2012). Yılmaz (2008), the successful and unsuccessful seventh grade students' reading strategy levels and creativity levels used in the Turkish course aims to examine the relationship between; at the level of creativity, it was found that the average of successful students' creativity scores were higher than the average of unsuccessful students (Kılıç and Tezel, 2012).

It was found that the physical education courses conducted according to the directed invention method showed a significant difference between the 7th grade students' specific cognitive sub-dimensions before and after the experiment. The special cognitive dimension is thought to be more effective in learning a technical skill. When a technical skill is taught using the directed invention method, students can experience meaningful learning by understanding the technique or logic by adopting the event. It can be said that studies dealing with specific cognitive sub-dimensions are possible in literature. This finding is consistent with that of Ille and Cadopi (1999) who used the cognitive imagery of young athletes gymnastics to increase the memory range of gymnastics performance and thus showed that the performance of gymnasts perform more accurately (Tiryaki and Kızıldağ, 2012). Weigand et al. (2007), examine the effect of the athletes use of imagination competition level (master / beginner) and skill type (open / closed), and found that it has effect on the competition level and skill type. The analyses showed that master athletes used their Special Cognitive and General Cognitive imagery more than novices (Elçi, 2014).

It was found that the physical education courses conducted according to the directed invention method showed a significant difference between the general cognitive sub-dimensions of 7th grade students before and after the experiment. It can be stated that cognitive dimension is effective in learning complex and difficult skills. By using the directed method of invention, a complex situation is revealed and the student is asked to train his / her high level cognitive skills and he / she can be said to reach a solution.

General cognitive sub-dimension studies are encountered in the literature. For example; In the study conducted by Abma et al. (2002) in order to examine how high and low level athletes and field athletes differ in their imagination content and imagination abilities, profile analyzes showed that each athlete with high degree of confidence in sports has less self-confident athletes category. Motivational General Stimulation, Motivational General Mastery, Motivational Special Imagination, General Cognitive and Cognitive imagery) were found to use significantly more (Elçi, 2014).

It was found that the physical education courses

conducted according to the directed invention method showed a significant difference between the 7th grade students' pre-experiment and post-experiment motivation sub-dimensions. Motivation can be defined as the desire to do something or the things that enable us to act. In the directed invention method, it can be stated that students are activated by asking questions. Students can be mentioned that their self-confidence develops, their motivation increases and they are happy with the appreciation of the teacher. In the literature, it is possible to come across studies dealing with motivation. For example, Martin and Hall (1995), a study parallel with this study, found that golfers who started to use visualization were better connecting to training programs than other groups that did not use visualization (Tiryaki and Kızıldağ, 2012).

## Conclusion

Paivio (1985) concluded that athletes using Motivational Special Imagination are better at maintaining goal-related tasks (such as training). In a study by Feltz and Riessinger (1990), it was found that the self-efficacy perceptions of athletes using this type of imagination increased (Aldemir et al., 2014).

According to the method of the invention, which is directed according to the gender variable, the average creativity pre-test scores of 7th grade male students were 95,9000, while the average post-test scores were 136,8500. However, the average score of creativity pre-test of female students was 93.7838, the average score of post-test was 125.2162.

In other words, it has been observed that both male and female students have improved creativity scores. It can be said that there is an improvement in the creativity of male and female students because of the continuous mental activity in the face of the questions and the constant thinking about new solutions. Since it can be stated that creativity requires high level of mental activity creativity studies are available in literature. Kılıç and Tezel (2011), from their research on students' scientific creativity levels, significant differences were found between the groups according to gender, the type of school they studied (public school, private school), parents' education, family monthly income, use of tools and equipment at home and having their own room (Kılıç and Tezel, 2012). In the study of Gülel (2006), which aims to determine the creativity levels of prospective classroom teachers according to their own perceptions, it has been found that the creativity levels of female students studying at Pamukkale University Faculty of Education Classroom Department are higher than male students (Kılıç and Tezel, 2011). Özben and Argun (2005) study on the students of Dokuz Eylül University Faculty of Education compared the creativity levels of university students according to some variables. According to the findings of the study, it was found that the level of fluency and flexibility was higher than the creativity levels of girls compared to boys. In the originality dimension, no differentiation was found between boys and girls (Kılıç and Tezel, 2012). The study findings do not show parallelism with the sample group and is thought to be due to the fact that the study area.

It was found that the physical education courses conducted according to the directed invention method showed a significant difference in the creativity levels of the students before and after the experiment. According to the basic effect of the measurement, a significant difference was found in terms of gender variable according to the mean scores of creativity pre-test and post-test of 7th grade students. Looking at the gender variable, it has been found that the directed invention method improves the creativity of both boys and girls.

From this method, both girls and boys can be said to have made a lot of mental effort. Even if there is a difference in the development of girls and boys during this period, it can be stated that the development levels are similar when viewed from the perspective of creativity.

It is seen that these standards will not be possible only with physical education practices focused on skill development. The importance of the harmony between teaching processes (aim, application, measurement and evaluation) in achieving teaching objectives has been revealed in many previous studies (Cohen, 1987; Anderson, 2002; James et al., 2008, İnce and Hünük, 2010).

According to the method of the invention directed by gender variable, the average of the 7th grade male students' specific cognitive pre-test scores was 25,6500, while the average of post-test scores was 34,8250. The mean score of creativity pre-test of female students was 25,4324 and the average of post-test was 33,4054. For higher cognitive dimensions of male students, it can be said that male students learn more of special cognitive technique. In this age, it can be said that male students are more oriented towards technical skills. The reason for the increase in the creativity of female students; it is thought that girls give more importance to mental processes rather than practice. In Aslan (2014) study, the effect of athletes in different age categories on depression levels and imagery styles, there was no significant difference in cognitive imagery scores according to gender. There was a statistically significant difference in motivational imagery scores according to gender. A statistically significant difference was found in terms of motivational general arousal scores in terms of gender. It was observed that there was no significant difference in terms of motivational general mastery scores according to gender (Aslan, 2014).

It was found that the physical education courses conducted according to the directed invention method did not show a significant difference in the level of special

cognitive subscales from the pre-experiment and post-experiment imagination levels of the students ($p>0.05$). According to the basic effect of the measurement, there was a significant difference between the level of imagination of 7th grade students in terms of gender variable according to the special cognitive subscale pre-test and post-test mean scores ($p<0.05$).

Regarding imagination, mental stimulation will be discussed as well. In the directed invention method, before answering the questions, male and female students first create some images in their minds. They can be said to express their dreams using their creativity. In the light of this study, Abma et al. (2002), profile analyses high and low level athletes confident in track and field athletes in order to examine how they differ in imagery content and imagination abilities, profile analysis of high degree of self-confident athletes in the sport of less self-confident athletes for each category of imagination (Motivational General Stimulation General Mastery, Motivational Special Imagination, General Cognitive and Cognitive Imagination) (Erdoğan, 2009).

According to the method of the invention directed by gender variable, the average cognitive pre-test scores of 7th grade male students were 9,5500; whereas the average post-test scores were 12,4750. The average score of general cognitive pre-test of female students was 8,3243, while the average of post-test was 11,7027. The general cognitive dimension is the development of performance, technical or tactical skills. It can be said that female and male students have increased their general cognitive scores to a level where they can make technical, tactical or performance evaluations. It was found that the physical education courses conducted according to the directed invention method did not show a significant difference in the general cognitive sub-dimension levels of the students' imagination levels before and after the experiment ($p>0.05$).

According to the basic effect of the measurement, there was a significant difference between the level of imagination of 7th grade students in terms of gender and general cognitive sub-dimension pre-test and post-test scores. It can be said that female and male students use imagination skills to develop new strategies and tactics when evaluating any performance, setting up games. There are a limited number of studies on imagination in the literature. Ağılönü (2014), in the study of dreaming and problem solving skills of athletes engaged in different sports branches, the cognitive imagery values of the imagination sub-dimensions and the values of gender, age and sports year, motivational special imagery values and the year of doing sports and cognitive imagery values, cognitive imagination and motivational special imagery, motivational general mastery values with gender, year of doing sports, a positive significant relationship between cognitive imagery, motivational special imagery and motivational general imagery variables were discovered; and there was a negative correlation between motivational general imagery values and gender variables (Ağılönü, 2014).

According to the invention method guided by gender variable, the average motivation pre-test scores of 7th grade male students were 12,8000; while the average post-test scores were 17,4250. On the other hand, the average pre-test score of female students was 11,1892 and the average post-test score was 16,7297. Increased general motivation scores of female and male students according to the directed invention method can easily solve more complex skills, develop new tactics, and adopt a multi-faceted way of thinking.

