International journal of child development and mental health
ISSN: 2286 - 7481; E-ISSN: 2586-887X *Vol. 7 No. 2 July – December 2019 (11-20)*

Working Memory and Learning Difficulties: An Evidence-Based Study in a Public Primary School in Jakarta

Susie Rutmalem[1], Tjhin Wiguna[2*], Raden Irawati Ismail[3],
Fransiska Kaligis[4],Noorhana Setyawati Winarsih Rahardjo[5]
[1,2,3,4,5] Department of Psychiatry Faculty of Medicine Universitas Indonesia
– dr. Cipto Mangunkusumo Hospital, Jakarta
*Corresponding author: Tjhin Wiguna, Email: tjin.wiguna@ui.ac.id

This article was "partially" presented at the The 6th Child Development and Mental Health (CDMH) International Forum & The 4th Asia Pacific Neurofeedback/ Biofeedback Conference held September 6-7th, 2018 in Chiang Mai, Thailand

Received: 22 July 2019
Revised: 20 August 2019
Accepted: 17 October 2019

Abstract

Working memory is the mechanism used for temporary storage during more complex task performance/activity. A child's learning ability is highly influenced by intelligence and memory. The deficit in working memory is one of the significant risks affecting a child's learning capacity and causing learning difficulties. The objectives of this study were: trying to identify the proportion of children with learning difficulties, deficits in working memory and elaborating the relationship between them. This was a cross-sectional design study that was done in one public primary school in Jakarta involving 184 students from grades one to six. Working memory was assessed and based on the Indonesian version of Working Memory Rating Scale (WMRS), which was filled out by the class teachers. Learning difficulties are defined as conditions marked by the students' achievements below the average academic class scores in one previous term. Chi-Square analysis is applied to find out the association, by using SPSS program for Windows. The study results showed that 87 (47.28%) children had learning difficulties with 11.41% (21 students) of them showing deficits in working memory. Children with working memory deficits had 4.826 times higher risk of learning difficulties compared to children without working memory deficits. Odds ratio was also significant ($p<0.05$) in the relationship between working memory deficits and learning difficulties in Indonesian literature (OR= 3.373), Mathematics (OR=4.935), and Science (OR=3.075). In conclusion, early detection for working memory deficits in primary students is a must, especially in inclusive primary schools, to prevent further learning difficulties.

Keywords: Working memory, WMRS, Learning difficulties, Jakarta, Primary school students

Introduction

Learning is a process to acquire behavioral change as a result of individual experience in interacting with the environment including cognitive, affective, and psychomotor aspects that involves various systems in the brain. Factors affecting the learning process are intellectual factor, physical factor, mental factor, social and emotional factor, environmental factor, teacher's personality, and learning methods (Irham & Wiyani, 2013).Learning difficulty is a certain condition experienced by a child that hinders an individual's overall process to acquire behavioral change, knowledge and new skills. Learning difficulty is a learning or emotional problem that might totally or partially affect one's ability to learn and interact with others in general. Learning difficulties are things or disturbances that cause failure, or at least become problems which delay learning progress. Similar to the opinion above, a child's learning difficulty showed as a gap

between his/her academic achievements compared with the average academic class score. Based on that, we can conclude that learning difficulties are obstacles faced by students during the learning process, hence affected students are unable to achieve optimum results (Irham & Wiyani, 2013). Learning difficulties in children and adolescents are often found in outpatient units of child and adolescent psychiatry. Children and adolescents visiting an outpatient clinic with learning difficulties are usually sent there by school teachers, fellow general physicians, pediatricians, and primary healthcare facilities, who noted obstacles or problems in children during the learning process, marked by their inability to reach the average class score or because the parents saw that their children were having difficulty studying at home (Mark, 2014). Learning difficulties experienced by children and adolescents according to the teacher's observation at school are: difficulties in understanding the lessons, difficulty or slow ability in reading and spelling, difficulty in counting, behavior disturbance, emotional problems (anxiety, fear, unhappiness, etc.), over activity (restlessness and lack of attention), difficulty in socializing, passiveness, stubbornness, hyperactivity, having conflicts with friends, and being the victim of bullying or becoming a bully. Children and adolescents with learning difficulties, who are referred by general physicians, usually have functional visuospatial and perception disturbances and delayed cognitive development. Pediatricians usually referred children with emotional, behavioral, and cognitive disorders (Mark, 2014).

