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REGULATION OF COGNITION AS A MEDIATOR IN THE RELATIONSHIP BETWEEN KNOWLEDGE OF COGNITION AND PERCEIVED SELF-INTERVENTION

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Abstract

Self-assessment is an important tool enabling learners at the level of higher education to control and construct their learning processes. To allow for further study, we modified a web-based self-assessment system to provide individuals with the opportunity to test and retest their own learning and receive feedback. This study included 59 students. Following completion of the test, feedback was structured based on a comparison of the student's performance to the standard performance, their position in the group and their previous performances. Each test deadline had to be waited for determining the positions in the group of students and the delayed feedback were sent to the learners by e-mail. Through this external feedback, learners were able to intervene in their own learning process, thus achieving better future learning prospects and to observe the effectiveness of these intervention though feedback from the next assessment. We defined this process as the self-intervention perception process due to the active participation of the learner. The determination of the structures that affect the meaning and using of the feedback received by the learners were at the forefront. This study aimed to examine the relation between learners' metacognitive awareness and their self-intervention perceptions and create a learner profile based on this information. Participants also completed Perceived Self-Intervention Scale and the Metacognitive Awareness Inventory. Learners with high levels of metacognitive skills awareness were found to have high levels of perceived self-intervention. Furthermore, knowledge of cognition had indirect effects on the perception of self-intervention, and that the regulation of cognition was the mediator variable.

Abstract in Turkish

Günümüzde yükseköğretimde yer alan öğrenenlerin öğrenme başarısına yönelik öz değerlendirme yapması kendi öğrenme sürecini denetim altına alabilmesi ve aynı zamanda kendi öğrenme yaşantısına müdahalede bulunabilmesi için önemli bir araçtır. Buna bağlı olarak araştırmada web tabanlı öz-değerlendirme sistemi (WT-ÖS) oluşturularak bireyin kendi öğrenmelerini test etmelerine ve dönüt almalarına fırsat verilmiştir. Araştırmanın çalışma grubunu 59 öğrenci oluşturmaktadır. Test tamamlandıktan sonra öğrenenin var olan yeterliklere, gruptaki konumuna ve daha önceki performanslarını karşılaştırmaya dayalı yapılandırılan dönütler öğrenene sunulmuştur. Gruba bağlı dönütlerin verilebilmesi için test süresinin bitmesi beklenmiş ve geciktirilmiş dönütler e-posta aracılığıyla öğrenenlere gönderilmiştir. Bu dışsal dönütler sayesinde öğrenenler öğrenmelerini iyileştirmek için kendi öğrenme süreçlerine müdahale edebilmiş; bir sonraki değerlendirmenin dönütü sayesinde de müdahalenin etkililiğini görebilmiştir. Araştırmacılar tarafından bu süreç öz-müdahale algısı olarak tanımlanmıştır. Öğrenenlerin aldığı dışsal dönütü anlamlandırmaları ve kullanmalarına etki eden yapıların belirlenmesi ön plana çıkmaktadır. Bu yüzden sistemi kullanarak dönütlerini alan öğrenenlerin kendi öğrenme süreçlerine müdahalede bulunması anlamına gelen öz müdahale algısı ile üstbilişsel farkındalık arasındaki ilişki incelenmiş ve bir öğrenen profili oluşturulmaya çalışılmıştır. Araştırma kapsamında Web Tabanlı testlerin

yanında WT-ÖS'de Algılanan Öz Müdahale Ölçeği, Bilişötesi Farkındalık Envanteri (MAI) katılımcılar tarafından cevaplanmıştır. Araştırmada üstbiliş beceri farkındalık düzeyleri yüksek olan öğrenenlerin algılanan öz müdahale düzeylerinin de yüksek olduğu görülmüştür. Ayrıca üstbiliş bilginin öz-müdahale algısı üzerine doğrudan bir etkisi olmadığı ve üstbilişsel becerinin aracı bir değişken olduğu belirlenmiştir.

Keywords: Self-intervention, Metacognitive Awareness, Web-based self-assessment system

Introduction

Higher education learners are expected to be able to determine their own learning needs, revise learning strategies, and have an awareness of the ways in which they most effectively learn (Boud, 2000). Therefore, it is vital that they be able to perform self-assessments, take responsibility of their learning process, and modify their learning experiences as necessary (Orsmond, 2011). In order to make effective internal assessments, learners need objective and well-structured external feedback. The use of feedback in the self-modification of learning experiences can be defined as self-intervention (Bayrak, 2014).

However, external feedback can be perceived differently by individual learners (Eva & Regher, 2005; Sargeant, Mann, van der Vleuten, & Metsemakers, 2009). Metacognitive awareness, which may be defined as thinking about thinking, can account for the differences in perception. Learners alter their learning processes in line with the results of their self-assessment and metacognition can function as a bridge between this self-intervention and external feedback received.

