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Investigation of Fifth Grade Students' Mathematical Calibration Skills

Gökhan ÖZSOY[a]
Aksaray University

Abstract

The purpose of this study is to develop a scale to measure fifth grade students' mathematical calibration skills. Besides, it aims to determine students' calibration skills through this scale. Results of the study revealed that fifth-grade students (n= 94) enrolling to study, have a medium-high level of (M= 55.12, SD= 21.76) mathematical calibration skills. Furthermore, the results showed that students' mathematical calibration skills do not show significant differences with respect to their gender (t=.501, p > .01). However, students' calibration skills show significant differences when considering their level of mathematics achievement ($F_{|2-91|}$=69.46, p <.001, η^2=.60). In addition, a positive and significant relationship was found between students' mathematical calibration skills and their mathematics achievement (r =.85, p <.001).

Key Words

Mathematical Calibration, Calibration, Metacognition, İtem-Specific Calibration, Calibration Measure.

Calibration, which is one of the metacognitive control skills (Nelson & Narens, 1990), is defined as the accuracy of learners' perceptions of their own performance (Pieschl, 2009). For this reason, calibration is considered as a part of self-regulated learning process and it is related with monitoring skills which are reported among metacognitive control skills (Veenman, van Hout-Wolters, & Afflerbach, 2006). Metacognitin refers to an individual's awareness of his own thinking process and his ability to control these processes (Flavel, 1979). It is observed that modern studies discuss the metacognition under three main facets: Metacognitive knowledge, metacognitive control and metacognitive experiences (Desoete, 2009b; Efklides, 2008; Flavell; Karably & Zabrucky, 2009). To sum up, metacognitive knowledge defines, awareness of how an individual learns, awareness of methods and strategies which are effective for learning process, awareness of selecting useful information and strategies (Bembenutty, 2009; Flavell; Kramarski, 2009; Sarac & Karakelle, 2012; Schraw & Moshman, 1995; Varsari, Battistelli, Cadamuro, & Farneti, 2009).

Metacognitive control skills consist of leading mental operations in metacognitive processes and can be defined as the ability to use the metacognitive knowledge strategically in order to attain cognitive objectives (Özsoy, Memiş, & Temur, 2009). The literature focuses on four metacognitive control skills (Brown, 1980; Desoete, 2009a; Desoete, Roeyers, & Buysee, 2001; Desoete, Roeyers, & Huylebroeck, 2006; Lucangeli & Cornoldi, 1997; Schraw, 2009; Schraw & Moshman, 1995); prediction, planning, monitoring and evaluation.

Calibration involves monitoring and it emerges with the common use of prediction and evalua-

a **Gökhan ÖZSOY, Ph.D.**, is working as an assistant professor at University of Aksaray, in the Department of Elementary Education. He specializes in metacognition, mathematical problem solving and elementary mathematics education. Correspondence: Assist. Prof. Gökhan Özsoy, University of Aksaray, Faculty of Education, Department of Elementary Education, 68100 Kampus Aksaray, Turkey. E-mail: gozsoy@gmail.com Phone: +90 382 288 2255.

tion skills which are metacognitive control skills (Desoete et al., 2001). Thus, calibration clarifies individuals' awareness of their own cognitive processes such as what they know and do not know or what they do and do not do (Stone, 2000). This kind of accurate monitoring is considered as a prerequisite for successful learning (Lin, Zabrucky, & Moore, 2002). On the other hand, literature reports that individual's can better monitor their own cognitive abilities, and thus better calibrated, with increasing age (Horgan, 1990; Johnson & Wellman, 1980). Calibration, is considered as one of the developmental changes depending on judgment of knowing (JOK) (Bembenutty, 2009; Cole, Martin, Peeke, Seroczynski, & Fier, 1999). Calibration is the accuracy between one's own judgment about the performance and his/her actual performance on a task (Hacker, Bol, & Bahbahani, 2008). Thus, to measure calibration, it is preferred to compare the actual performance and the evaluation of his own performance (Lin & Zabrucky, 1998; Schraw & Moshman, 1995; Tobias & Everson, 1996; Winnie & Muis, 2011).