It was found that 8% of American children have learning difficulties (Mark, 2014). The number of girls with learning difficulties are predicted approximately three times more than boys (Amy, Fruzsina, Alison, Usha, & Dénes, 2013). The explanation of this gender difference showed greater biological vulnerability in boys and referral bias (boys tend to receive counseling for their behaviors (Jamie & Richard, 2015). The prevalence of learning difficulties in primary students grades 1-6 at West Java Province, Lampung, West Kalimantan, and East Java from studies by the Center for Curriculum and Educational Facilities Development Balitbang Pendidikan Kebudayaan/Research and Development Ministry of Education on 4,994 students showed that 13.94% had general learning difficulties. The report conveyed that learning difficulties in children need serious attention from all parties, including from education, medical, and psychological backgrounds, parents, and other related parties. Factors related to learning difficulties are multifactorial including biological, psychological, social, and cultural factors. Biological factors include genetics, family history of the physical and mental disease, physical disability, and nutritional state. Social factors include upbringing, family economy, parents' educational background, siblings, and home environment. Psychological factors, for example emotions, behavior, intelligence, and cognition, one of which includes working memory (Irham & Wiyani, 2013).

Working memory is a mechanism to use temporary storage in performing a more complex task or activity. As in reading and comprehension, we must retain the incoming information in our memory. Working memory is also found as the key factor in understanding sentences read in different languages (Kashiwagi, 2011). When a student shows learning difficulty or difficulty in reading comprehension, studies found that such problems are related to working memory function (Pimperton & Nation, 2010). Furthermore, verbal working memory was also found to be the best indicator of difficulty in reading comprehension (Macaruso & Shankweiler, 2010). Besides being related to reading comprehension, working memory also affects the ability to perform problem - solving and mathematics (Zheng, Swanson, & Marculides, 2011; Nyroos & Wiklund -Hornquist, 2012). Working memory assessment is needed for students at primary and secondary levels. Improvement in working memory occurs with age, but if working memory impairment is undetected early on, of course, the teachers and parents cannot help the child, causing

learning difficulties. Therefore, working memory assessment is needed for every child, especially primary school students (Fawzy, 2016).

An inclusive school is one of the choices for children with special needs. Children with special needs at inclusive schools are children with specific characteristics different from other students without always showing mental, emotional, or physical inabilities. Special needs students can include students with impairment in sight, hearing, speech, physicality, and learning ability, which slow learning; with poor concentration; special students; special talents, and students with special social needs. The objectives of inclusive education are to increase understanding and respect for differences and become a democratic society; to give a humanity based education, and to provide wider access to quality education for special needs students. It is the teachers' duty and responsibility that the learning process is carried out while taking into account the differences in every individual's ability, and the special needs of students to develop them according to their abilities. Public primary school SDN 01 Serdang Jakarta is an inclusive school at Kemayoran district, DKI Jakarta Province, and is the primary school partner for community service from the child and adolescent psychiatry division FKUI/RSCM. Education for special needs students at this school is performed with other students in one class, and each class has special needs students. It is not clear yet about the proportion of working memory and learning difficulty in students at SDN 01 Serdang Jakarta and the relationship between both topics in relation to the students' academic achievements.

Objectives

The objectives of this study are (1) to obtain the proportion of working memory deficits in students at SDN 01 Serdang, (2) to obtain the proportion of learning difficulty in students at SDN 01 Serdang, (3) to identify the relationship between working memory deficits and learning difficulty in primary school students.

