Eğitimde Kuram ve Uygulama
Journal of Theory and Practice in Education
ISSN: 1304-9496

Articles /Makaleler
2016, 12(1), 1-16

THE IDENTIFICATION OF THE VIEWS OF RATERS ON STANDARD RUBRICS AND RUBRICS BASED ON THE SOLO TAXONOMY*

(STANDART VE SOLO TAKSONOMİSİNE DAYALI RUBRİKLER HAKKINDAKİ PUANLAYICI GÖRÜŞLERİNİN İNCELENMESİ)

Mustafa İLHAN[1]
Bayram ÇETİN[2]

ABSTRACT

The purpose of the study was to provide a comparative analysis of the views of raters on rubrics that are not based on a particular taxonomy and those that are based on the SOLO taxonomy. The study was designed as a descriptive one, and the data were collected through two surveys comprised of close-ended and open-ended questions. A total of seven mathematics teachers (three women and four men) participated in the study. The data collection procedure was divided into several stages. First, a mathematics achievement test, which was composed by the researchers and comprised of eight open-ended questions, was administered to 104 eight grade students. Afterwards, the raters rated the students' responses using the standard rubrics developed by the researchers. This was followed by the administration of *the Survey of the Views on Standard Rubrics* to the raters. Next, the raters rated the responses for the second time, this time using the rubrics developed by the researchers on the basis of the SOLO taxonomy. Then, the raters were subject to *the Survey of the Views on the SOLO Taxonomy*. The close-ended questions included in the surveys were analyzed through arithmetic mean values whereas the open-ended ones were analyzed descriptively. The findings suggested that the raters viewed rubrics based on the SOLO taxonomy as a better rating scale than standard ones in terms of objectivity, the ability to distinguish among students of varying levels, the ability to provide effective feedback on student performance, and ease of preparation and use.

Keywords: Rubric, the SOLO taxonomy, views of rater

ÖZET

Bu araştırmada, herhangi bir taksonomi temele alınmadan hazırlanan standart rubrikler ve SOLO taksonomisine dayalı rubrikler hakkındaki puanlayıcı görüşlerinin karşılaştırmalı olarak incelenmesi amaçlanmıştır. Araştırma, verilerin kapalı ve açık uçlu sorulardan oluşan bir anket aracılığıyla toplandığı betimsel bir çalışma olarak desenlenmiştir. Araştırmanın katılımcılarını üçü bayan ve dördü erkek olmak üzere yedi matematik öğretmeni oluşturmaktadır. Araştırma verilerinin toplanması birkaç aşamada gerçekleşmiştir. İlk olarak, araştırmacılar tarafından geliştirilen ve açık uçlu sekiz sorudan oluşan matematik başarı testi sekizinci sınıfa devam eden 104 öğrenciye uygulanmıştır. Daha sonra puanlayıcılar, araştırmacılar tarafından geliştirilen standart rubrikleri kullanarak öğrenci cevaplarını puanlamıştır. Puanlamaları takiben, standart rubrik ile düşünceler anketi puanlayıcılara uygulanmıştır. Ardından, yine araştırmacılar tarafından geliştirilen SOLO taksonomisine dayalı rubrikler kullanarak ikinci puanlama işlemi yapılmıştır. Puanlamalar sonrasında SOLO taksonomisi ile ilgili düşünceler anketi puanlayıcılara uygulanmıştır. Standart ve SOLO taksonomisine dayalı rubrikler hakkındaki düşünceler anketinde yer alan kapalı uçlu soruların analizinde aritmetik ortalama değerleri kullanılırken, açık uçlu soruların çözümlenmesinde betimsel analiz yaklaşımından yararlanılmıştır. Araştırmada puanlayıcıların; objektiflik, ölçülen özelliğin farklı seviyelerindeki öğrencilerin birbirinden ayırt edilebilmesi, öğrencilere performansları ile ilgili etkili geri bildirimler sunulabilmesi, hazırlanma ve kullanım kolaylığı gibi özellikler açısından SOLO taksonomisine dayalı rubrikleri standart rubriklere kıyasla daha etkili bir puanlama ölçeği olarak gördükleri belirlenmiştir.