To examine this, we modified a web-based self-assessment system (WB-SS) and provided participants with the opportunity to test and retest their own learning. Feedback was structured on the basis of the learners' existing efficacies, their position in the group and comparison between their previous performances. To ensure that learners benefited as much as possible from the feedback, they were given a timeframe in which to create their own interventions and the opportunity to repeat the test to determine the effectiveness of these interventions. This study aimed to examine the relation between learners' metacognitive awareness and their self-intervention perception and to create a learner profile using this information in the web-based self-assessment system.

Self-assessment and Feedback

Learner-centred approaches and self-assessment methods have recently come into prominence in the context of both learning and evaluation (APA, 1997). Self-assessment methods in the context of education are instruments used to increase the information related to learners' own learning by increasing the effectiveness of learning strategies and information about these strategies for use at the next stage (Mok, Lung, Cheng, Cheung, & Ng, 2006). The process of assessment in which learners make judgements about their current performance plays a key role in formative assessment (Andrade & Valtcheva, 2009; Tan, 2007; p.123) and is considered indispensable for effective learning (Black & William, 1998; p.26). Furthermore, self-assessment encourages student independence, and helps students develop the necessary skills for autonomous (and lifelong) learning (Karran, 2005).

While self-assessments are highly important, external information regarding performance (the feedback) also contributes to learning (Molloy, Bornell-Carno, & Epstein, 2013; p.55; Sadler, 1998; Yorke, 2003). The constructivist perspective emphasises that learners must actively construct their own understanding and feedback would support learners in becoming more self-directed (Davies, 2010).

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A great number of studies on feedback given to learners are available and a wide variety of classifications have been provided in the literature with regard to the types of feedback and feedback strategies (Dempsey & Wager, 1988; cited by Mory, 2004; p.757; Hattie & Timperley, 2007; Kulhavy & Stock, 1989; Shute, 2008). One of them is about the time of giving. Feedback can be presented as immediate or delayed. The current study focused on providing each learner delayed feedback; because of determining the position of the learner in the group of students.

Therefore, computer-assisted environments may be beneficial for learners to both monitor their own development and receive external feedback. Moreover, with item pool and item selection algorithms, performance can be displayed effectively (Conejo, Guzman, Millan, Trella, Pérez-de-la-Cruz, & Ríos, 2004) and scoring can be performed in an efficient manner, thus allowing for the rapid creation of diagnostic reports and individualised feedback. In this way, learners can take tests of diverse questions to determine their actual performance, can clarify the dimensions learnt and identify deficiencies (Gikandi, Morrow, &Davis, 2011).

Assessment activities are categorised as teacher-driven, programme-driven and future-driven (Tan, 2007). In programme-driven assessments criteria are pre-defined in the context of the programme and learners are expected to evaluate themselves in accordance with these criteria (Andrade & Valtcheva, 2009). Therefore, it is important that learners are aware of the criteria (McMillan, 2007; p.144) and can benefit from self-assessment tests based on the programme requisites in order to make more objective decisions about their own learning situation.

Programme-driven self-assessment was considered as the basis for this study, utilizing the process of self-assessment based on the curriculum-based assessment and measurement first developed by Deno in 1985. While curriculum-based assessment feedback was given to allow teachers to make instructional intervention when necessary, feedback was structured to support university-level education for the purposes of self-intervention.

Self-intervention and Metacognition

The concept of instructional intervention is generally described in the literature in reference to learners with special education needs (Vaughn & Fuchs, 2003). Teachers can monitor the task performances of such student through in-class assessments and, if needed, make instructional interventions such as changing the learners' in-class position or providing supplemental and or alternative teaching materials. The effectiveness of each instructional intervention can be seen in the next assessment. The concept and original practice of curriculum-based assessment was developed by Stanley Deno in the 1980s. This approach emerged as the theory of response to intervention (RTI) for students with learning disabilities. Deno's approach to curriculum-based evaluation served as the basis for the use of assessments based on common skills, called "curriculum-based measurement", in the "No Child Behind Left Act" in the USA. Black and William (1998) pioneered the curriculum-based measurement and assessment models as assessment-driven models. In assessment-driven models, learners can test themselves repeatedly. In this respect, it was reported in studies that the students who had to take self-assessment tests repeatedly performed significantly better on the exam (Ćukušić, Garača, & Jadrić, 2014; Wilson, Boyd, Chen, & Jamal, 2011). However, how the feedbacks are used by the learners and the structures affecting this process need to be examined. The use of feedback in the self-modification of learning experiences can be defined as self-intervention (Bayrak, 2014) and metacognitive awareness, which may be defined as thinking about thinking, can be examined.

Metacognition was reported as an important factor influencing learning by the American Psychological Association (1997). The term metacognition, first used by Flavell (1979), is defined as "thinking about thinking", and was elaborated by Martinez (2006) as monitoring and controlling

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thought. In terms of educational psychology, metacognition is related to the level of learning, learners' self-regulation and the improvement of learning (Karakelle & Saraç, 2010). In this sense, metacognition is also considered to be one of the internal factors influencing the process of self-assessment (Mok, Lung, Cheng, Cheung, & Ng, 2006). In a similar vein, Karakelle and Saraç (2010) also stated that the metacognitive approach forms the theoretical foundation of self-assessment.