It was found that there was a significant difference between the pre-test and post-test motivation scores of the 7th grade students of physical education courses according to the gender-directed invention method ($p<0.05$). There was a significant difference in the motivation subscale of the 7th grade students according to the gender variable according to the pre-test and post-test mean scores of the physical education course consistent with the directed invention method ($p<0.05$). Motivation was also expressed as the desire to do something; as a reason for the significant difference in terms of gender variable and in terms of both sub-dimensions, it is said that the students' self-confidence increases with the correct answers to the questions and accordingly they are more willing to the subject and the course. It is possible to come across the literature on motivation. Kulinna and Cothran (2003) found that the most commonly used styles of teachers were teacher-centered and the least used styles were learner-centered styles. While teaching centered styles scripts and exercises, learner-centered styles are self-teaching and student-initiated methods. In the country, in the field of physical education, İnce and Hünük (2010) examined the teaching styles used by experienced physical education teachers and their perceptions about these styles by adapting the tool prepared by Kulinna and Cothran (2003) to Turkish and as a result of the research, the most commonly used styles were instructed. This was the least used styles learner-centered (student initiation and self-teaching) (Saraç and Muştu, 2013).

Conclusively, there was a significant difference between the level of imagination and creativity in favor of the post-test according to the directed invention method of 7th grade students. It was found that the level of imagination and creativity of middle school students participating in the experimental study showed a significant difference from before the experiment, being in different process groups and the repeated effects factors had a common effect on imagination and creativity. This finding was found to have different effects on increasing the level of imagination and creativity of 7th grade students who participated in the program according to gender variable. The creativity and imagination scores of male students increased compared to the pre-experiment. Physical education courses, using guided

invention method, contributes to the development of imagination and creativity levels in revealing high level cognitive skills of students. In the directed invention method according to the level of readiness of students, while expressing a new concept or skill, can re-synthesize an existing situation and create a new concept.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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# The effect of differential learning method on the international tennis number level among young tennis player candidates

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**The objective of the study is to assess the effects of Differential Learning (DL) approach on learning the tennis stroke techniques, retention of skills, and improving the mobility time of young tennis player candidates in comparison with the traditional teaching methods and, accordingly, to present the teaching methods that are suitable for a more effective development in tennis education. It is thought to be one of few studies on tennis education and determining the retention, although there are studies on DL. Twenty-four (12 girls-12 boys) volunteers doing high school-level tennis courses in İstanbul province were involved in this study (15.00±0.00 years, 1.65±0.06 m, 63.46±10.64 kg and body mass index 23.26±2.91 kg/m$^2$). One of the groups was named DL group, whereas the other group was named control group (6 girls and 6 boys in each). In both groups, 90-min trainings (three days/week) were performed for 10 weeks. In the present study, the International Tennis Number (ITN) test was used in determining the ITN scores and mobility times. The mobility test of ITN was modified using the Fitlight TrainerTM device according to the expert opinion. According to the results of the study, it was determined that, while the DL method is more effective than traditional training methods in learning tennis strokes and retention of learning, no statistically significant difference was observed in mobility time for both groups.**

**Key words:** Differential learning, traditional learning, tennis skill, mobility.

## INTRODUCTION

In recent years, various studies were carried out on the learning models that might enhance the classical learning approaches within the sports branches' own skill education for the athletes (Henz and Schöllhorn, 2016). In order to determine how the sports education has been developed, the studies recommended analyzing the education practice (Canadas et al., 2018). Despite that, there still are few studies focusing on the most appropriate training practices and methods aiming to enhance the athletic performance (Rivera and Badillo, 2019).

In the sports branches, in which equipment, racket, and such instruments are used, it might be difficult to maintain the quality in repeating the skills since there may be

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different requests regarding the implementation of methods incorporating constant variability during the game. Different situations may be observed. For this reason, in order for the learning to be effective and persistent, the teaching methods should also incorporate the variability (Frank et al., 2008).

In different studies carried out on this subject or various sports branches, it was emphasized that the practices incorporating differences improve the motor learning rates more than the repetitive learning programs do. Among these studies, the remarkable ones have reported the efficiency of differential learning in football (Schöllhorn et al., 2004; Hegen and Schöllhorn, 2012), athletics (Jaitner et al., 2003; Beckmann and Gotzes, 2009; Beckmann and Schöllhorn, 2006), handball (Wagner and Müller, 2008), basketball (Schönherr and Schöllhorn, 2003; Lattwein et al., 2014), volleyball (Römer et al., 2009), ice skate (Savelsbergh et al., 2010), hockey (Beckmann et al., 2010), and tennis (Humpert and Schöllhorn, 2006).

Moreover, the retention of learning is also important. In order to achieve the long-term retention, certain physiological changes should be created in the body during the exercise (Saltin and Rowell, 1980; Boström et al., 2013; Alleman et al., 2015). The priority here is to protect the mechanisms that are responsible for the homeostasis. Thus, the retention of long-term adaptation processes in the body will be achieved (Boström et al., 2013). Similarly, the learning process will be accelerated and given retention by increasing the perception level of athlete, who will learn. Nowadays, the rate of participation in the tennis, which is the most popular among the racket sports, rapidly increases and, consequently, the competition also increases (Pluim et al., 2007). It became important to support this increase with the training practices.

The tennis is a multifaceted sports branch, which requires high level of technical, tactical, psychological, and physical skills. Although the technical skills are the dominant factor, the physical fitness, agility, speed, strength, and aerobic and anaerobic capacity of athletes are very important (Fett et al., 2017; Reid and Schneiker, 2008; Fernandez et al., 2006). In tennis, the successful performance depends on the combination of speed, accuracy, and agility. Thanks to the new training approaches implemented in improving these physical characteristics, the technical skill trainings reached a higher speed levels during the game (Fernandez et al., 2013). Especially service strokes at high speed became the key factor for winning the game (Fett et al., 2017; Kovacs, 2007; Reid and Schneiker, 2008). A non-fast stroke would give the opponent an advantage even if it is a technically correct stroke (Landlinger et al., 2012; Carlton et al., 2006).

The fact that the tennis is a dynamic branch of sports

requires the athletes to rapidly change their positions in different directions and to accelerate and decelerate. In order to be able to have a good stroke, the athletes must be at the right point of the court. From this aspect, the speed and mobility are very important for reaching the ball (Ferrauti et al., 2002). In order to achieve this fast change of position, the role of mobility, which is one of the important components of physical fitness, in the trainings should be carefully adjusted (Paul et al., 2011). Mobility is defined as the athletes' ability to adapt to changing conditions, to react quickly, to adjust their body positions and to apply skills most efficiently (Ratamess, 2012; Brown and Ferrigno, 2005). Another factor playing role in the sufficiency of mobility is the cognitive functions. The term "mobility", defined as the ability of independently moving in the environment, also requires a complex control mechanism that can adapt to the internal and external changes (Brustio et al., 2018; Azadian et al., 2016; Shumway-Cook and Woollacott, 2012). As can be understood from these definitions, the term "mobility" is one of very important prerequisites of the effective performance of skills.

Within the scope of these factors, meeting the multifaceted demands regarding the physical and skill characteristics of the tennis is the key factor for success. Within this context, it became very important to employ the scientific and innovative methods in achieving the desired level of performance. One of these methods is the differential learning (Schöllhorn, 2000). In this method, the diversity in a method is considered rather than the repetition for multiple times. The Differential Learning Method is based on adapting to the random instruments, ground, and body motions to the skill in order to confuse the mind, avoiding the repetition during the training, and avoiding corrective feedbacks (Schöllhorn et al., 2012). The results obtained by integrating random tools, grounds and movements into the skill in the learning process are at least as successful as the results obtained in traditional teaching methods. Moreover, it was observed that the skill learning gains are at a higher level in the differential learning approach (Müller et al., 2009).

The objective in the present study is to evaluate the effect of differential learning approach on the skill education of tennis player candidates in comparison to the traditional teaching methods. The first hypothesis is that the differential learning method would have positive effect on the tennis stroking techniques and mobility scores. The second hypothesis is that the increases in ITN scores would be more effective than in the traditional teaching methods. The third hypothesis is that the retention effect of differential learning approach would be higher.

## MATERIALS AND METHODS

### Participants

Twenty four (12 girls and 12 boys) volunteers doing high school-

**Table 1.** Descriptive statistics by group (mean ± SD).

| Group | Age (years) | Body height (m) | Body mass (kg) | BMI (kg/m$^2$) |
|---|---|---|---|---|
| DLG (n = 12) | 15.00 ± 0.00 | 1.66 ± 0.06 | 62.72 ± 11.68 | 22.60 ± 3.06 |
| CG (n = 12) | 15.00 ± 0.00 | 1.64 ± 0.05 | 64.20 ± 9.96 | 23.90 ± 2.72 |
| Total (n = 24) | 15.00 ± 0.00 | 1.65 ± 0.06 | 63.46 ± 10.64 | 23.26 ± 2.91 |

DLG = Differential Learning Group; CG = Control Group; BMI = Body Mass Index.

level tennis courses in Istanbul Province were involved in this study. According to the pre-test results, the participants were divided into 2 homogeneous groups (6 girls and 6 boys in each). One of the groups was Differential Learning Group (DLG), whereas the other group was the control group (CG). The demographic and anthropometric characteristics of the participants are presented in Table 1. The body heights of participants were measured using 0.1cm-sensitive stadiometer (Holtain), whereas the body weight was measured with lightweight clothes and bare feet by using 0.1kg-sensitive digital bascule (Omron) (Sanz et al., 2019).