Methods

This study had a cross-sectional design and took place at SDN 01 Serdang from August to October 2017. This school has 347 students from grades 1-6 as reached population. The inclusion criteria for this study were (1) students from grades 1-6 primary school, (2) the parent and child agreed to join the study and signed informed consent forms. Parents, students, and teachers were given a preliminary explanation of the purpose and objectives of the study. If the parents agreed to join the study, they had to fill in the informed consent form. The sample was 184 students from grades 1 to 6 SDN 01 Serdang who fitted the inclusion criteria at random.

Learning difficulty is generally defined as all academic achievements during one school term being lower than the average class score (Cockcroft, 2015). Learning difficulty in mathematics is a condition marked by academic achievement in mathematics lower than the average class score during the previous term. Learning difficulty in Bahasa Indonesia is a condition marked by academic achievement in Bahasa Indonesia lower than the average class score during the previous term. Learning difficulty in science is a condition marked by academic achievement in science lower than the average class score during the previous term.

Instruments

The Working Memory Rating Scale (WMRS) was used to assess working memory deficit conditions in children aged 5-11 years old. WMRS was developed by Alloway et al. and other professional class teachers. Every question had answers ranging from not correct at all (0), sometimes correct (1), quite correct (2), and very correct (3). WMRS was validated in Indonesian language on 2011. The cut-off point is based on the T-score and differentiates its results into two groups: (1) children aged 6-11 years old (sensitivity=0.161 and specificity=0.674) and (2) children aged 10-12 years old (sensitivity =0.186 and specificity=0.929). T score >60 showed a deficit in working memory. The class teacher was asked to fill in the Working Memory Rating Scale questionnaire in Bahasa

Indonesia to find out deficits in working memory. Learning difficulty was assessed from the subject scores during the previous term. We also analyzed the demographic data of students and parents.

Results

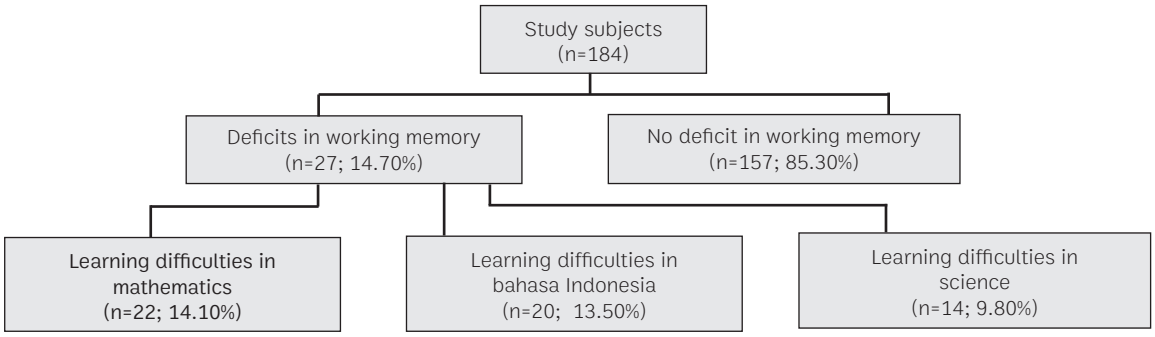

Figure 1: Distribution of Deficits in Working Memory and Learning Difficulties

As many as 90 (48.90%) respondents were males, and 94 (51.10%) respondents were females. The age of respondents ranged from 6-13 years old with an average age of 9.32 (SD=1.73) (Table 1). Respondents were from grades 1-6 with the most students being from grade 4, consisiting of 41 students (22.30%). As many as 11 students (60.90%) were Javanese, 30 students (16.30%) were from Jakarta, 15 students (8.20%) were from West Java, 4 students (2.20%) were from North Sumatra, 12 students (6.50%) were from West Sumatra, and the rest numbered 11 students (6.00%). As many as 124 students (67.40%) have parents making more than IDR 2,200,000 per month, and 60 students (32.60%) have parents making less than IDR 2,200,000 per month. The demographic characteristics are available in Table 1. The general learning difficulty and learning difficulty in Indonesian Literature and Mathematics can be assessed for grades 1-6 while learning difficulty for science can only be assessed for grades 3-6 because grades 1-2 do not have science as a school subject.