Anahtar Sözcükler: rubrik, SOLO taksonomisi, puanlayıcı görüşeri

---

* This study includes a part of the PhD thesis by Mustafa İLHAN

[1] Research Assistant, PhD, Dicle University, Ziya Gokalp Faculty of Education, mustafailhan21@gmail.com
[2] Associate Proffesor, Gazi University, Gazi Faculty of Education, bcetin27@gmail.com

INTRODUCTION

Depending on how they are rated, tests used in education and psychology are commonly divided into two, namely objective tests and subjective tests. Objective tests are those measurement instruments with predetermined answer keys that are easy to rate and free from rating errors. In the rating of such instruments, the rater's subjective judgments cannot affect the student's score. Examples include multiple-choice tests, matching tests, and true-false tests (Dogan, 2013). On the other hand, measurement instruments that cannot be rated objectively, including written and oral exams, entail that the student's score differs depending on the rater. Susceptible to the rater's subjective judgments (Tekin, 2009), such measurement instruments are considered as a way of performance assessment (Stecher, 2010). In performance assessment, it is hard to make sure that the student is assigned the same score by all the raters (Turgut & Baykul, 2012). Therefore, raters remain as a variable in the way student performance is interpreted (Congdon & MeQueen, 2010). Rater-induced factors in students' performance scores are collectively called the rater effect (Schaefer, 2008). The achievement of an acceptable level of reliability in performance assessment can only be possible through the minimization of rater effects. Various recommendations have been made for reducing rater effects that interfere with performance assessment, such as the use of more than one rater in the rating process (Ebel, 1951) and organizing training sessions for raters (Woehr, 1994). Another way to decrease rater effects is to use a rubric (Wolf & Stevens, 2007).

Rubrics are rating guides that define the characteristics and criteria associated with various aspects of performance and that are used for making judgments on performance in reference to these characteristics and criteria (Kan, 2007). They enable the rating procedure to be carried out independently of the time of rating and the rater. In this way, they help to minimize rater effects that could interfere with performance assessment (Moskal & Leydens, 2000). Some rubrics are not based on a particular taxonomy. In the present study, those rubrics that are not based on a particular taxonomy were called *standard rubrics*. In standard rubrics, the criteria used to evaluate learning outputs are determined without the use of a taxonomy, and are based on rankings such as *insufficient*, *needs to be improved*, *acceptable*, *good* and *very good* (Gronlund, 1998). The level that corresponds to a student's answer is determined considering the procedure followed in the solution of problem, the accuracy of the answer, and the adequacy and comprehensibility of the explanation of the problem's solution. For instance, if both the answer and the method used to solve an open-ended mathematics problem are wrong, it indicates *insufficiency*. If the method is correct, but the operations and the answer are wrong, the answer *needs to be improved*. If the answer is correct, and the steps used to solve the problem are clear and comprehensible, the answer is graded as *very good*.

On the other hand, rubrics can also be developed on the basis of various models such as the reflective thinking model, Bloom's taxonomy or the SOLO taxonomy (Chan, Tsui, Mandy & Hong, 2002). Those rubrics based on the SOLO taxonomy, in particular, are commonly used for rating open-ended questions for

many different courses and for many different educational stages from primary school to higher education (Hattie & Purdie, 1998).

The SOLO taxonomy was put forward by Biggs and Collis (1982) to explain the structure of observed learning outcomes. According to the taxonomy, the learning cycle is comprised of a five-level structure including prestructural level, unistructural level, multistructural level, relational level, and extended abstract level (Mohd Nor & Idris, 2010). At the prestructural level, the student cannot perform the required task in a proper way (Leung, 2000). At the unistructural level, the student deals with the subject from a narrow and superficial point of view and focuses on one single aspect. At the multistructural level, the student can understand more than one aspect of the subject but fails to establish a connection (Lucas & Mladenovic, 2009). It is in the relational level that the student can see various aspects of the subject and use them to form a meaningful whole. At this level, concepts can be applied to similar situations or problems (Kanuka, 2011). The extended abstract level is described as the level in which the student can be involved in reflection and assessment, create hypotheses, and transfer what is learnt to a different field through the use of inductive, deductive and combinational thinking processes (Lake, 1999). In other words, association, consistency and multi-faceted thinking are enhanced as one proceeds from the bottom levels to the upper ones in the SOLO taxonomy (Hattie & Purdie, 1998).