The families and school principles of the participants were informed about the study protocol and their written consents for the participation were obtained. Moreover, the consents of the children were also obtained and the volunteer consent form prepared in accordance with Helsinki Convention was. All the procedures were approved by the Ethics Council of Marmara University's Faculty of Medical Sciences (09.01.2017-1).

### Measurements and procedures

In both groups, 90 min trainings (three days per week) were performed in the sports hall of high school for 10 weeks. Following the warm-up, the tennis training was performed with differential learning method in DLG, whereas the traditional methods were used in CG. In differential teaching practices, the differential principles of Schöllhorn were adopted and the process was constructed on adapting to the random instruments, ground, and body motions to the skill in order to confuse the mind, avoiding the repetition during the training, and avoiding corrective feedbacks (Schöllhorn, 1999). Different balls (crazy ball, crumpled paper, ping-pong ball etc.), different rackets (brush handle, soccer ball, funnel, etc.), different floors (on balance board, on the gymnastic cushion, on the cobblestone ground etc.) and different body movements (arms are extended in different directions, on one leg, bending the body in different directions, etc.) were used. In the traditional teaching group, a standard training incorporating multiple repetitions and corrective feedbacks was performed. At the end of training, the cooling session was performed at the same duration and with the same content in both groups.

The tests were performed on a standard tennis court (firm ground) in the morning hours in the weekends. The athletes performed no tiring physical activity within last 24 h before the tests and consumed no food or beverage other than water in the last 3 h. All the tests and measurements were performed in the same day and 15 min warm-up and stretching were performed before the tests. The pretest was performed before the tests, the posttest was performed at the end of 10-week training process, and the retention test was performed after 2 weeks from the end of study. The athletes were informed about the tests and study protocols and the volunteer consent form prepared in accordance with the Declaration of Helsinki was filled out.

### Tennis stroke test

The tennis strokes were measured and scores using the International Tennis Number (ITN) test. ITN is a practice introduced by ITF (International Tennis Federation) in order to determine the levels of tennis players throughout the world. While performing this test, rather than the technical aspects of tennis strokes, the consistency, accuracy, depth, and strength in Service, Ground, and Volley Stokes are analyzed among 5 game situations (International Tennis Federation, 2004). ITN score refers to the score calculated by summing the total points obtained from tennis strokes and the total score of mobility.

### Mobility test

In order to measure the tennis-specific mobility, the mobility test of International Tennis Number (ITN) was modified and implemented according to the opinions of experts (Figure 1). In the ITN mobility test, there are racket at 1$^{st}$ light and balls at the other lights and it is aimed to gather the balls on the racket in the shortest minimum time. The time is measured using a chronometer (International Tennis Federation, 2004). Because of the risk of ball falling and because of the use of chronometer, it is thought that this test is not suitable for the scientific studies. For this reason, a Fitlight TrainerTM (Fitlight TrainerTM, 2019) light was placed at the each of ball locations and a new test setup was designed. The locations of lights are as seen in the standard tennis court. The beginning point was the middle of rear line; each of the lights turns on according the order specified and then manually turned off: 1 – 2 – 1 – 3 – 1 – 4 – 1 – 5 – 1 – 6 – 1. The time begins when the light 1 is turned off. The light 1 turns on whenever a light is turned off and the time stops when the light 1 is turned off last time. The time is recorded as second. The total time is recorded as second in the ITN mobility test and there is a score system corresponding to every length of time. In the present study, the results of mobility measurements were expressed as Mobility Time (seconds) in the analyses and the scores corresponding to the seconds were used in calculating the total ITN score (Figure 2).

### Statistical analysis

The data analyses were performed using SPSS 16.0 package software (SPSS Inc., Chicago, IL, USA). The OneWay ANOVA test was used in analyzing the intergroup differences, whereas the Repeated Measures test was used for the differences between the pretest, posttest, and retention test scores of groups. In interpreting the statistical analyses, the level of significance was set at $p<0.05$.

## RESULTS

As a result of the pretest performed at the beginning of study, it was determined that there was no statistically significant difference between the total stroke scores of the groups ($F=0.07$, $p=0.795>0.05$). However, there were statistically significant differences between the groups in

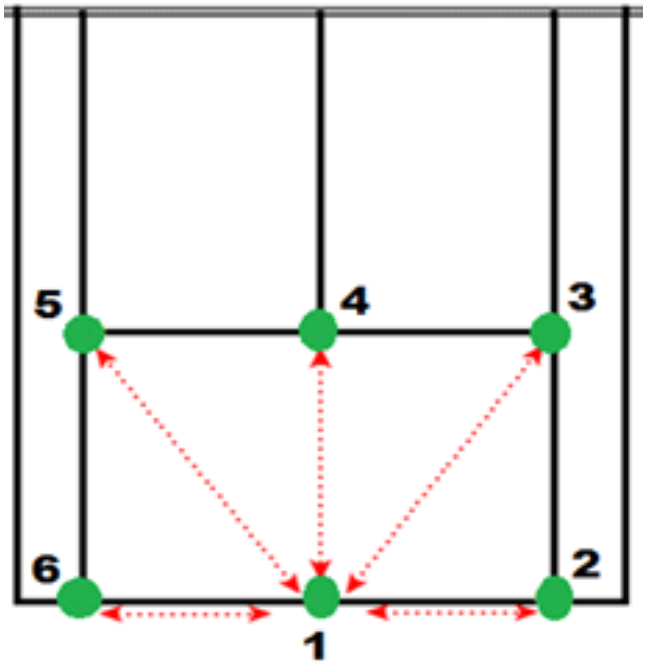


**Figure 1.** ITN mobility test.

| Time (s) | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Point** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 21 | 26 | 32 | 39 | 45 | 52 | 61 | 76 |

**Figure 2.** ITN mobility test's time and score chart (International Tennis Federation, 2004).

terms of posttest and retention test scores (F=5.24, p=0.032<0.05; F=4.99, p=0.036<0.05, respectively). As a result of repetitive tests, it was determined while evaluating the advancements within the groups that there was a statistically significant increase from pretest and posttest in the mean total stroke scores of DLG and CG groups (p=0.000<0.05). Although the increases in both groups were statistically significant, the increase in DLG group doubled the increase in CG (129.3 and 67.9%, respectively). It was determined that there was no statistically significant change between posttest and retention test scores in both groups (p=1.000>0.05) (Table 2).

In the present study, it was determined that there was no statistically significant difference between the groups in terms of mobility time pretest, posttest, and retention test scores (F=0.51, p=0.485>0.05; F=1.08, p=0.309>0.05; F=0.18, p=0.674>0.05, respectively). As a result of the repetitive tests, the advancements in the groups were examined and it was determined that, regarding the mean mobility times of DLG and CG groups, there were irregular increases and decreases from pretest to posttest and from posttest to retention test but the changes were not statistically significant (Table 3).

As a result of the pretest performed at the beginning of study, it was determined that there was no statistically significant difference between the mean ITN scores of the groups (F=0.00, p=0.958>0.05). Given the results of posttest, it was determined that there was a statistically significant difference between the groups (F=4.63, p=0.043<0.05). In the retention test, it was found that

**Table 2.** The results of ANOVA test of total stroke score pretest, posttest, and retention test and Repeated Measure test of change scores in DLG and CG groups.

| Group | | Pre-test (1) | Post-test (2) | Retention-test (3) | Repeated measures | | |
|---|---|---|---|---|---|---|---|
| | | Mean (Points) | Mean (Points) | Mean (Points) | Test | Mean differences (%) | Sig.[b] |
| DLG (n = 12) | | 45.17 ± 20.80 | 103.59 ± 27.74 | 103.92 ± 26.67 | 1 - 2 | - 129.31* | 0.000 |
| | | | | | 2 - 3 | - 0.33 | 1.000 |
| | | | | | 1 - 3 | - 130.06* | 0.000 |
| CG (n = 12) | | 47.58 ± 24.13 | 79.92 ± 22.67 | 79.33 ± 27.26 | 1 - 2 | - 67.97* | 0.000 |
| | | | | | 2 - 3 | 0.74 | 1.000 |
| | | | | | 1 - 3 | - 66.73* | 0.000 |
| ANOVA | F | 0.07 | 5.24 | 4.99 | | | |
| | P | 0.795 | 0.032* | 0.036* | | | |

*Significant difference ($p < 0.05$).