Table 1: Results of Bivariate Tests

		Deficits in Working Memory		p	PR (95% CI)
		Yes	No		
Learning difficulties	Yes	21	66	0.001*	4.826
	No	6	91		(1.846-12.616)
Learning difficulties in Indonesian Literature	Yes	20	72	0.007**	3.373
	No	7	85		(1.349-8.432)
Learning difficulties in Mathematics	Yes	22	74	0.001*	4.935
	No	5	83		(1.779-13.691)
Learning difficulties in Science	Yes	14	51	0.036**	3.075
	No	5	56		(1.034-9.138)

Bivariate analysis for working memory deficits and learning difficulty used the Chi-Square test. The Chi-Square test for all cells fulfilled the test criteria with no expected value less than 5. The results for Chi-Square test can be viewed in Table 1. Prevalence risk for learning difficulty in children with deficits in working memory was 4.826 (p=0.001). The results of Chi-Square test between the deficit in working memory and learning difficulty in Bahasa Indonesia (PR=3.373), mathematics (PR=4.935), and science (PR=3.075) were all significant ($p \leq 0.05$).

Table 2: Research Subjects Characteristics

Characteristics	Children with Learning Difficulties				Children with Deficits in Working Memory (n=27/14.67%)	Children with Deficits in Working Memory and Learning Difficulties (n=21/11.41%)	Total (n=184/100%)
	Overall (n=87/47.28%)	Indonesian Literature (n=92/50%)	Mathematics (n=96/52.1%)	Science (n=65/35.32%)			
Sex							
– Male	51 (58.60%)	47 (51.10%)	50 (52.10%)	36 (55.40%)	18 (66.70%)	17 (80.95%)	90 (48.90%)
– Female	36 (41.40%)	45 (48.90%)	46 (47.90%)	29 (44.60%)	9 (33.30%)	4 (19.05%)	94 (51.10%)
Age							
– 6	1 (1.10%)	1 (1.10%)	1 (1.10%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (2.20%)
– 7	16 (18.40%)	19 (20.70%)	17 (17.70%)	0 (0.00%)	6 (22.30%)	6 (28.60%)	37 (20.10%)
– 8	10 (11.50%)	11 (12.00%)	9 (9.40%)	2 (3.00%)	1 (3.70%)	1 (4.80%)	20 (10.90%)
– 9	16 (18.40%)	12 (13.00%)	15 (15.60%)	13 (20.00%)	2 (7.40%)	2 (9.50%)	27 (14.70%)
– 10	24 (27.60%)	28 (30.40%)	32 (33.30%)	30 (46.20%)	9 (33.30%)	6 (28.60%)	54 (29.30%)
– 11	9 (10.40%)	11 (12.00%)	12 (12.50%)	10 (15.40%)	3(11.10%)	0 (0.00%)	21 (11.40%)
– 12	6 (6.90%)	5 (5.40%)	5 (5.20%)	5 (7.70%)	2 (7.40%)	2 (9.50%)	16 (8.70%)
– 13	5 (5.70%)	5 (5.40%)	5 (5.20%)	5 (7.70%)	4 (14.80%)	4 (19.00%)	5 (2.70%)
Range of age	6-13	6-13	6-13	8-13	7-13	7-13	6-13
Average age (SD)	9.40 (1.74)	9.36 (1.75)	9.47 (1.68)	10.28 (1.19)	9.89 (2.02)	9.71 (2.26)	9.32 (1.73)
Grade							
– 1	18 (20.70%)	21 (22.80%)	18 (18.80%)	0 (0.00%)	8 (29.60%)	8 (38.10%)	38 (20.70%)
– 2	10 (11.50%)	11 (12.00%)	9 (9.40%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	20 (10.90%)
– 3	14 (16.10%)	12 (13.00%)	17 (17.70%)	15 (23.10%)	2 (7.50%)	2 (9.50%)	30 (16.30%)
– 4	26 (29.90%)	21 (22.80%)	22 (22.90%)	24 (36.90%)	5 (18.50%)	5 (23.80%)	41 (22.30%)
– 5	8 (9.20%)	17 (18.50%)	20 (20.80%)	15 (23.10%)	6 (22.20%)	0 (0.00%)	31 (16.80%)
– 6	11 (12.60%)	10 (10.90%)	10 (10.40%)	11 (16.90%)	6 (22.20%)	6 (28.60%)	24 (13.00%)
Ethnicity							
– Java	53 (60.90%)	59 (64.20%)	58 (60.40%)	33 (50.80%)	15 (55.60%)	11 (52.40%)	112 (60.90%)
– Betawi	13 (14.90%)	12 (13.00%)	15 (15.60%)	13 (20.00%)	4 (14.80%)	4 (19.00%)	30 (16.20%)
– Sunda	9 (10.40%)	8 (8.70%)	9 (9.40%)	9 (13.80%)	5 (18.50%)	4 (19.00%)	15 (8.20%)
– Batak	1 (1.10%)	1 (1.10%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (2.20%)
– Minang	6 (6.90%)	8 (8.70%)	7 (7.30%)	7 (10.80%)	1 (3.70%)	1 (4.80%)	12 (6.50%)
– Others	5 (5.80%)	4 (4.30%)	7 (7.30%)	3 (4.60%)	2 (7.40%)	1 (4.80%)	11 (6.00%)
Parent income							
– <2,200,000	36 (41.40%)	34 (37.00%)	35 (36.50%)	24 (36.90%)	12 (44.40%)	11 (52.40%)	60 (32.60%)
– >2,200,000	51 (58.60%)	58 (63.00%)	61 (63.50%)	41 (63.10%)	15 (55.60%)	10 (47.60%)	124 (67.40%)