Measuring Calibration

Previous research studies show that fundamentally two different approaches have been used to measure the ability of calibration. One part of these approaches (Glenberg & Epstein, 1985; Glenberg, Sanocki, Epstein & Morris, 1987), in order to measure the calibration, a correlation calculation between student's performance on a standard test and his level of understanding is used. It is assumed that the closer the correlation to +1, the student is closer to a perfect calibration and vice versa. On the other part, an instrument with four factors developed by Schraw, Potenza ve Nebelsick-Gullet (1993) have been used for calibration measurement. This approach, on the one hand, calculates the accuracy between the predicted and the real performance, on the other hand, calculates the internal validity of the instrument with bi-serial correlation and the alpha coefficient of the predicted and the real performance. According to Schraw (1995), the most consistent values for the calibration level is obtained by the comparison of the predicted and the real performance values obtained for each test items (*item-specific calibration*). Total calibration score can be obtained by calculating the avarege of each test item's calibration scores (Ramdass, 2009). In the present study, item-specific calibration is used to develop mathematical calibration skills instrument.

Purpose

This research study has mainly focus on two points. First of all, it aims to develop an instrument to determine mathematical calibration skills and secondly, it aims to determine fifth-grade students' mathematical calibration skills using this instrument. In addition, students' calibration skills are compared with respect to their gender and their mathematics achievement levels.

Method

The present study aiming to determine primary school fifth-grade students' mathematical calibration skills was carried out through survey method. Survey method is an approach which is used to describe the past and the current situation as it is (Karasar, 2000).

Participants

The participants of the study consist of 93 fifth-grade students (mean age 11.1, SD = .57) from a public primary school in Aksaray, which is a medium-sized city in Turkey. Out of these students, 54% of them were girls and 46% of them were boys The study carried out during the spring semester of 2011. The participants of the study selected through convenient sampling model.

Mathematical Calibration Instrument

Mathematical Calibration Instrument which is developed by the researcher is used to determine students' calibration skills. During the development of the instrument, previously used approaches chosen to measure metacognitive skills (prediction and monitoring) are followed (Cross & Paris, 1988; Desoete et al., 2001; Lucangeli, Cornoldi, & Tellarini, 1998). The instrument includes 28 items covering measurement of prediction skills (14 items) and evaluation skills (14 items). Prediction and evaluation items are designed to be associated with each other (Appendix-1).

Mathematical operations and problems placed in the instrument are designed taking into account the relevant achievements stated in Primary School Mathematics Curricula (Ministry of Education/Milli Eğitim Bakanlığı [MEB], 2004). Pilot study was conducted under the supervision of the researcher with 158 fifth-grade students enrolling to two primary public schools located in the center of Aksaray. The reliability of the instrument was calculated as r = .93 (p

< .001), using Cronbach's Alpha. On the other hand, in accordance with the data obtained from the preliminary application with 158 fifth-grade students, Kappa value is calculated to determine the internal consistency of the instrument. The results revealed that Kappa values of prediction and evaluation items change between .42 and .68. When Kappa values for all items are examined, it is possible to say that the consistency between the prediction and the evaluation items range from medium (.41-.60) to high (.61-.80) levels. Kappa values for each item are presented in Appendix- 2.

Mathematical Achievement Test

Mathematics Achievement Test (MAT) is used to determine mathematical achievement levels of students. The MAT was developed by the researcher (Özsoy, 2011) and consists of 30 multiple choice questions. It includes numbers and operations, geometry, measurement, and statistics questions; consistently with the curricula (MEB, 2004). The maximum and minimum scores on the mathematics test could be 30 and 0, respectively. The validity of the questionnaire was assured by taking the views of three professionals about the relevancy of each item. Cronbach's alpha reliability for the test was found to be r = .89 (M = 20.72, SD = 5.52).

Data Analysis

The data of the research were obtained at the end of the spring semester in 2011. All participants were assessed inside the classroom setting for a total about 1 hour in two different days. Then the data obtained were analyzed using ITEMAN and SPSS 15.0 software. Inferential statistics, independent samples t-test and ANOVA, were used to find out the relationships between the independent variables of gender and mathematical achievement levels and the scores obtained from MCI. Besides, Pearson correlation coefficient is calculated to determine the correlation between MAT and MCI scores. Before using parametric tests, Kolmogorov-Simirnov test is conducted to check the normal distribution (for MCI, Z= 1.043, p > .01; for MAT, Z= 0.647, p > .01) and Levene test is conducted to check the homogeneity of the variances.

The results of these analyses were reported to be significant at the p < .01 level statistical significance. To check whether the obtained statistically significant results were also practically significant effect sizes were calculated. Eta square (η^2) values were made to determine effect size values (Kotrlik & Williams, 2003).