**Table 3.** The results of ANOVA test of mobility time score pretest, posttest, and retention test and repeated measure test of change scores in DLG and CG groups.

| Group | | Pre-test (1) | Post-test (2) | Retention-test (3) | Repeated measures | | |
|---|---|---|---|---|---|---|---|
| | | Mean (Second) | Mean (Second) | Mean (Second) | Test | Mean differences (%) | Sig.[b] |
| DLG (n = 12) | | 20.42 ± 2.02 | 20.08 ± 1.78 | 20.84 ± 1.75 | 1 - 2 | 1.67 | 1.000 |
| | | | | | 2 - 3 | - 3.78 | 0.080 |
| | | | | | 1 - 3 | - 2.06 | 0.943 |
| CG (n = 12) | | 21.00 ± 2.00 | 20.83 ± 1.75 | 21.15 ± 1.80 | 1 - 2 | 0.81 | 0.997 |
| | | | | | 2 - 3 | - 1.54 | 1.000 |
| | | | | | 1 - 3 | - 0.71 | 1.000 |
| ANOVA | F | 0.51 | 1.08 | 0.18 | | | |
| | P | 0.485 | 0.309 | 0.674 | | | |

*Significant difference ($p < 0.05$).

there was no statistically significant difference between the groups ($F=3.83$, $p=0.063>0.05$). As a result of the repetitive tests, the advancements in the groups were examined and it was determined that there was a statistically significant increase in mean ITN score of DLG from pretest to posttest (78.28%, $p=0.000<0.05$) but there was no statistically significant change from posttest to retention test (1.70%, $p=1.000>0.05$). Regarding the mean total stroke scores of CG group, it was determined that there was a statistically significant increase from pretest to posttest (42.72%, $p=0.000<0.05$), whereas no statistically significant change from posttest to retention test was observed (0.23%, $p=1.000>0.05$) (Table 4).

## DISCUSSION

The importance of new teaching approaches, which influence the duration, effectiveness, and retention of skill education in sports, and the number of studies examining this subject gradually increase (Velička et al., 2016). In various studies, it was reported that the variable practice approaches increased the motor learning rates more than the repetitive learning protocols did (Lage et al., 2015; Henz et al., 2018).

In the studies carried out in last 20 years, the repetition of program-centered exercises has been questioned (Schöllhorn, 1999; Savelsbergh et al., 2010; Lage et al., 2015; Henz and Schöllhorn, 2016). In the present study, it was aimed to examine the effects of differential learning on learning the tennis stroke techniques, retention of skills, and improving the mobility time in comparison to the traditional teaching methods. The first hypothesis of the present study is that the differential learning method would positively affect the tennis stroke techniques and the mobility time. The results obtained supported the first hypotheses. Although significant increases were observed in the mean value of total stroke scores of both groups, it was also determined in the posttest that the increase in DLG was statistically significantly higher than in CG. In a similar study carried out on the shooting skills in football, it was found that the differential learning method was statistically significantly more effective than the traditional method (Hegen and Schöllhorn, 2012). In

**Table 4.** The results of ANOVA test of ITN score pretest, posttest, and retention test and Repeated Measure test of change scores in DLG and CG groups.

| Group | | Pre-test (1) | Post-test (2) | Retention-test (3) | Repeated Measures | | |
|---|---|---|---|---|---|---|---|
| | | Mean (Points) | Mean (Points) | Mean (Points) | Test | Mean differences (%) | Sig.[b] |
| DLG (n = 12) | | 76.75 ± 29.49 | 136.83 ± 34.30 | 134.50 ± 33.35 | 1 - 2 | - 78.28* | 0.000 |
| | | | | | 2 - 3 | 1.70 | 1.000 |
| | | | | | 1 - 3 | - 75.24* | 0.000 |
| CG (n = 12) | | 76.08 ± 31.43 | 108.58 ± 29.87 | 108.33 ± 32.11 | 1 - 2 | - 42.72* | 0.000 |
| | | | | | 2 - 3 | 0.23 | 1.000 |
| | | | | | 1 - 3 | - 42.39* | 0.000 |
| ANOVA | F | 0.00 | 4.63 | 3.83 | | | |
| | P | 0.958 | 0.043* | 0.063 | | | |

*Significant difference ($p < 0.05$).

the other studies carried out on this subject, it was reported that the differential learning method was more effective on the learning levels and retention when compared to the traditional methods (Henz and Schöllhorn, 2016; Hegen et al., 2016). Moreover, the increase percentage in DLG almost doubled the increase in CG (129.3% and 67.9%, respectively). In another study carried out on the individuals learning speed skating, it was determined that the differential learning method was more effective than the traditional teaching methods (Savelsbergh et al., 2010).

However, no statistically significant difference was observed in the mobility time. It can be stated that the study period was not sufficient because the mobility is a very complex phenomenon. In a study investigating the effects of differential learning on the mobility, it was reported that there was a slight but statistically insignificant change (Poureghali et al., 2019). The second hypothesis was that the differential learning method would be more efficient in terms of the advancement in ITN scores when compared to the traditional teaching method. When testing this hypothesis, it was determined that DLG had statistically significantly higher scores in posttest when compared to CG. According to these results, it can be stated that differential learning method is more effective in improving the ITN score in comparison to the traditional methods but there was no difference in terms of the retention of learning; it can be said that the learning is permanent in both groups. Examining the improvement within the groups, it was determined that there were statistically significant increases in both groups from pretest to posttest but there was no change in the score from posttest to retention test. Given this result, it can be stated that the methods implemented in both groups increased the ITN score but the differential method was more effective than the traditional methods. In a study carried out on the tennis skill education and retention, it was reported that significant improvements from pretest to posttest were achieved both traditional and differential learning groups but a remarkable decrease was observed in traditional group in the period until retention test, whereas the differential learning group maintained their level (Hegen et al., 2016). In another country, in comparison to the traditional group, both of differential learning groups showed superior performance in learning the techniques and maintaining the performance after the test (Schöllhorn et al., 2012).

The third hypothesis was that the differential learning method would be more effective on the retention. The change between posttest and retention test was similar in both groups. In a study examining the retention by making use of different learning methods, it was reported that, to the contrary with our results, the traditional learning group regressed to the initial levels but differential learning group remained stable (Hegen et al., 2016). In another study, the differential learning method and traditional teaching methods were compared among the shot putters; in all the retention tests performed at the end of 4-week training period and $2^{nd}$ and $4^{th}$ weeks after the end of training period, it was determined that the improvement in differential learning group was statistically significantly higher than in the other group (Beckmann and Schöllhorn, 2003). In another study, to the contrary with the groups in which the traditional teaching methods were used, it was reported that the differential learning group achieved a remarkable improvement but the retention scores were similar to each other (Schöllhorn et al., 2012). These studies differ from the present study in terms of achieving the learning and the retention of learning.

All the studies achieved in the present study show similarity with many studies in the literature. In these studies, when compared to the traditional teaching methods, it was found that the differential learning method was more useful and the learning was more permanent (Beckmann and Schöllhorn, 2003; Schöllhorn et al., 2006; Henz and Schöllhorn, 2016). According to

the principles of traditional teaching philosophy, repeating for many times is deemed to be compulsory for mastery and it is assumed that the "ideal" movements defined by the athletes at the world standard would be improved by repeating as many times as possible (Schöllhorn, 2000). Considering the results of the present study, it is thought that the principles of traditional education philosophy should be revised.

In conclusion, it was determined in the present study that a higher level of improvement was observed in the skill performances of differential learning group when compared to the control group. Moreover, since there are no multiple repetitions in the differential learning method, it saves from the total time of training. Besides that, the successful results have been achieved in the literature, in which the differential learning method was employed in other studies on the other sports branches, and it was reported that the differential learning method can be used in training programs for both new beginners and advanced level athletes (Savelsbergh et al., 2010; Schöllhorn et al., 2012). The trainings should directly influence the performance of athlete and maximize the performance during the games. In fact, the previous reports revealed that the training programs focusing on the differential learning and physical literacy improved the players' ability to make use of environmental knowledge (Coutinho et al., 2017). The differential learning method may establish a new skill implementation model since it exceeds beyond the nature of movement and it incorporates new trials under different conditions (Torrents et al., 2007).

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## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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# Developing indicators of creative and productive leadership for basic education school administrators

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**This research was conducted to develop indicators and test the congruence of structural relationship model and the indicator concurrent validity of creative and productive leadership for basic education school administrators. The first phase was creation of framework and outlining factors as well as indicators by focus group discussion with 9 experts selected by purposive sampling. The second phase was creation and developing indicator. A sample of 630 people was selected by multistage sampling composed of educational administrators, school administrators, and teachers in schools under the Office of the Basic Education and the same sample of 802 people in the third phase. The third phase was congruence examination of structural relationship model of indicators with empirical data. The fourth phase involves checking concurrent validity of indicators with known-group. A sample of 139 people was implemented comprising administrators. Research instrument were focus group discussion and questionnaire. A software package was used in statistical analysis. The results showed that: Indicators of creative and productive leadership for basic education school administrators consisted with 46 indicators of 5 main factors in descending order: Production (PRO) (ß = 0.991), participation (PAR) (ß = 0.981), adaptation (ADA) (ß = 0.933), creation (CRE) (ß = 0.894), and discretion (DIS) (ß = 0.677). The model fit to empirical data: Chi-Square (χ2) = 871.021, df = 859, p-value = 0.3803, CFI = 1.000, TLI = 1.000, RMSEA = 0.004, SRMR = 0.017, and χ2/df = 1.014 and all indicators had concurrent validity showing the level of statistical significance of 0.01.**