Discussion

The finding showed that 87 children (47.28%) (Table 2) experienced learning difficulties. This percentage is higher than the learning difficulties found in the children population in the United States of America at 8% (Irham & Wiyani, 2013) and compared to the previous studies on primary school students population in Jakarta at 13.71% (Wiguna, Setyawati, & Kaligis, 2012). This is due to the fact that SDN 01 Serdang is one of the inclusive schools in Jakarta. The school provides education for special needs students in the DKI Jakarta Province together with regular students in the same class. These special needs students might have lower scores than the average class score (have learning difficulties). The study identified that 21 children (11.41%) (Table 2) experienced learning difficulties with deficits in working memory. This was similar to a previous study that found 8.04% children with learning difficulties had also deficits in working memory; meanwhile the relative prevalence for learning difficulties in this study was 4.826 compared to the previous study found the odds ratio for deficit in working memory was 7 (Wiguna et al., 2012). The study revealed that deficit in working memory is a significant risk factor affecting a child's learning capacity (Wiguna, Noorhana, Fransiska & Myron, 2012) A child's learning ability is highly influenced by the child's intelligence and memory. Existing studies showed that: (1) working memory is important in predicting a child's learning ability; (2) assessment for working memory is much more significant in predicting a child's learning ability, compared to IQ value which only showed level of intelligence; (3) there is a relationship between working memory function and intelligence (Alloway, 2009). A longitudinal study reported that working memory at 5 years of age is a strong indicator of academic achievements 6 years later, compared to IQ (Sedek, Krejtz, Rydzewska, Kaczan, & Rycielski, 2016).

Another study showed that children with academic achievements below the average score have deficits in working memory function, not related to intelligence. (Cockcroft, 2015). On the contrary, children with average academic achievement, do not show deficits in working memory, which is also not related to intelligence .The study stated that working memory should be considered as an important academic success predictor that can cause great achievements or failure at school. An individual's competency of working memory should be considered as related to the diagnosis and intervention for children with learning difficulties (Maehler & Schuchardt, 2016). This study also found 6 children (3.26%) with deficits in working memory but they did not have learning difficulties. It is caused by different cognitive loads affecting the student's internal process. A student's internal process is determined by (1) a student's ability to inhibit unneeded association. If the child needs more effort to diminish the unneeded association, then it will add more cognitive load; (2) level of mastery on previous material and knowledge. If the child has not yet mastered the previous material or the ones needed to process newly given materials, then it will need more internal processing and will add more cognitive load for the time being; (3) other cognitive factors are related to working memory such as processing speed and fluid reasoning ability; lower processing ability causes an increase in cognitive load and lower retention because repetitive exercise will be done less often (Goldstein, Naglieri, Princiotta, & Otero, 2014). The student's internal process affecting the cognitive load is probably causing some children to not have learning difficulties even with working memory disorder.