For the current study, a web-based self-assessment system was modified to provide individuals with the opportunity to test and retest their own learning. After completing the tests, feedback was given to the learners. The aim of this study was to examine the relation between learners' self-intervention perceptions and their metacognitive awareness and create a learner profile based on these assessments.

Method

Participants tested themselves repeatedly through a web-based self-assessment system (WB-SS) and feedback of differing types was given to the learners based on the existing standards, the learner's position in the group and a comparison with their previous performances. The effects of metacognitive awareness on the learners' perception of their interventions into their own learning process following feedback were examined and an attempt was made to create a learner profile.

The correlational research method was employed to determine the correlations between learners' perception of the interventions in their own learning process and their metacognitive awareness. The structural equation model was produced in order to examine the effects of metacognitive awareness (knowledge and regulation of cognition) on the self-intervention perception in the WB-SS.

Study Group

The study was composed of 59 students (32 females and 27 males) attending the Measurement and Evaluation in Education course in the Computer and Instructional Technologies Department of the Faculty of Education.

Web-based Self-Assessment System

The REAP (Re-engineering Assessment Practices), WET (Vocational Education and Training), WATA (Web-based Assessment and Test Analysis System) systems and the guides and principles concerning these systems (Nicol, 2007; 2009; Nicol & Macfarlane-Dick, 2006; Wang, 2007; 2014; Wang, Wang, Wang, Huang, & Chen, 2004) were reviewed to determine system components during the development stage of this study. The system was designed on the basis of curriculum-based measurement models. An item pool was created to allow for repeated measurements.

The assessment system developed by Bayazıt (2007) was modified to suit the research purposes. Students were able to access to the assessment system using their student number and passwords. Entering the system, the participants were able to complete the test assigned by the educator at any time before the deadline.

Question numbers were listed in the menu on the left side of the screen and the test title and time allocated at the top. When answered, questions could be completed by clicking on the "save answer" button. Questions could be left blank if desired. By clicking the "finish test" button participants were able to exit the test before the time was completed (Figure 1).

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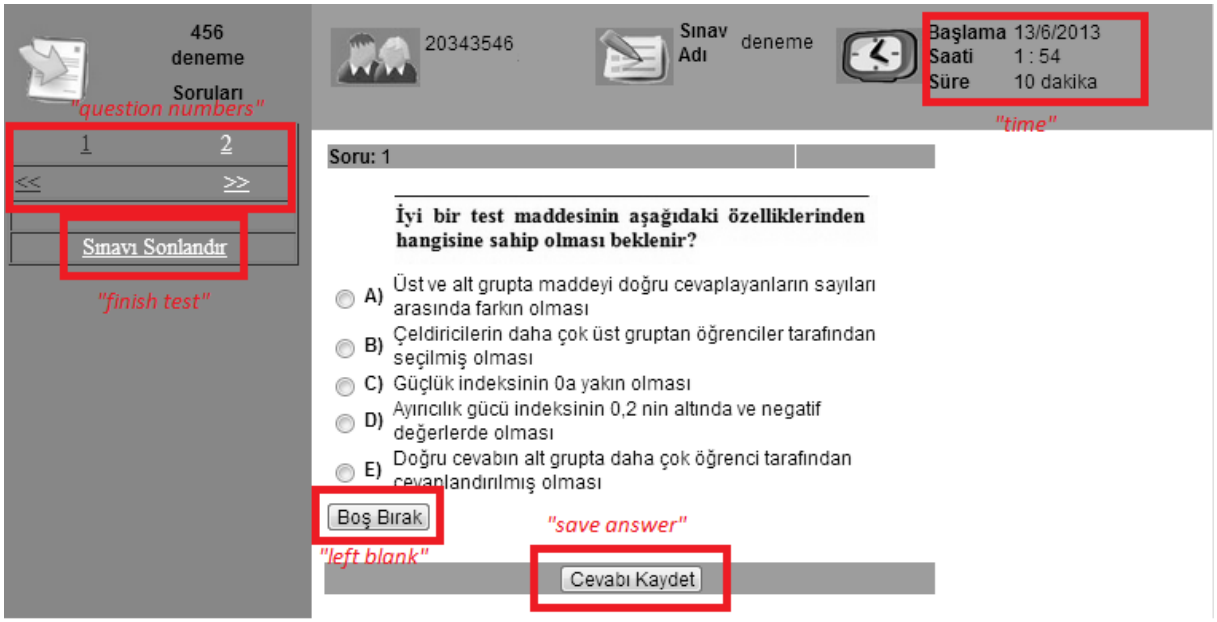

Figure 1. Test Interface

A wide variety of classifications have been provided in the literature with regard to the types of feedback and feedback strategies (Dempsey & Wager, 1988; cited by Mory, 2004; p.757; Hattie & Timperley, 2007; Kulhavy & Stock, 1989; Shute, 2008). The feedback types used in the WB-SS are illustrated in Table 1.