**Key words:** Creative and productive leadership, indicators.

## INTRODUCTION

The Thailand 4.0 Model is a policy declared by the Thai government for the purpose of developing economy of Thailand to become one of the developed countries by transforming the economic structure into value-based economy. This developmental approach focuses on increasing productivity relying on innovation, technology,

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and creativity to overcome middle-income, inequality, and imbalance traps. Educational management in this era enable learners to create their innovation, to have critical thinking skill, and to have literacy of global changes that can lead to abilities of valuable productivity, self- and social responsibility, and increase of global competitiveness. School administrators are key persons and highly influence quality and outcome of school management. Therefore, school administrators have to possess creative and productive leadership for efficient productivity to respond to many things changing rapidly (Sinlarat, 2016). In the meantime, leadership in the 21st century, stated by Meister (2010), consists of collaboration, building networks, developing human resources, giving straightforward information, and giving opportunities to people to learn and be able to use new technology for working including becoming aware of social responsibilities and creating innovation in the future. Similarly, Bersin (2012) additionally supports that the 21st century leadership is composed of having self-development and adaptation in accord with any changes. Also, Bohlander et al. (2001) say that modern leaders are people who can change and be flexible in working. Moreover, the leaders also have many skills such as thinking and perception, giving encouragement to the team, dedication, technology creation, and having great vision. Accordingly, the creative leadership theory developed by Ash and Persall (1999) believes, “In a school, there may be many leaders playing role of leadership in different ways, so leadership is not specifically found in administrators only”. However, administrators have to be responsible for providing opportunities for teachers and team members to learn for self-development to become productive leaders as well as leaders of leaders. Based on Bellanca and Brandt (2010), the school administrators who have creativity can promote teachers’ creativity as well. Stoll and Temperley (2009) clarify that creative leadership is an ability to lead others with new methods to build new creative things. As a school administrator, the author sees the development of indicators of creative and productive leadership (CPL) for basic education school administrators as important since it can be used as a guideline for improving educational quality according to the Thailand 4.0 Model that emphasizes human resources for better security, wealth, and sustainability within the country.

## Objectives

1. To develop the indicators of creative and productive leadership for basic education school administrators.
2. To test the consistency between structural model of creative and productive leadership for basic education school administrators and empirical data.
3. To examine the indicators of creative and productive leadership for basic education school administrators with known group.

## Hypotheses

1. Indicators of creative and productive leadership for basic education school administrators show their fitness value with factor loading of main factors of 0.70 or over and factor loading of indicators of 0.50 or over.
2. Structural relationship model of indicators of creative and productive leadership for basic education school administrators developed from theories and research is congruent with empirical data; Chi-Square ($\chi^2$) having no significance, or p-value showing value of over 0.05, GFI and AGFI showing value of over 0.90, and RMSEA showing value of below 0.05.
3. The developed indicators of creative and productive leadership for basic education school administrators have concurrent validity when checking with known group; having an average of 3.50 or over.

## METHODOLOGY

This research used quantitative research as the major methodology and used qualitative research as the minor methodology.

### Population, sample, and informant

In Phase 1 which involves creation of framework and outlining factors and indicators of creative and productive leadership for basic education school administrators, focus group technique was applied to 9 informants who were the experts selected by purposive sampling (Phophueksanand, 2014). These experts consisted of 1) 3 school administrators with qualifications of 1.1) holding academic standing of specialist director or over, 1.2) experiences in basic education school administrators at least 10 years, and 1.3) holding a doctoral degree in the field of educational administration, 2) 3 educational administrators and supervisors with qualifications of 2.1) taking a position of educational administrator or supervisor, 2.2) holding academic standing of specialist level or over, and 2.3) holding a doctoral degree in the field of education, 3) 3 academicians with qualifications of 3.1) taking a position of higher education lecturer, 3.2) holding academic standing of assistant professor or over, and 3.3) holding a doctoral degree in the field of education.

In Phase 2 which involves exploratory factor analysis of creative and productive leadership for basic education school administrators, the population consisted of 343,243 people who were educational administrators, school administrators, and teachers of 2019 academic year under the Office of the Basic Education Commission (from 225 educational service area offices composed of 2 groups, that is, Primary Educational Service Area Office and Secondary Educational Service Area Office). The sample consisted of educational administrators, school administrators, and teachers of 2019 academic year under the Office of the Basic Education Commission (from 48 educational service area offices composed of 2 groups, that is, Primary Educational Service Area Office and Secondary Educational Service Area Office). Criteria for factor analysis of Hair et al. (2010) were used for considering the sample. The acceptable sample size was minimized to 50 people and maximized to 100 people. The statistical significance of factor loading should be considered

together with the sample size in order to decide whether the factor loading have statistical significance. If the size is greater, the statistical significance of the considered loading will be lower. The factor with value of 0.30 is considered as significant in case of the sample of 350 or over. If the sample is 250, 200, 150, 120, and 100, the significant factor loading will be 0.35, 0.40, 0.45, 0.50, and 0.55, respectively. This research specified the sample size based on factor loading as 0.50, which was a statistically significant level of 0.05. Therefore, the acceptable sample size was 200 people. When considering the indicators from the questionnaire, there were 63 items used in the questionnaire for this phase, so the sample size was specified as 630 people, or 10 units per 1 variable through multistage sampling.

In Phase 3 which deals with congruence examination of structural relationship model of indicators of creative and productive leadership for basic education school administrators with empirical data, the population consisted of 343,243 people who were educational administrators, school administrators, and teachers of 2019 academic year under the Office of the Basic Education Commission.

The sample was defined as 802 people who were educational administrators, school administrators, and teachers of 2019 academic year under the Office of the Basic Education Commission (from 48 educational service area offices composed of 2 groups, that is, Primary Educational Service Area Office and Secondary Educational Service Area Office). The sample size was specified according to the Lindeman's rule suggesting that ratio between sampling units and a number of parameters or variables should be 10 to 20:1 (Schumacker and Lomax, 1996).

In Phase 4 which encompass checking concurrent validity of indicators of creative and productive leadership for basic education school administrators with known-group, the population consisted of 395 people who were school administrators holding academic standing of expert-level director of 2019 academic year under Primary and Secondary Educational Service Area Offices, the Office of the Basic Education Commission. The sample was defined as 139 people who were school administrators holding academic standing of expert-level director under both Primary and Secondary Educational Service Area Offices, the Office of the Basic Education Commission. The sample was selected by using purposive sampling technique (Hair et al., 2006).

### Research instruments

For Phase 1, the instruments used in focus group discussion were document containing the outline of factors and indicators synthesized from related research, as well as record form of focus group discussion for recording recommendations related to factors and indicators of creative and productive leadership.

For Phase 2, the 63-item questionnaire for data collection, which was developed in Phase 1, was composed of 2 parts. The first part was the check-list questions about personal information of respondents including sex, age, highest level of education, employment position, and employment experience under the Office of the Basic Education Commission. The second part was suitability of indicators of creative and productive leadership for basic education school administrators employing 5-point rating scale: very high, high, moderate, low, and very low. Its content validity reviewed and evaluated by 5 experts had Item-Objective Congruence Index (IOC) between 0.80 and 1.00. Thereafter the questionnaire was tried out with a different group of 30 people with similar qualification to the sample but not getting involved in this research in order to test the reliability using Cronbach's alpha coefficient. From the test, the questionnaire had reliability of 0.989.

For Phase 3, the 46-item questionnaire was developed by the researcher based on the result of Phase 2 comprising 2 parts. The first part was the check-list questions about personal information of respondents including sex, age, highest level of education, employment position, and employment experience under the Office of the Basic Education Commission.

The second part was suitability of indicators of creative and productive leadership for basic education school administrators employing 5-point rating scale: very high, high, moderate, low, and very low. Its content validity reviewed and evaluated by 5 experts had Item-Objective Congruence Index (IOC) between 0.80 and 1.00, or all items were qualified.

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### Data collection

For Phase 1, data were obtained from the experts' opinions through the focus group technique. For Phase 2, Google Form was used to collect data from 630 informants who were educational administrators, school administrators, and teachers of 2019 academic year under the Office of the Basic Education Commission; thereafter, data were checked before being analyzed. For Phase 3, Google Form was used to collect data from educational administrators, school administrators, and teachers under the Office of the Basic Education Commission; then completeness and correctness of data were checked before being analyzed. For Phase 4, Google Form was also used to collect data in this phase; thereafter, completeness and correctness of data were checked before being analyzed.

### Data analysis

For Phase 1, data analysis involved the 6-step content analysis of Krueger (1994): 1) question sequencing and allowing informants to get familiar with issues used in the discussion, 2) getting the point and taking notes, 3) coding, 4) rechecking the accuracy of data from a report by members either during or after the group discussion process, 5) checking data by discussion moderator and assistant after finishing the group discussion, and 6) feedback and sharing between participants and related parties.

For Phase 2, exploratory factor analysis (EFA) was conducted to extract and classify the factors through the principal component analysis (PCA). Also, the orthogonal rotation was employed by selecting the Varimax method facilitated by a computer program. The obtained result was then analyzed for factor reorganization.