The effect of working memory towards academic achievements has been known for some time. At age 7-14 years old, children with low scores in working memory are associated with below standards executive function skill in Great Britain (Gathercole, Brown, & Pickering, 2003). A study identified 3 executive functions in working memory: shifting, updating, and inhibition. Shifting involves a forward and backward pattern in multiple tasks, operational

and mental packages. Updating needs monitoring and coding for incoming information as well as accuracy in placing the item into the previous working memory by replacing the previous information which is no longer relevant to the new information. Inhibition refers to the ability to inhibit dominant or automatic response (Miyake & Shah, 1999). A study assessed the academic achievement, shifting, updating, inhibition, and verbal and visuospatial working memory in children aged 11 and 23 years old. Inhibition is related to academic achievements in mathematics (St. Clair-Thompson & Gathercole, 2006).

Table 2 shows that the number of prevalence risk of working memory deficits towards learning difficulties in mathematics was 4.935. This is similar to a study which found a strong association between mathematics and working memory because mathematics involves a mechanism employing skills to process and solve problems needing central executive support (Gathercole et al., 2003) The study showed that, based on central executive task score, we could differentiate a child's academic ability level at school. The study gave two central executive tests and two phonological loop assessments using Working Memory Battery for Children to assess a child's working memory capacity. Academic achievement performance assessment included scores in literacy, mathematics, and science achievement. As expected, children with low, medium and high performance showed a significant difference in central executive average task performance. In the study, the number for central executive task performance effects (after adjusted for age) in mathematics was -0.93, while visuospatial effects was -0.51, and the phonological loop effect was -0.36. The central executive task tested in the study was a task requiring the participants to periodically manipulate and process verbal information. This type of task is assessing switching function in the executive central component. The deficit in central executive function is responsible for lack of performance in tasks needing information fetching from long-term memory and towards difficulty in switching between tasks. Phonological loop task is needed for active storage and repetition of verbally given materials. The number of numeric related central executive effect was -1.29. The number of numeric related phonological loop has a medium effect at -0.52. The difference in a phonological loop between numeric and non-numeric related (-0.43) showed an executive function component (such as in coordinating two operations, inhibiting distractions, and switching between tasks) which is also influenced by the component for working memory storage. The number of visuospatial working memory effect tends to be consistent (-0.63), but not for verbal working memory (-0.70). Based on these findings, it is concluded that a phonological loop deficit did not cause mathematical learning difficulty. However, attention must be given towards deficits in visuospatial working memory. The deficit in visuospatial working memory is what differentiates people with low and medium mathematical achievement, especially in younger children, for example, in backward digit span task which represented visuospatial rather than central executive. This finding is consistent with the interpretation of the importance of specific domain knowledge (such as numerical knowledge). This result indicated that medium difficulty in mathematics is influenced by non-numerical visuospatial working memory, not only affecting executive coordination function but also other functions. This finding also explained why good visuospatial supports are loading tasks in central executive function and phonological loop. We can also say that medium effect of visuospatial can be caused by higher central executive loading (David, 2012).