Table 1: Types of Feedback Used in The Feedback Cards

Categories	Types of Feedback	Explanation
According to the information contained (Kulhavy & Stock, 1989)	Verification	Information on whether responses given to each question are correct or incorrect
	Elaboration	Information as to under what heading each question is included within the scope of the curriculum. Learners can thus see what subject to study.
According to the context of the information contained (Hattie & Timperley, 2007)	Feedback for confirmation	Information offered in relation to confirming the performance displayed by the learners
According to the reference for comparison (Brookhart, 2008)	Criterion referenced	Information on learners' position according to the curriculum
	Norm referenced	Information on learners' position compared to the other learners (in what order, SATO caution index, Chen, Lai, & Liu, 2005; Acar, 2006)
	Self-referenced	Information on learners' position in previous tests
According to level (Hattie & Timperley, 2007)	Task	Assessment feedbacks providing information at the task level
According to the time of giving (Dempsey & Wager, 1988; Akt: Mory, 2004, p. 757)	Delayed	Feedback card given to the learners after completion of the time allocated to the tests.

In the process, criterion, norm and self-referenced feedbacks were given together. Therefore, each test deadline had to be waited to generate norm referenced feedback and feedback were presented as delayed.

The system was opened to access at week 10 of the semester. Face-to-face classes continued for the remaining 4 weeks of the semester and the students completed the 4 tests assigned to them.

Participants were not obliged to use the system and no extra scores were given to those who had used it.

Participants were given five days to take each test. Tests were announced to participants in a written message on a web-based social network. Data were analysed by the researcher after the five-day period. Individualised feedback based on the data were created by the researcher and e-mailed to the students 2 days later. At the end of the four weeks, the students answered the items in the Metacognitive Awareness Inventory and the Perceived Self-Intervention Scale.

Data Collection Tools

The web-based tests, the Perceived Self-Intervention Scale and the Metacognitive Awareness Inventory were answered by the participants.

Web-based Tests

Four tests were created for the system. The first one was composed of 15 multiple-choice questions to familiarize the learners with the system. The remaining 3 tests each contained 35 multiple-choice items prepared on the basis of the achievement test developed by Doğan and Inal (2012) and expert opinion.

The Perceived Self-Intervention Scale in the WB-SS

Deno's special education problem solving model (1998; p.12) was first examined during the development of the self-intervention scale. Accordingly, the intervention was defined as a decision-making process based on data collected using a systematic approach. Twelve items were prepared by the researchers and the opinion of 3 students representative of the study group on their understanding of the items. Responses were given based on a 7-point Likert scale with 1 representing *I strongly disagree* and 7 *I strongly agree.*

A total of 59 participants answered the assessments. Missing data were compensated for with the average. Kurtosis and skewness values were in the -3 to +3 range, demonstrating a normal distribution. The KMO value was 0.915 and the Barlett test was significant ($p < 0.05$). Confirmatory factor analysis was performed to determine the factorial validity of the structure of the Perceived Self-Intervention Scale in the WB-SS. It is recommended that the number of samples should be 3 or 10 times greater than the number of items for confirmatory factor analysis (Kline, 2005). The fact that the number of students in the study group was restricted to the students accessing the system may be considered to be a limitation of this research. The fit and error indices determined in consequence of the analyses were interpreted accordingly.

The fit and the error indices and recommended modifications were analysed in the confirmatory factor analysis. In addition, an exploratory factor analysis was performed to observe how the items moved. Due to the presence of overlapping items, 2 items were removed from the measurement models to be established in the confirmatory factor analysis. Later, a one-dimensional measurement model was established and the fit and error indices were checked. The fit and the error indices conformed to the desired criteria ($X^2(43) = 48.13$, $p > 0.05$, RMSEA = 0.05, GFI = 0.86; CFI = 0.99; NNFI = 0.99).

The reliability of the scale was tested using both the construct validity (0.94) and the Cronbach Alpha (0.94). Both values were above 0.70, the level reported as valid by Nunnully and Berstein (1994).

The construct validity, which determined whether or not a scale measures the intended structure, was analysed using the techniques of convergent validity and discriminant validity. Factor loads and the average variance extracted (AVE = 0.60) were larger than 0.50, reflecting convergent validity. As shown in Figure 2, the standardized factor loads of the scale items in relation to the dimension ranged between 0.66 and 0.89, and t values for the factor loads were significant. It was also determined that the average variance extracted values were greater than 0.50, the determined value.