For Phase 3, confirmatory factor analysis (CFA) used the maximum likelihood method (ML) while model validity test of indicators of creative and productive leadership for basic education school administrators used the second order confirmatory factor analysis method.

For Phase 4, concurrent validity was checked using t-test by comparing mean obtained from the know-group with prescribed criteria ($\mu \geq 3.50$).

## RESULTS

As regards Phase 1, from reviewing documents and

**Table 1.** The result of reliability assessment of questionnaire.

| Main factors | Alpha coefficient |
|---|---|
| 1. Critical (CRI) | 0.903 |
| 2. Creative (CRE) | 0.933 |
| 3. Collaboration (COL) | 0.962 |
| 4. Vision (VIS) | 0.938 |
| 5. Productive (PRO) | 0.946 |
| 6. Flexibility (FLX) | 0.964 |
| 7. Responsibility (RES) | 0.973 |
| Total | 0.989 |

**Table 2.** Result of analyzing relationships among variables.

| Variable | Statistics | df | Sig |
|---|---|---|---|
| KMO: Kaiser-Meyer-Olkin measure of sampling adequacy | 0.985 | 1953 | 0.000 |
| Barlett's test of sphericity approx.chi-square | 3.768 | | |

related research as well as organized focus group discussion with the experts, 7 factors and 63 indicators of creative and productive leadership for basic education school administrators were determined: 9 indicators for critical thinking, 9 indicators for creative thinking, 9 indicators for collaboration, 9 indicators for vision, 9 indicators for productivity, 9 indicators for flexibility, and 9 indicators for responsibility. This result would be used in designing questionnaire for indicator development in the next phase. The questionnaire was then evaluated for its content validity by 5 experts. The result revealed the Item-Objective Congruence Index (IOC) between 0.80 and 1.00. After that the questionnaire was tried out with a different group of 30 people with similar qualification to the sample but not getting involved in this research in order to assess the reliability using Cronbach's alpha coefficient. From the test, the questionnaire had reliability of 0.989 as shown in Table 1.

Further, the corrected 630 questionnaire were calculated for data fitness value using the Kaiser-Meyer-Olkin Measure of Sampling, the identity matrix using Barlett's test, and significance. The result revealed that KMO is equal to 0.985, which is higher than 0.5 and gets close to 1. Thus, it can be concluded that the existing data were suitable for the use of factor analysis technique. The result of Barlett's test of Sphericity indicated the level of statistical significance of 0.01 (approx. chi-square = 3.768, sig = 0.000). Based on the result, relationships between variables could be found, and they are fit for using the technique of factor analysis as shown in Table 2.

With regard to Phase 2, considering the factor loading of 0.5 or over (Hair et al., 2014; Mukminin et al., 2018), the result of exploratory factor analysis revealed that the extracted and rotated factors had eigenvalue of 1.0 or over, while each factor had 3 indicators or over. According to the general principle of model identification, 5 factors and 46 indicators can be possible, and the 5 factors can be renamed as 1) adaptation (ADA), 2) participation (PAR), 3) production (PRO), 4) creation (CRE), and 5) discretion (DIS). Each factor consisted of its indicators as shown in Tables 3 to 7.

Concerning Phase 3, composite indicators of creative and productive leadership for school administrators consisted of 5 main factors in descending order: production (PRO) (ß = 0.991), participation (PAR) (ß = 0.981), adaptation (ADA) (ß = 0.933), creation (CRE) (ß = 0.894), and discretion (DIS) (ß = 0.677) as shown in Table 8.

Table 8 shows that the model has construct validity as can be seen from the following statistics: $\chi^2$= 871.021, df = 859, p-value = 0.3803, CFI = 1.000, TLI = 1.000, RMSEA = 0.004, SRMR = 0.017, and $\chi^2$/df = 1.014.

In consequence, the measurement model of factors and indicators of creative and productive leadership for basic education school administrators in the model of second order confirmatory factor analysis has construct validity, or it is congruent with empirical data at pretty high level as shown in Figure 1.

Regarding Phase 4, opinion level of each indicators of creative and productive leadership for basic education school administrators showed its mean ($\bar{x}$) of between 4.12 and 4.57 with the level of statistical significance of 0.001 in all indicators. Thus, it can be said that 46 indicators from 5 factors had concurrent validity.

To confirm the concurrent validity of factors and indicators of creative and productive leadership for basic education school administrators, the 5-point Likert scale questionnaire containing 46 indicators was applied to the known group, that is, 139 basic education school

**Table 3.** Indicators of Factor 1: Adaptation (ADA).

| No. | Variable | Indicator | Factor loading |
|---|---|---|---|
| 1 | SEL2 | Being not too thirsty for win | 0.758 |
| 2 | SEL3 | Adjusting attitude into creative thinking and action | 0.710 |
| 3 | SEL1 | self-esteem and satisfaction with self-decision | 0.702 |
| 4 | PUR1 | Working with diligence, responsibility, prudence, and readiness | 0.637 |
| 5 | PUR3 | Trying to find new ways of working that harmonizes with current situation and circumstance to achieve goals with efficiently | |
| 6 | ADA2 | Accepting opinions of others and any conditions from operation in every situation | 0.600 |
| 7 | ACC3 | Seeking for and developing methods as well as improving educational quality | 0.600 |
| 8 | ADA3 | Getting ready for any changes to get successful and for school benefits | 0.592 |
| 9 | CH1 | Adapting how to think and work creatively according to situations | 0.577 |
| 10 | ADA1 | Adapting to situations rapidly and properly | 0.565 |
| 11 | PUR2 | Having a process for quality assessment of work relying on using resources | 0.565 |
| 12 | ACC2 | Trying not to surrender to any kinds of problems or obstacles | 0.533 |
| 13 | CH2 | Promoting members and networks to get involved in improving work performance | 0.528 |
| 14 | ACC1 | Accepting when any mistakes are made | 0.527 |

**Table 4.** Indicators of Factor 2: Participation (PAR)

| No. | Variable | Indicator | Factor loadings |
|---|---|---|---|
| 1 | PAR3 | Using principles of collaboration to work with transparency and accountability | 0.709 |
| 2 | PAR2 | Having the principles in working together | 0.684 |
| 3 | TRU3 | Cooperation | 0.662 |
| 4 | PAR1 | Promoting all sectors to participate in sharing ideas, making decisions, planning, monitoring, evaluating, and improving for better work performance | 0.649 |
| 5 | DEC3 | Encouraging confidence to achieve the mission of school | 0.637 |
| 6 | CON3 | Using peaceful way to handle with conflicts among parties | 0.608 |
| 7 | TRU1 | Building reliability in operation and following the given arrangement with strictness | 0.593 |
| 8 | TRU2 | Being responsible and diligent to become successful | 0.556 |
| 9 | REA1 | Performing based on justice | 0.532 |
| 10 | CON2 | Being able to analyze the causes of conflicts happening in school | 0.528 |
| 11 | FOR2 | Being able to analyze circumstances both inside and outside school for future prediction of school | 0.511 |

**Table 5.** Indicators of Factor 3: Production (PRO).

| No. | Variable | Indicator | Factor Loadings |
|---|---|---|---|
| 1 | EFI3 | Improving performance continuously using resources effectively | 0.624 |
| 2 | BEN3 | Having acceptable best practice | 0.620 |
| 3 | EFF2 | acquisition of means, ideas, methods, products, and innovation to create new alternatives for better outcomes | 0.615 |
| 4 | EFI2 | Motivating colleagues | 0.610 |
| 5 | BEN1 | Creating works/innovation reflecting modernity to benefit individual, social, and environment sufficiently | 0.607 |
| 6 | EFI1 | Providing management system of educational resources with lowest cost but highest benefits | 0.578 |
| 7 | BEN2 | Satisfaction to all stakeholders | 0.575 |
| 8 | EFF3 | Promoting both teachers and students to create innovation | 0.558 |
| 9 | EFF1 | Applying knowledge and skills to creation of innovation to achieve highest goals of school | 0.512 |

administrators possessing creative and productive leadership. The obtained mean at high level ($\mu \geq 3.50$), which was based on the criterion reference, was compared and the result indicated the concurrent validity with the level of statistical significance of 0.001 as shown in Table 9.