Working memory and working skill vary with age. When comparing children with difficulty in learning mathematics and children with average academic achievements, we found that age mediates central executive and visuospatial function. Meanwhile, phonological loop effects are not significant because the findings do not vary between age groups. The 8-10 age group already has an average phonological loop (which will be stable until adulthood) (David, 2012). Overall, deficits or

delay in central executive are persistent, might affect general study domains, and will be more significant in younger ages because it becomes a bottleneck in the academic learning process. Moreover, delay or deficits in central executive function can explain the specific procedural competency in children with learning difficulty in mathematics and low academic achievements (low achievers) which showed more computational procedural errors and immature strategy during a long period. The persistent deficit in groups with learning difficulty in mathematics and low achievers can be explained at least because initially there was a difficulty in central executive function in inhibiting irrelevant information (David, 2012). A practical implication from these findings is that deficit in working memory is very closely related to learning difficulty in mathematics, especially the central executive component and is moderately related to visuospatial. Children with learning difficulty in mathematics can be given training in working memory (specific for numerically related central executive function) with interventions designed to form or improve numeric representation and relationship between numbers. Learning difficulty in mathematics is also influenced by other central executive functions because the central executive function is needed in problem-solving and instructional adaptations can be used to lessen central executive component loading (David, 2012).

However, cognitive components, such as working memory and mathematical knowledge, are not the only factors that determine a child's performance in mathematics. Teachers should not only focus on learning terms such as concept, procedures, curriculum, and instructions but also on emotions and anxiety in children which can affect learning conditions. There is a potential for mathematical anxiety that can affect mathematical achievement in first and second graders. This finding stated that children who know that they have higher working memory tend to be more susceptible to experiencing mathematical anxiety due to their worries, having higher expectations for mathematic achievement. If anxiety is present, then improvements in anxiety will also improve academic achievement in mathematics (Ramirez, Gunderson, Levine, & Beilock, 2013). The number of prevalence risk for working memory towards learning difficulty in Bahasa Indonesia was 3.373. Learning difficulty in Bahasa Indonesia is related to a child's ability to understand a passage and provide answers. It is still debated in literature on whether an individual's ability to understand a passage is influenced by process or storage of working memory capacity. Many studies support the view that the process of working memory capacity in the semantics domain and phonology is important in explaining the variety in reading abilities. The role of storage function has also been studied in the phonology domain but does not yet describe the semantics domain because studies usually only use assessment for phonology information storage capacity compared to semantics information. Reading comprehension ability is a product of complex integration between knowledge and skills in cracking codes, vocabulary, syntaxes, and semantics processes. Besides that, reading comprehension also depends on higher control function of working memory, which is a strong predictor in adults and children. Phonological loop in the reading comprehension process plays a temporary role in digesting verbatim word information and storing information in order to be active and accessible during complex cognitive task controlled by the central executive. (Macaruso & Shankweiler, 2010).

A study analyzed the contribution of semantics and phonology storage and semantics and phonology working memory towards reading comprehension. According to the study, semantics storage directly affects reading comprehension (r=0.20). This semantics storage also affects semantics working memory (r=0.36), therefore semantics working memory can be used as a predictor in reading comprehension ability (r=0.90). This semantics working memory component is what affects a student's achievement in Bahasa Indonesia. (Pimperton & Nation, 2010). The number of risk prevalence for deficits in working memory for science was

3.075. This is similar to a study which found a strong association between science and working memory. As in mathematics, science also goes through a mechanism involving processing and problem-solving skills depending on support from the central executive. Another study found that children with good working memory will try to understand science, while children with deficits in working memory will tend to memorize it. Understanding previous materials will reduce the child's cognitive load and therefore reduce the working memory load. A low achiever in science with deficits in working memory is caused by the high cognitive load. (Nyroos, et al., 2012). A setback in this study is that the sample was taken from only one school. Besides, there is no standardized definition on learning difficulty to be used in this study. If there is a standardized definition available, maybe we can improve the results of this study. The strong point in this study is that the sampling was taken from an inclusive primary school. A study connecting learning difficulties with deficits in working memory in an inclusive primary school has never been done before in Indonesia, especially with the focus on specific learning difficulties in subjects such as Bahasa Indonesia, mathematics, and science.

Limitation

The limitation of this study is that the sampling was only done in one school and there were no standardized learning difficulties that could be used in this study.

Ethics approval

Ethical approval number: 875/UN2.F1/ETIK/2017

References

Alloway, T. P. (2009). Working memory, but not IQ, predicts subsequent learning in children with learning difficulties. *European Journal of Psychological Assessment, 25*(2), 92-98.