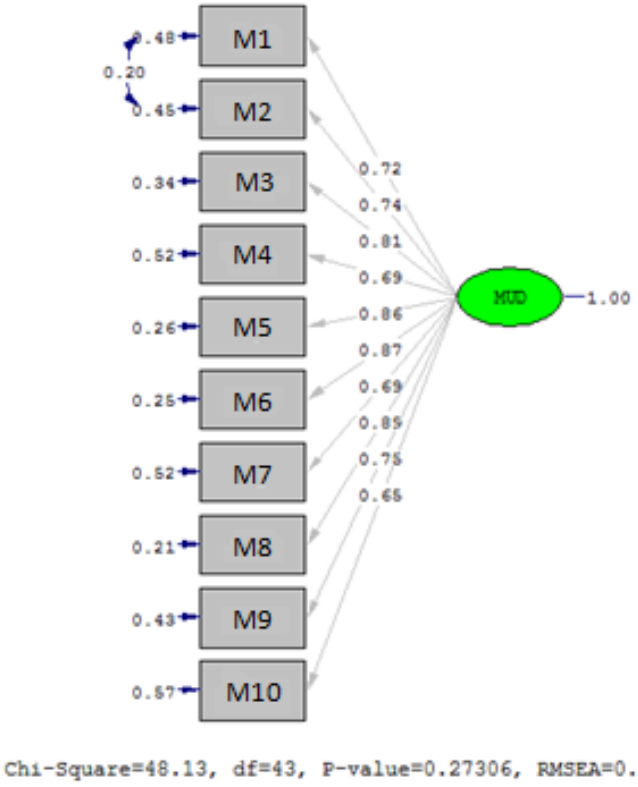

Figure 2. The Standardized Parameter Values for the Scale of Self-Intervention Perceived in the WB-SS (MUD: Self Intervention, M1: Item 1)

Metacognitive Awareness Inventory (MAI)

The Metacognitive Awareness Inventory was developed by Schraw and Dennison (1994) for adults. The validity and reliability analyses of the Turkish version were performed by Akın, Abacı and Çetin in 2007. The 52-item inventory was scored in the form of 5-pointed Likert scale, with 1 representing *Never*, 2 *Rarely*, 3 *Often*, 4 *Usually* and 5 *Always*. The original form of the MAI was composed of 8 factors in the two basic dimensions of knowledge of cognition and regulation of cognition. The knowledge of cognition dimension contained three sub-dimensions: declarative knowledge, procedural knowledge, and conditional knowledge. The regulation of cognition dimension contained five sub-dimensions: planning, monitoring, evaluation, debugging, and information management (Schraw & Dennison, 1994; Akın, Abacı, & Çetin, 2007). The internal consistency coefficient for the whole inventory was 0.95. Permission was obtained from the researchers to use the scale. The internal consistency coefficient calculated in this research was 0.92 for the whole inventory, 0.83 for the dimension of knowledge of cognition, and 0.89 for the dimension of the regulation of cognition.

Results

This study investigated the relationship between "perceived self-intervention" and "metacognition awareness". Unrelated factor scores were calculated for each dimension of the Metacognitive Awareness Inventory. The equation model was created to examine the effects of these two structures on self-intervention as perceived in the WB-SS.

The fit and the error indices (GFI = 0.81; RMSEA = 0.00; NNFI = 1.00; CFI = 1.00) demonstrated that all indices with the exception of GFI were within the acceptable ranges. Because the GFI value was influenced by the number of observations (Breivik & Olson, 2011; cited in Kline, 2011; p.207), it was found that the good model-data fit when the other fit and error indices were considered as the basis. The effect model and the standardized parameter values are shown in Figure 3.

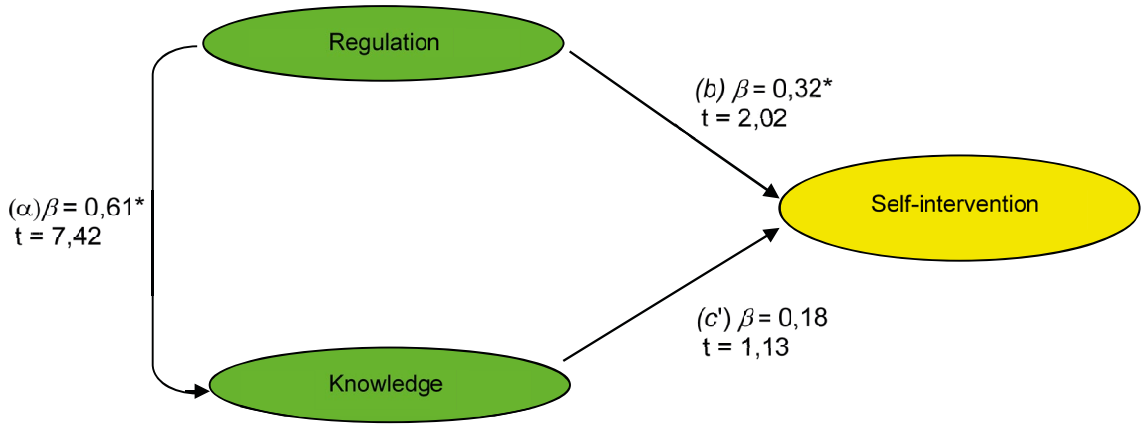

Figure 3. The Standardized Parameter Values for the Effect Model of Learners' Knowledge and Regulation of Cognition on the Self-Intervention Perceived in the WB-SS, * significant at the $p < 0.05$ level. (β (Standardized regression coefficients) can be interpreted as the correlation coefficient.)