The use of a rubric based on the SOLO taxonomy provides one with a number of advantages regarding the evaluation process. First of all, the SOLO taxonomy does not make an evaluation like the student has understood the subject or the student has not understood the subject; instead, it is focused on the extent to which the subject has been understood (Ireson, 2008). In other words, an evaluation based on the SOLO taxonomy gives an answer to the question as to "the extent to which the student has understood the subject." Next, rubrics based on the SOLO taxonomy enable one to determine not only quantitative but also qualitative aspects of learning. As a matter of fact, the levels of the SOLO taxonomy have been arranged in a way that will reflect quantitative and qualitative learning (Burnett, 1999). For instance, a student who has failed to understand the subject or misunderstood the subject at the prestructural level will be focused on one single aspect of the subject at the unistructural level and will be able to list more than one aspect of the subject at the multistructural level without being able to establish a connection among them. Therefore, the student experiences a quantitative increase in his/her learning while he/she is moving from the prestructural level to the multistructural level. On the other hand, a student at the relational level can form a meaningful whole using the characteristics he/she has listed at the multistructural level, and he/she can transfer the consistent whole he/she has achieved at the relational level to a different field and can restructure it at a higher level of abstraction. In this respect, relational and extended abstract levels represent qualitative aspects of learning (Brabrand & Dahl, 2009).

According to Hattie and Purdie (1994), another advantage of rubrics based on the SOLO taxonomy is that they can ensure a higher inter-rater reliability. Studies on the advantages of the use of rubrics based on the SOLO taxonomy are significant in that they can reveal how functional it is for the evaluation process to base rubrics on the SOLO taxonomy. Nevertheless, it is still necessary to explore how raters view standard rubrics that are not based on a particular taxonomy and those rubrics that are based on the SOLO taxonomy so as to fully reveal how functional the latter is when compared to the former. In this context, the purpose of the present study is to compare and contrast, through the views of raters, standard rubrics and those rubrics that are based on the SOLO taxonomy in terms of objectivity, the ability to distinguish among students with varying levels of competence in a given subject, the ability to provide effective feedback on student performance, and ease of use and preparation. A review of literature suggests that there are already studies on the exploration of the views of raters concerning rubrics based on the SOLO taxonomy (Yazici, 2013). However, there are not any studies on the exploration of the views of raters to compare and contrast standard rubrics and those based on the SOLO taxonomy. The study of the views of raters on rubrics based on the SOLO taxonomy independently of their views on standard rubrics fails to provide an answer to the question as to how useful it is to base rubrics on the SOLO taxonomy. The present study attempts to provide a comparative analysis of the views of raters on standard rubrics and those based on the SOLO taxonomy; in this respect, it will hopefully reveal how raters view rubrics based on the SOLO taxonomy.

METHOD

Study Design

The study was designed as a descriptive one, and the data were collected through two surveys comprised of close-ended and open-ended questions. Descriptive studies attempt to reveal the existing state of a given subject.

Participants

The study was carried out with seven mathematics teachers who volunteered to participate in the study. Whereas three of them were women, the remaining four were men. Since the research was conducted on open-ended mathematics questions and rubrics used for scoring that questions, the participants of the study was determined as the mathematics teachers. The seven mathematics teachers who constitute the participants of the research were acted rater in the study. Therefore, the letter R was used to represent the participants. Table 1 presents the demographics of the participants.