**Table 6.** Indicators of Factor 4: Creation (CRE).

| No. | Variable | Indicator | Factor Loadings |
|---|---|---|---|
| 1 | CHA1 | Creating motivation and daring to make decisions carefully under high-risk condition without fear of any mistakes | 0.719 |
| 2 | CHA3 | Setting big and clear goals at work | 0.701 |
| 3 | CHA2 | Opening to new experiences to achieve big goals efficiently | 0.687 |
| 4 | ORI1 | Applying information and references to working reasonably | 0.623 |
| 5 | ORI3 | Having self-confidence and creating new things to achieve highest goals of school | 0.613 |
| 6 | IMA3 | Being able to analyze future trends to use them for making working plans efficiently | 0.588 |
| 7 | IMA1 | Being creative in improving how to work to achieve goals | 0.569 |
| 8 | IMA2 | Analyzing situations using vision and experience to prevent possible problems | 0.562 |
| 9 | ORI2 | Being confident to choose the best practice to achieve goals of school | 0.559 |

**Table 7.** Indicators of Factor 5: Discretion (DIS).

| No. | Variable | Indicator | Factor Loadings |
|---|---|---|---|
| 1 | ANA2 | Analyzing policies for school mission and roles of school administrators | 0.758 |
| 2 | ANA1 | Conducting projects applying knowledge, principles, concepts, and importance to analysis from start to finish | 0.747 |
| 3 | ANA3 | Creating products through analysis of goals and directions of school clearly by considering situations happening in society in all dimensions | 0.724 |

**Table 8.** Statistics used for testing model validity of second order confirmatory factor analysis of creative and productive leadership.

| Latent Variable | $X^2$ | df | $X^2$/df | P -value | CFI | TLI | RMSEA | SRMR |
|---|---|---|---|---|---|---|---|---|
| CPL | 871.021 | 859 | 1.014 | 0.3803 | 1.000 | 1.000 | 0.004 | 0.017 |

## DISCUSSION

According to the results, the indicators of creative and productive leadership for basic education school administrators consisted of 5 factors (that is, TPPCD): adaptation (ADA), participation (PAR), production (PRO), creation (CRE), and discretion (DIS). These factors included fit and congruent 46 indicators. It was possible that factors and indicators of creative and productive leadership for basic education school administrators were synthesized through several experts as well as both qualitative and quantitative research methodology as expressed in the following details.

1. From reviewing theories, concepts, and related studies, this research received 8 main factors and 90 indicators; thereafter, the focus group discussion with the experts was organized. After the focus group discussion, this research gained 7 main factors and 63 indicators. After performing the exploratory factor analysis, the extracted and rotated factors had the factor loading of 0.5 or over, eigenvalue of 1.0 or over, and 3 indicators or over included in each factors according to the three indicator rule; a factor dispersing into a new one (Vanichbuncha, 2018). Furthermore, the reorganized 5 factors and 46 indicators were renamed by factor loading in descending order: production (PRO) (ß = 0.991), participation (PAR) (ß = 0.981), adaptation (ADA) (ß = 0.933), creation (CRE) (ß = 0.894), and discretion (DIS) (ß = 0.677).

The first factor is adaptation (ADA). School administrators do not have to get too thirsty for win. They additionally have to adapt or make their action and thinking more creative; in other words, they ought to have self-control to transform negative emotion into positive emotion. Also, they have to be satisfied with what they have and choose to be a good role model for others.

Based on Smit and Wandel (2006) and Seyayongka (2013), human adaptation is an action performed to handle different types of change by analyzing and measuring situations and effects so that goals at work can be targeted. Similarly, the Office of the Education Council, Ministry of Education (2014) states that education is an important tool for national reform and human resource development to respond to the social needs and get prepared for the 21st century with 5 ways of adaptation. First, Thai citizen's identity should be

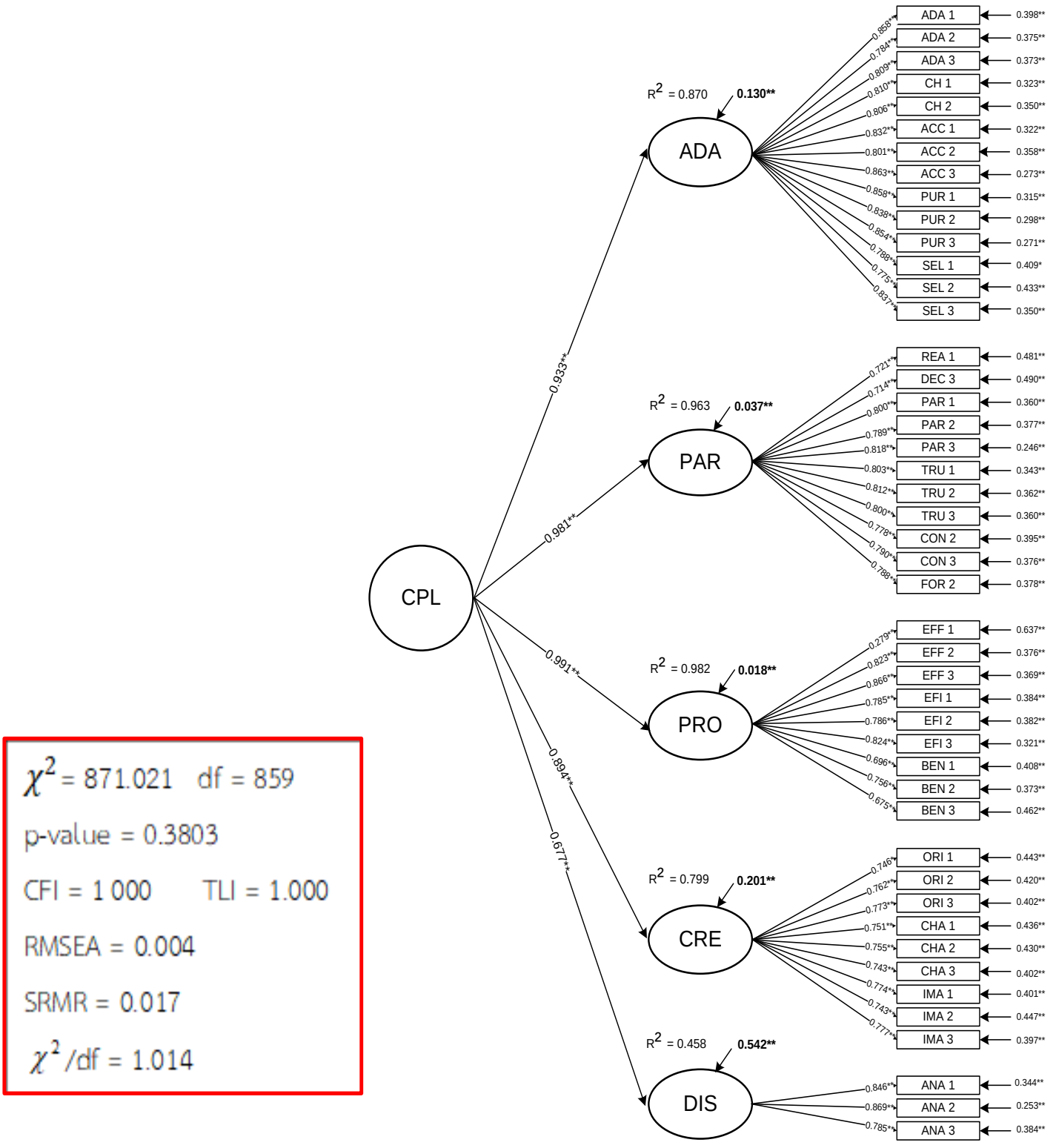


**Figure 1.** Model of second order confirmatory factor analysis for indicators of creative and productive leadership.

transformed into universality. Second, reorientation of human resource should be changed from producing for industrial responses to producing for living and social responses. Third, paradigm should be adapted from overcoming nature to living with nature. Fourth, culture should be transformed from competition into collaboration

**Table 9.** Result of concurrent validity of indicators of creative and productive leadership for basic education school administrators checked with known group.