Scores for the regulation of cognition had significant effects on the perceived self-intervention in the WB-SS according to the model ($\beta = 0.32$; $t = 2.02$) (Figure 3). As the learners' metacognitive regulation skills were high, feedback obtained from the self-assessment were used to shape their own learning process. On the other hand, low or high levels of metacognitive knowledge awareness did not have a scientifically significant effect on the revision of learning experiences. However, Ibabe and Jauregizar (2009) argued that learners require self-assessment activities to develop their metacognitive knowledge. The findings in this research, however, indicated that the learners' benefited from self-intervention independently of the metacognitive knowledge awareness due to the assessment experiences provided for the learners in the self-assessment environment. Determining the relation between metacognitive knowledge and metacognitive regulating skills in particular ($r = 0.61$; $R^2 = 0.37$) necessitates additional analyses. The level of metacognitive knowledge awareness is high in learners with a high level of metacognitive regulation skills awareness (the opposite is also true). This finding was in line with that obtained in the literature (Declos & Harrington, 1991). Therefore, it may be said that learners require cognitive knowledge for regulation skills (Pintrich, 2002). However, the presence of an unexplained variance [0.63 ($1-R^2$)] was thought to have stemmed from the fact that the metacognitive regulation awareness played an instrumental role in the model as the effect coefficients gave the total effect and not the direct effect (Figure 4).

Baron and Kenny (1986) reported several conditions that should be met in order to determine whether a variable is instrumental. The knowledge of cognition should affect the regulation of that

cognition [(a) β = 0.61; t = 7.42] and this regulation should in turn affect the perception of self-intervention [(c) β = 0.37; t = 2.82] (Figure 4). In addition, while the effects of the regulation of cognition and of the cognitive knowledge on self-intervention are examined together, the previously existing significant effect between cognitive knowledge and self-intervention perception should not be significant and the previous level of significance should be reduced [(c) β = 0.18; t = 1.13].

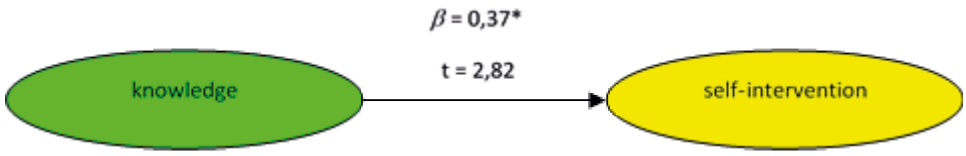

Figure 4. The Standardized Parameters for the Effect Model of Learners' Knowledge of Cognition on the Self-Intervention Perceived in the WB-SS

The fit and the error indices (GFI = 0.80; RMSEA = 0.06; NNFI = 0.98; CFI = 0.98) established to determine the influence of the knowledge of cognition on self-intervention perception showed that all the indices were within the acceptable range, with the exception of GFI. According to the model, knowledge of cognition had a statistically significant effect on the perception of self-intervention (β = 0.37; t = 2.82) (Figure 4), higher than that of the previous model (β = 0.18; t = 1.13) (Figure 3). In other words, whereas there were no statistically significant effects of metacognitive knowledge on self-intervention in the regulation of cognition model (Figure 3), there were significant effects in the reduced model set up to observe direct effects (Figure 4). These findings show that Baron and Kenny's conditions (1986) were met, that knowledge of cognition had indirect effects on the perception of self-intervention, and that the regulation of cognition was the mediator variable.

Discussion, Conclusion and Suggestions

Self-assessment activities and experiences are defined as decisions made by students in relation to their current learning status (Andrade & Valtcheva, 2009; Terzis & Economides, 2011) and are important elements in learner-centred e-learning systems (Roberts, 2006; p.14). While such self-assessment methods are often used in the learning management systems (LMS) of higher education institutions, they are inadequate for providing configured/individualized feedback and/or repeated self-assessment tests.

This study aimed therefore to examine the relation between learners' metacognitive awareness and their self-intervention perceptions and create an individualized learner profile using a web-based self-assessment system with delayed feedback. By connecting the system with the curriculum of a specific class using curriculum-based measurements (Deno, 1985), learners were provided with the opportunity to repeatedly test themselves. Thus, learners were able to observe both their current level of learning and their development in terms of the same learning products through self-referenced feedback. The repeated self-assessment enabled learners to decide whether self-interventions were needed in their own learning process and to understand their effectiveness. This approach is supported by intervention theory. It has been reported in the literature that learners have differing perceptions of external feedback after their computer based assessment experiences (Timmers & Veldkamp, 2011). Thus, it becomes important to determine the variables influencing the perceived self-intervention. Our results found that learners with high levels of metacognitive skills awareness (regulation of cognition) also had high levels of perceived self-intervention. On the other hand, while learners' perceived self-intervention was influenced by their metacognitive skills, their perceived self-intervention acted independently of their level of metacognitive