Amy, D., Fruzsina, S., Alison, N., Usha, G., & Dénes S. (2013). Gender differences in developmental dyscalculia depend on diagnostic criteria. *Learning and Instruction, 27*, 31-39.

Cockcroft, K. (2015). The role of working memory in childhood education: Five questions and answers. *South Afr J Child Educ, 5*(1), 20.

David, C. V. (2012). Working memory deficits in Math learning difficulties: a meta-analysis. *International Journal of Developmental Disabilities, 58*(2), 67-84.

Fawzy, C. T. (2016). *Working memory in children: How does it affect learning? Different methods and techniques that can be used to train and enhance the working memory of children.* Retrieved from http://dar.aucegypt.edu/handle/10526/4862

Gathercole, S. E., Brown, L., & Pickering, S. J. (2003). Working memory assessments at school entry as longitudinal predictors of National Curriculum attainment levels. *Educational and Child Psychology, 20*(3), 109-122.

Goldstein, S., Naglieri, J. A., Princiotta, D., & Otero, T. M. (2014). Introduction: A history of executive functioning as a theoretical and clinical construct. *In Handbook of executive functioning* (pp. 3-12). Springer, New York, NY.

Irham, M. & Wiyani, N. A. (2013). *Psikologi Pendidikan: Teori dan aplikasi dalam proses pembelajaran.* Jogjakarta: Ar-ruzz Media.

Jamie, M. Q., & Richard, K. W. (2015). Gender Differences in Reading Impairment and in the Identification of Impaired Readers: Results From a Large-Scale Study of At-Risk Readers. *Journal of Learning Disabilities, 48*(4), 433-445.

Kashiwagi, A. (2011). *Processing relative clauses in first and second language: A case study,*

Doctoral dissertation, The Ohio State University.

Macaruso, P., & Shankweiler, D. (2010). Expanding the Simpler View of Reading in Accounting for Reading Skills in Commuity College Students. *Reading Psychology, 33*(5), 454 -471.

Maehler, C., & Schuchardt, K. (2016). The importance of working memory for school achievement in primary school children with intellectual or learning disabilities. *Research in developmental disabilities, 58*, 1-8.

Mark, S. (2014). Quality of Life Among Asian American Youth. Harvard Medical School and RAND Corporation, Santa Monica, California Quality of Life Among Asian American Youth. *Asian American Journal of Psychology, 5*(1), 13.

Miyake, A., & Shah, P. (1999). *Models of working memory: Mechanisms of active maintenance and executive control.* Cambridge University Press.

Nyroos, M., & Wiklund-Hornquist, C. (2012). The Association between Working Memory and Educational Attainment as Measured in Different Mathematical Subtopics in the Swedish National Assessment Primary Education. *Educational Psychology, 32*(2), 239-256.

Pimperton, H., & Nation, K. (2010). Suppressing Irrelevant Information from Working Memory: Evidence For Domain Specific Deficits in Poor Comprehenders. *Journal of Memory and Language, 62*(4), 380-391.

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187-202.

Sedek, G., Krejtz, I., Rydzewska, K., Kaczan, R., & Rycielski, P. (2016). Three functional aspects of working memory as strong predictors of early school achievements: The review and illustrative evidence. *Pol Psychol Bull Wars, 47*(1), 103–111.

St Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *Quarterly journal of experi mental psychology, 59*(4), 745-759.

Wiguna, T., Setyawati, N., & Kaligis, F. (2012). Indonesian validation study on working memory rating scale (WMRS). *Sari Pediatri. 14*(3), 191–217.

Wiguna, T., Noorhana, S. W., Fransiska K., & Myron, L. B. (2012). Learning difficulties and working memory deficits among primary school students in Jakarta, Indonesia. *Clinical Psychopharmacology and Neuro Science, 10*(2), 105-109.

Zheng, X., Swanson, H. L., & Marculides, G. (2011) Working Memory Components as Predictors of Children's Mathematical Word Processing Abilities. *Journal of Experimental Child Psychology, 110*(4), 481-98.