Results

When the scores of participants are examined, it is observed that their mean prediction score is 26.00 (SD = 11.60), average evaluation scores is 29.11 (SD = 10.65), and mean calibration scores is 55.11 (SD = 21.75). Depending on the results obtianed, it can be concluded that participants have medium-high level of calibration skills. To show whether there are significant differences between boys and girls with respect to their mathematical calibration skills, independent samples t-test was run. The results of the study showed that there were no significant differences between boys and girls with respect to their prediction scores (t= .88, p > .01), evaluation scores (t= .07, p > .01) and calibration scores (t= .50, p > .01). In order to examine, whether a significant relationship exists among students with different mathematical achievement levels with respect to their mathematical calibration skills, ANOVA analysis was conducted. Before the analysis, students were grouped into three; as low, middle and high achievers, depending on their scores obtained from MAT. The results showed that there are significant differences between students' calibration test scores with respect to their mathematical achievement ($F_{(2\text{-}91)}$= 69.46, p < .001) with a large effect size (η^2= .60). The post-hoc results showed the statistical significance exists among all groups; high achievers get higher scores (M= 77.58, SD= 7.06) than middle achievers and low achievers and middle achievers (M= 54.27, SD= 16.70) get higher scores than low achievers (M= 26.15, SD= 13.49).

Additionally, a correlation analysis was conducted to find out if participants' scores obtained from MCI and MAT are significantly correlated. Results showed that high positive statistically significant relationships exist between students' MAT scores and prediction scores r= .84 (p < .01); their MAT scores and evaluation scores r= .82 (p < .01); their MAT scores and calibration scores r= .85 (p < .01).

Discussion

One of the primary purposes of this study was to develop an instrument to measure primary school students' mathematical calibration skills. Through the study, a valid and reliable instrument; Mathematical Calibration Instrument, was developed. In order to name the instrument, "mathematical calibration" is used because calibration skills show discrepancies with respect

to related course or task (Winnie & Muis, 2011). In the literature, there is not any course/subject independent calibration instrument.

Another purpose of this study was to determine students' mathematical calibration skills and investigating their calibration skills with respect to several variables by using the newly developed instrument. The developed instrument is applied to 94 fifth-grade students, the results showed that participants have a medium level of mathematical calibration skills. It is possible to argue that students' calibration skill level is not sufficient considering the importance of calibration in students' achievement. Winnie and Perry (2000) reports that students with low calibration skills will fail to control their own learning process efficiently. Overconfident students do not change their study habits since they believe that they do not need to complete their missing knowledge. Underconfidence students do not try to change since they believe that they will always fail (Battistelli, Cadamuro, Farneti, & Versari, 2009). For this reason, it is important to self monitor and evaluate one's own performance during learning process.

Previous research studies showed that there is a significant relationship between mathematical calibration skills and mathematical achievement (Chiu & Klassen, 2010). It is known that students with high calibration skills perform mathematical tasks successfully during problem solving process. It is observed that, these students can easily control the problem solving process, solve complex problems by separating simpler pieces, ask themselves questions to clarify their thoughts (Glenberg et al., 1987; Dermitzaki, Leondari, & Goudas, 2009; Özsoy & Ataman, 2009).

One of the problems of the study was, to investigate how students' calibration skills change with different variables. For this purpose, how calibration skills change with gender differences is investigated and it is found that there are no significant differences between boys and girls with respect to their calibration scores. This result is not consistent with the previous research studies (Connell & Ilardi, 1987; Cole et al., 1999). In these studies, it was found that boys have more accurate predictions about their performances than girls. Similar results obtained from studies focusing on university students' calibration skills (Beyer, 1998).

In the present study, the relationship between mathematical calibration skills and the mathematic achievement is also investigated. It is found that there is a positive and significant relationship between the students' scores obtained from MCI and MAT. This result is expected and supported by the related literature. According to Desoete et al. (2001) prediction and control skills explains 16% of mathematical achievement. Similarly, previous research (Bol & Hacker, 2001; Butler & Winne, 1995; Pajares & Miller, 1994; Pintrich & de Groot, 1990; Ramdass, 2009) has reported a relationship between mathematics achievement and mathematical calibration skills. Research studies focusing on calibration shown that calibration has a significant impact on students' achievement, thus students with higher levels of calibration skills are more successful than students with lower levels of calibration skills. For this reason, studies improving students calibration skills can be used as useful toold for their development.

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