knowledge (knowledge of cognition). Examination of the direct effects of metacognitive knowledge on the perception of self-intervention revealed that the effect was statistically significant and higher than the indirect effect. In connection, regulation skills may be considered to function as a mediator variable between metacognitive knowledge and the perceived self-intervention. On reviewing the literature concerning metacognition, metacognitive knowledge was observed to be a pre-requisite for metacognitive regulations (Pintrich, 2002). In addition, Ibabe and Jauregizar (2009) argued that self-intervention experiences are useful in developing metacognitive knowledge in particular. However, the current research showed that metacognitive knowledge is meaningful only in implementing the metacognitive regulation skills in the use of knowledge obtained from self-assessment experiences for the purposes of self-intervention. In line with these results, it might be concluded that metacognitive knowledge is inadequate while learners are using the web-based self-assessment system with delayed feedback and that guides are needed to show how metacognitive knowledge employs metacognitive skills. In a nutshell, the results of the study demonstrated the importance of metacognitive skills of students when the self-assessment systems used to support the learning process in blended learning. In the study, delayed feedback was given because of the norm referenced feedback. Web-based self-assessment system has been updated for giving immediate feedback and it is planned to examine these structures again for the new system.

References

1. Acar, T. (2006). *Sato uyarı indeksleri ile madde ve başarı analizleri.* Retrieved from http://www.parantezegitim.net/hakkimizda/Sato-TulinACAR.pdf
2. Akın, A., Abacı, R., & Çetin, B. (2007). The validity and reliability study of the Turkish version of the Metacognitive Awareness Inventory. *Educational Science: Theory & Practice, 7*(2), 671-678.
3. American Psychological Association (1997). *Learner-centered psychological principles: A framework for school reform and redesign.* Retrieved from http://www.apa.org/ed/governance/bea/learner-centered.pdf
4. Andrade, H., & Valtcheva, A. (2009). Promoting learning and achievement through self-assessment. *Theory into Practice, 48*(1), 12-19. doi: 10.1080/00405840802577544
5. Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.
6. Bayazıt, A. (2007). *Çevrim içi sınavlar ve kağıt-kalem sınavları arasındaki sınav süresi ve öğrenci başarım farklılıkları.* PhD diss., University of Hacettepe.
7. Bayrak, F. (2014). *The effectiveness of perceived self intervention in web based self-assessment system*. PhD diss. University of Hacettepe.
8. Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education, 5*(1), 7–74. doi: 10.1080/0969595980050102
9. Boud, D. (2000). Sustainable assessment: rethinking assessment for the learning society. *Studies in Continuing Education, 22*(2), 151-167. doi: 10.1080/713695728
10. Brookhart, S. M. (2008). *How to give effective feedback to your students.* Alexandria, VA: ASCD.
11. Chen, D., Lai, A., & Liu, I. (2005). The design and implementation of a diagnostic test system based on the enhanced S-P model. *Journal of Information Science and Engineering, 21,* 1007-1030.

12. Conejo, R., Guzmán, E., Millán, E., Trella, M., Pérez-De-La-Cruz, J. L., & Ríos, A. (2004). SIETTE: A web–based tool for adaptive testing. *International Journal of Artificial Intelligence in Education, 14*(1), 1-33.
13. Ćukušić, M., Garača, Ž., & Jadrić, M. (2014). Online self-assessment and students' success in higher education institutions. *Computers & Education, 72*, 100-109.
14. Davies, S. (2010). *Effective assessment in a digital age A guide to technology-enhanced assessment and feedback*. Bristol: JISC Innovation Group.
15. Delclos, V. R., & Harrington, C. (1991). Effects of strategy monitoring and proactive instruction on children's problem-solving performance. *Journal of Educational Psychology, 83*(1), 35-42. doi: 10.1037/0022-0663.83.1.35
16. Deno, S. L. (1985). Curriculum-based measurement: the emerging alternative. *Exceptional children, 52*(3), 219-232.
17. Deno, S. L. (1998). Curriculum-based measurement and special education services: A fundamental and direct relationship. In M. R. Shinn (Ed.), *Curriculum-based measurement: Assessing special children* (pp.1-17). Guilford Press.
18. Doğan, N., & İnal, H. (2012, September). *Eğitim fakültesi öğrencilerinin öğrenme stilleri ve ölçme ve değerlendirme dersi başarısı arasındaki ilişki.* Paper presented at Eğitimde ve Psikolojide Ölçme ve Değerlendirme III. Ulusal Kongresi, Bolu, September, 19-21.
19. Eva, K. W., & Regher, G. (2005). Self-assessment in the health professions: A reformulation and research agenda. *Academic Medicine, 80*(10), S46–S54. doi:10.1097/00001888-200510001-00015.
20. Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906-911.
21. Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education, 57*(4), 2333-2351. doi: 10.1016/j.compedu.2011.06.004
22. Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77,* 81-112. doi: 10.3102/003465430298487
23. Ibabe, I., & Jauregizar, J. (2010). Online self-assessment with feedback and metacognitive knowledge. *Higher Education, 59*(2), 243-258. doi: 10.1007/s10734-009-9245-6
24. Karakelle, S., & Saraç, S. (2010). Üst biliş hakkında bir gözden geçirme: üst biliş çalışmaları mı yoksa üst bilişsel yaklaşım mı? *Türk Psikoloji Yazıları, 13*(26), 45-63.
25. Karran, T. (2005). On-line assessment for E-Learning: options and opportunities. In T. Latomaa, J. Pohjonen, J. Pulkkinen, & M. Ruotsalainen (Eds.), *eReflections: Ten years of educational technology studies at the University of Oulu* (pp. 109-125). Oulu, Finland: Oulun yliopiston kasvatustieteiden tiedekunnan. Retrieved from http://eprints.lincoln.ac.uk/1610/1/OuluAssessmentChapterforRepository.pdf
26. Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford Publication, Inc.
27. Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York: Guilford Publication, Inc.
28. Kulhavy, R. W., & Stock, W. A. (1989). Feedback in written instruction: The place of response certitude. *Educational Psychology Review, 1*(4), 279–308.