Table 1. The Demographics of the Raters

Rater	Gender	Age	Length of Service as a Teacher	Educational Status
R1	Woman	22	-	She is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Mathematics Teaching.
R2	Woman	22	7 months	She is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Educational Measurement and Evaluation.
R3	Woman	23	7 months	She is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Educational Measurement and Evaluation.
R4	Man	26	2 years	He is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Educational Measurement and Evaluation.
R5	Man	25	2 years	He is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Educational Measurement and Evaluation.
R6	Man	25	7 months	He is a graduate in Elementary Mathematics Teacher Education and is currently doing a master's degree in Measurement and Evaluation.
R7	Man	26	3 years	He is a graduate in Mathematics Majored in Computer Science and is currently doing a master's degree in Educational Measurement and Evaluation.

Data Collection Instruments

Two surveys comprised of close-ended and open-ended questions were designed in order to determine the views of raters on standard rubrics and those based on the SOLO taxonomy. The procedures for the preparation of the survey were as follows.

The Survey of the Views on Standard Rubrics: A two-part survey was designed in order to reveal the views of the raters on standard rubrics. The first part contained 5 close-ended (structured) questions. Composed in reference to the relevant literature, these five items were measured on a five-point scale. Next, two experts were asked to assess the scope and comprehensibility of the items. They asserted that the first item must be expressed in a more clear way whereas no revision was required for the remaining four items. For the first item "The Objectivity of Standard Rubrics [*Too Low* (1) →*Very High* (5)]", the experts recommended that an explanation should be made as to what was meant by the term objectivity so that a common perception could be achieved among the raters. Accordingly, the item "The Objectivity of Standard Rubrics" was followed by the following explanation: "having the same result regardless of the rater." After necessary revisions were made in accordance with what the experts had recommended, the first part, which contained close-ended questions as to standard rubrics, was ready to use.

The second part of the survey consisted of open-ended (unstructured) questions as to the views of the raters on standard rubrics. Great care was taken to compose easily comprehensible questions and to avoid disputable, multi-

dimensional and prescriptive questions (Buyukozturk, Cakmak, Akgun & Demirel, 2010; Yildirim & Simsek, 2011). Furthermore, an attempt was made to avoid yes/no questions. The questions were composed in a way that would enable the raters to express their ideas in a clear way. For instance, the views of the raters on the objectivity of standard rubrics were explored not through the question "Do you think that standard rubrics are objective?" but through "What do you think about the objectivity of standard rubrics?" The second part contained six open-ended questions as to the objectivity of standard rubrics, their ability to provide feedback on students' strengths and weaknesses, and their ease of use. These questions were submitted to three experts who specialized in curriculum and instruction, measurement and evaluation and classroom teaching respectively. They were revised in accordance with their opinions. The second part was finalized after the questions were subject to required revisions and changes.

The Survey of the Views on Rubrics Based on the Solo Taxonomy: The questions as to the views of the raters on rubrics based on the SOLO taxonomy were borrowed from *the Survey of Views on Standard Rubrics*. Needless to say, the expressions "standard rubrics" were replaced by "rubrics based on the SOLO taxonomy." For example, the question as to "the ability of standard rubrics to provide feedback on students' strengths and weaknesses [*Too Low* (1) → *Very High* (5)]" was replaced by the question as to "the ability of rubrics based on the SOLO taxonomy to provide feedback on students' strengths and weaknesses [*Too Low* (1)→ *Very High* (5)]." The open-ended questions in the second part of the survey were subject to similar changes. To illustrate, the question "What do you think about the necessity of organizing training sessions on standard rubrics before they are administered?" was replaced by the question "What do you think about the necessity of organizing training sessions on rubrics based on the SOLO taxonomy before they are administered?" Unlike *the Survey of the Views on Standard Rubrics*, *the Survey of the Views on Rubrics Based on the Solo Taxonomy* included one more question as follows: "Do you prefer to use standard rubrics or rubrics based on the SOLO taxonomy for rating open-ended mathematics questions? Why?" Therefore, the second part of *the Survey of the Views on Standard Rubrics* contained six open-ended questions whereas the second part of *the Survey of the Views on Rubrics Based on the Solo Taxonomy* contained seven open-ended questions. Since the questions in the latter drew on the ones included in the former, they were not subject to expert judgment for the second time. However, this was not the case for the seventh question which was included in the *Survey of the Views on Rubrics Based on the SOLO Taxonomy* but not in *the Survey of the Views on Standard Rubrics*. This question was submitted to the three experts who had assessed the open-ended questions for standard rubrics. In this way, the *Survey of the Views on Rubrics Based on the SOLO Taxonomy* was ready to use, too.