| No. | Indicators | n = 139 | | | P -value |
|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | t | |
| 1 | ADA1 | 4.32 | 0.66 | 109.282 | 0.000 |
| 2 | ADA2 | 4.45 | 0.64 | 115.205 | 0.000 |
| 3 | ADA3 | 4.40 | 0.64 | 113.999 | 0.000 |
| 4 | CH1 | 4.33 | 0.65 | 110.782 | 0.000 |
| 5 | CH2 | 4.40 | 0.63 | 116.032 | 0.000 |
| 6 | ACC1 | 4.47 | 0.65 | 115.566 | 0.000 |
| 7 | ACC2 | 4.39 | 0.66 | 110.227 | 0.000 |
| 8 | ACC3 | 4.41 | 0.68 | 107.633 | 0.000 |
| 9 | PUR1 | 4.42 | 0.66 | 112.087 | 0.000 |
| 10 | PUR2 | 4.39 | 0.67 | 109.336 | 0.000 |
| 11 | PUR3 | 4.46 | 0.65 | 114.400 | 0.000 |
| 12 | SEL1 | 4.44 | 0.60 | 124.163 | 0.000 |
| 13 | SEL2 | 4.45 | 0.64 | 115.246 | 0.000 |
| 14 | SEL3 | 4.45 | 0.63 | 117.268 | 0.000 |
| 15 | REA1 | 4.50 | 0.64 | 117.309 | 0.000 |
| 16 | DEC3 | 4.50 | 0.63 | 119.432 | 0.000 |
| 17 | PAR1 | 4.45 | 0.66 | 112.347 | 0.000 |
| 18 | PAR2 | 4.47 | 0.66 | 112.737 | 0.000 |
| 19 | PAR3 | 4.52 | 0.66 | 113.893 | 0.000 |
| 20 | TRU1 | 4.37 | 0.68 | 107.669 | 0.000 |
| 21 | TRU2 | 4.51 | 0.63 | 118.457 | 0.000 |
| 22 | TRU3 | 4.57 | 0.64 | 119.849 | 0.000 |
| 23 | CON2 | 4.36 | 0.72 | 100.808 | 0.000 |
| 24 | CON3 | 4.50 | 0.69 | 108.077 | 0.000 |
| 25 | FOR2 | 4.45 | 0.66 | 112.347 | 0.000 |
| 26 | EFF1 | 4.47 | 0.64 | 116.648 | 0.000 |
| 27 | EFF2 | 4.36 | 0.69 | 106.096 | 0.000 |
| 28 | EFF3 | 4.44 | 0.64 | 116.186 | 0.000 |
| 29 | EFI1 | 4.44 | 0.64 | 115.168 | 0.000 |
| 30 | EFI2 | 4.35 | 0.65 | 112.409 | 0.000 |
| 31 | EFI3 | 4.46 | 0.62 | 120.757 | 0.000 |
| 32 | BEN1 | 4.25 | 0.66 | 106.657 | 0.000 |
| 33 | BEN2 | 4.32 | 0.67 | 108.313 | 0.000 |
| 34 | BEN3 | 4.20 | 0.71 | 98.990 | 0.000 |
| 35 | ORI1 | 4.20 | 0.66 | 106.288 | 0.000 |
| 36 | ORI2 | 4.27 | 0.63 | 113.611 | 0.000 |
| 37 | ORI3 | 4.33 | 0.62 | 115.886 | 0.000 |
| 38 | CHA1 | 4.19 | 0.66 | 105.946 | 0.000 |
| 39 | CHA2 | 4.27 | 0.70 | 101.233 | 0.000 |
| 40 | CHA3 | 4.24 | 0.69 | 101.994 | 0.000 |
| 41 | IMA1 | 4.31 | 0.66 | 109.526 | 0.000 |
| 42 | IMA2 | 4.27 | 0.66 | 107.050 | 0.000 |
| 43 | IMA3 | 4.22 | 0.68 | 102.983 | 0.000 |
| 44 | ANA1 | 4.12 | 0.66 | 103.634 | 0.000 |
| 45 | ANA2 | 4.18 | 0.69 | 100.732 | 0.000 |
| 46 | ANA3 | 4.18 | 0.65 | 107.434 | 0.000 |

and fellowship. And fifth, Thailand should be upgraded to become one of the first world nations by building the prestige of patriotism. Suwansawat (2019) supports that educational administrators should understand and adjust themselves to the changes in the disruption era. Therefore, they do not have to stick to the previous success because the word “security” may not be possible in the disruption era. In other words, failure can happen to people in all social classes at any time. Thus, leaders have to possess clear vision and be ready to learn new things all the time. Also, trust in organization has to be built by promoting all members to have learning avidity and realize that self-development is important.

The second factor is participation (PAR). The principles of participation and collaboration with transparency and accountability are used. Participative management, defined by Rakliang (2013), is provision of opportunities for the stakeholders to get involved in sharing ideas, making decisions, planning, doing, supporting, monitoring, evaluating, solving problem, taking responsibilities and taking pride in overall operation and awards, along with welcoming any complaints. Thongdi (2018) says that those who are administrators have to listen to other members’ opinions in order to raise their self-confidence as well as organizational commitment. Moreover, the administrators have to decentralize and support the members in many things such as cooperative problem solving, learning new things, listening to others, and showing honor to one another. These supports can reduce interpersonal conflicts and create moral support as well as better workplace atmosphere. The third factor is production (PRO). Teachers and students are promoted to create their own innovation with acceptable best practice, concepts, methods, and new alternatives for better outcomes. Sinlarat (2016) says that the administrators ought to have creative and productive mind and create innovation. Moreover, power has to be generated for operational support and developed into best practices or best doing. The basis of this strategy consists of rethinking, reinventing, and retaking social responsibility. Also, Arunwong et al. (2017) explained the concept of Newell et al. (1963) in terms of considering one of the creative products by using the following criteria: (1) products that are regenerated and valuable for thinker, social, and culture, (2) products that are not in line with phenomenalism in case of adaptive thinking and product cancellation or previous acceptable concept, (3) products that are highly and steadily encouraged in long term or with high attempt, and (4) products that are obtained from analysis of problems which are pretty unclear or ambiguous.

The fourth factor is creation (CRE). The administrators have to create motivation and daring to make decisions carefully under high-risk condition without fear of any mistakes. Also, big and clear goals at work are set, and opening to new experiences is one important thing to do to achieve big goals efficiently. As stated by Othakanon (2018), the leaders in innovative and intelligent organizations should have the characteristics of bravery and being accountable for inventing to get better overall outcome by giving opportunities to everyone in using creative thinking that leads to new inventions. Furthermore, Sinlarat (2015) says that the administrators have to be responsible for empowerment and development because it is impossible that only one person can achieve success. Therefore, the administrators have to motivate others and build self-empowerment for better collaboration. According to Songboonsart (2016), school administrations’ behaviors and actions of using creativity in innovation production and educational promotion and management can encourage teachers and educators in creativity relying on technology and information. Also, the administrators can promote and motivate teachers to increase their creativity through brainstorming and other methods.

The fifth factor is discretion (DIS). According to the Professional Development Curriculum for Teachers and Educational Personnel specified by the Office of the Basic Education Commission (2019) on school director appointment, the designed learning units are composed of analysis and synthesis policies for school mission and roles of school administrators. This is to promote those who would be the school directors to have the following abilities: developing strategic plans in accordance with the school context, making decision based on information and principles rightly, applying the principles of good governance to school administration, managing educational resources effectively, managing internal quality assurance system, promote teacher as well as educational personnel to show their academic potentials, managing the network party system for school development, and doing supervision, monitoring, evaluation, and report as well as analyzing laws, regulations, rules, and guidelines related to school director’s performance, and other related issues. Sinlarat (2016) supports that the administrators should have clear results of analysis on goal and direction of school by considering current social situations in all dimensions.

There were two important findings regarding the congruence of structural relationship model of indicators school administrators with empirical data. (1) Measurement model of each main factor developed from theories and studies was very well congruent with empirical data. From this result, the 46 indicators became important to the indicators of creative and productive leadership for basic education school administrators. (2) From the second order confirmatory factor analysis of 5 factors and 46 indicators, the structural relationship model of indicators of creative and productive leadership for basic education school administrators developed from theories and studies was very well congruent with empirical data. This finding showed the following statistics: Chi-Square ($\chi^2$) = 871.021, df = 859, P-value = 0.3803, CFI = 1.000, TLI = 1.000, RMSEA = 0.004, SRMR = 0.017, and $\chi^2$/df = 1.014. As a result, it could affirm the research hypotheses because factors and indicators of creative and productive

leadership were synthesized by various experts together with employing both quantitative and qualitative research methodology, and they were then checked by the known group. Additionally, in recent and current situations, the basic education school administrators have been developed in terms of characteristics or behaviors to be in line with theories and studies as the main factors. Also, the indicators used in the research could reflect the actions of the basic education school administrators that were consistent with the policy of organization having responsibility in education personnel development. For instance, (a) the National Institute for Development of Teachers, Faculty Staff and Educational Personnel (2016) together with the Office of the Basic Education Commission introduced policy, plan, and guideline on development of teachers, faculty staff and educational personnel. The curriculum of teacher and educational personnel development was provided before getting appointed and promoting the school director, deputy director and director of the educational service area for 2 main purposes. (i) Core competency improvement was composed of achievement motivation, service mind, expertise, and teamwork. (ii) Functional competency improvement was composed of analytical thinking and conceptual thinking, communication influencing, caring and developing others, and visioning. (b) The Office of the Basic Education Commission (2016) had a policy on promoting the leadership skill for school administrators so that they can get more insight in their own experience and leadership and can realize the way to deal with any conflicts at work and promote behaviors including leadership skills to achieve goals under challenging conditions. (3) The Office of the Basic Education Commission (2019) released a policy for the 2016 fiscal year to encourage individual excellence in the school administrators in terms of innovative and strategic thinking, academic leadership, accountability, and cooperative administration.

To confirm the concurrent validity of factors and indicators of creative and productive leadership for basic education school administrators, the 5-point Likert scale questionnaire containing 46 indicators was applied to the known group, that is, 139 basic education school administrators possessing creative and productive leadership. The obtained mean at high level ($\mu \geq 3.50$), which was based on the criterion reference, was compared. The result indicated the concurrent validity with the level of statistical significance of 0.001. According to the result, it can be applied to organizational administration in many dimensions such as policy formulation, strategic planning, human resource development, training program development, etc. In consequence, the Office of the Basic Education Commission should promote the school administrators under the area of responsibility to put these 46 indicators of creative and productive leadership into practice. This promotion can enhance teachers' creative and productive leadership that is beneficial towards quality development of students based on the Thailand 4.0 policy that aims to bring the country into security and sustainability.

## Suggestions

1) Educational institutes should apply the obtained indicators to measurement of creative and productive leadership for educational administrators, school administrators, and teacher. Also, the outcome of this research should be used as information for developing educational personnel.
2) Variables or factors influencing creative and productive leadership for school administrators should be investigated during further research.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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