29. Martinez, M. E. (2006). What is metacognition? *Phi Delta Kappan, 87*(9), 696–699.
30. McMillan, J. H. (2007). *Formative classroom assessment: Research, theory and practice.* New York: Teacher's College Press.
31. Mok, M. M. C., Lung, C. L., Cheng, D. P. W., Cheung, R. H. P., & Ng, M. L. (2006). Self-assessment in higher education: experience in using a metacognitive approach in five case studies. *Assessment in Education, 3*(4), 415-433. doi: 10.1080/02602930600679100
32. Molloy, E.K., Borrell-Carrio, F., & Epstein, R. (2013). The impact of emotions in feedback. In D. Boud & E. Molly (Eds.), *Feedback in Higher and Professional Education – Understanding It and Doing It Well* (pp-50-71). London: Routledge.
33. Mory, E. H. (2004). Feedback research revisited. *Handbook of research on educational communications and technology, 2,* 745-783.
34. Nicol, D. (2007). E-assessment by design: using multiple choice tests to good effect. *Journal of Further and Higher Education, 31*(1), 53-64. doi: 10.1080/03098770601167922
35. Nicol, D. (2009). *Transforming assessment and feedback: enhancing integration and empowerment in the first year.* Mansfield: The Quality Assurance Agency for Higher Education.
36. Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education, 31*(2), 199-218. doi: 10.1080/03075070600572090
37. Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York: McGrawHill.
38. Orsmond, P. (2011). *Self-and peer-assessment: guidance on practice in the biosciences.* Centre for Bioscience, The Higher Education Academy.
39. Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. *Theory into Practice, 41*(4), 219-225. doi: 10.1207/s15430421tip4104_3
40. Roberts, T. S. (Ed.). (2006). *Self, peer and group assessment in e-learning.* IGI Global.
41. Sadler, D. R. (1998). Formative assessment: revisiting the territory. *Assessment in Education: Principles, Policy & Practice, 5*(1), 77-84. doi: 10.1080/0969595980050104
42. Sargeant, J. M., Mann, K. V., van der Vleuten, C. P., & Metsemakers, J. F. (2009). Reflection: a link between receiving and using assessment feedback. *Advances in Health Sciences Education, 14*(3), 399-410.
43. Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*, 460-475.
44. Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*(1), 153–189. doi: 10.3102/0034654307313795
45. Tan, K. (2007). Conceptions of self-assessment: What is needed for long term learning? In D. Boud & N. Falchikov (Eds.), *Rethinking assessment in higher education: Learning for the longer term* (pp. 114-127). London: Routledge.
46. Terzis, V., & Economides, A. A. (2011). The acceptance and use of computer based assessment. *Computers & Education, 56*(4), 1032-1044. doi: 10.1016/j.compedu.2010.11.017
47. Timmers, C., & Veldkamp, B. (2011). Attention paid to feedback provided by a computer-based assessment for learning on information literacy. *Computers & Education, 56*(3), 923-930. doi: 10.1016/j.compedu.2010.11.007

48. Vaughn, S., & Fuchs, L. S. (2003). Redefining learning disabilities as inadequate response to instruction: The promise and potential problems. *Learning Disabilities Research & Practice, 18*, 137-146. doi: 10.1111/1540-5826.00070

49. Wang, T. H. (2007). What strategies are effective for formative assessment in an e-learning environment? *Journal of Computer Assisted Learning, 23*(3), 171–186. doi: 10.1111/j.1365-2729.2006.00211.x

50. Wang, T. H. (2014). Developing an assessment-centered e-Learning system for improving student learning effectiveness. *Computers & Education, 7,* 189-203. doi: 10.1016/j.compedu.2013.12.002

51. Wang, T. H., Wang, K. H., Wang, W. L., Huang, S. C., & Chen, S. Y. (2004). Web-based Assessment and Test Analyses (WATA) system: development and evaluation. *Journal of Computer Assisted Learning, 20*(1), 59-71. doi: 10.1111/j.1365-2729.2004.00066.x

52. Wilson, K., Boyd, C., Chen, L., & Jamal, S. (2011). Improving student performance in a first-year geography course: Examining the importance of computer-assisted formative assessment. *Computers & Education, 57*(2), 1493-1500.

53. Yorke, M. (2003). Formative assessment in higher education: moves towards theory and the enhancement of pedagogic practice. *Higher Education, 45*(4), 477–501.