Procedure

In order for the views of the raters on standard rubrics and those based on the SOLO taxonomy to be determined, these raters needed to be involved in rating by

using standard rubrics and those based on the SOLO taxonomy. The necessity was taken into consideration for the present study. First, the researcher composed a mathematics achievement test comprised of 8 open-ended questions, 8 standard rubrics for these questions (one rubric for each question), and 8 rubrics based on the SOLO taxonomy (one rubric for each question). Next, the achievement test was administered to 104 eight grade students, and the papers were photocopied. Since each of the seven raters in the study would have to rate the mathematics achievement test using a standard rubric and then a rubric based on the SOLO taxonomy, 14 copies were made for the exam papers. Afterwards, the raters rated the responses of the students to the open-ended mathematics questions using the standard rubrics. This was followed by the administration of *the Survey of the Views on Standard Rubrics* to the raters. Then, the raters rated the responses using those rubrics based on the SOLO taxonomy. This was followed by the administration of *the Survey of the Views on Rubrics Based on the SOLO Taxonomy* to the raters. In order to set an example; in appendix it was presented an open-ended math question and, the standard rubric and the rubic based and the SOLO taxonomy used for grading this guestion. For the reliability of the research, the procedures followed in the data collection process were described in detail. In addition, it was intended to increase the reliability of the study by confirming the responses to the closed-ended questions with the responses to the open-ended questions.

Data Analysis

The raters' responses to the close-ended questions included in *the Survey of the Views on Standard Rubrics* and *the Survey of the Views on Rubrics Based on the SOLO Taxonomy* were analyzed via arithmetic mean values. The responses to the open-ended questions, on the other hand, were subject to a descriptive analysis. In a descriptive analysis, data are interpreted in reference to predetermined themes (Yildirim & Simsek, 2011). For the present study, the data on the responses to the open-ended questions were interpreted in reference to the themes presented by the questions included in *the Survey of the Views on Standard Rubrics* and *the Survey of the Views on Rubrics Based on the SOLO Taxonomy*. Therefore, it was a good idea to use the descriptive analysis approach for analyzing the responses to the open-ended questions. Direct quotations were incorporated into the study so as to reflect the raters' views on the standard rubrics and those rubrics based on the SOLO taxonomy in a striking way. For the direct quotations, each rater was represented by the letter *R* and number. For instance, R1 and R5 stood for Rater 1 and Rater 5 respectively. An attempt was made to pick up those quotations that would reflect the existing state in the best way possible. Detailed reporting of the collected data and giving place to the direct quotations from the participants' opinions has contributed to ensure the validity of the study.

FINDINGS

The findings were presented in this section. First, the arithmetic mean values for the raters' responses to the close-ended questions in *the Survey of the Views on Standard Rubrics* and *the Survey of the Views on Rubrics Based on the SOLO Taxonomy* were calculated, and the findings were presented in Table 2. Next, their responses to the open-ended questions were classified in reference to the themes presented by the questions, and direct quotations were inserted when necessary.

Table 2. The Arithmetic Mean Values for the Raters' Responses to the Close-Ended Questions in the "Survey of the Views on Standard Rubrics" and the "Survey of the Views on Rubrics Based on the SOLO Taxonomy"

Items	Scale	Mean Value for the Rubrics Based on the SOLO Taxonomy	Mean Value for the Standard Rubrics
Objectivity (Having the same result regardless of the rater)	[*Very high (5)→ Too low (1)*]	4.33	3.00
Ability to distinguish among students with varying levels of competence in a given subject		3.83	3.00
Ability to provide feedback on students' strengths and weaknesses		3.83	3.00
Preparation	[*Very easy (5)→ Too difficult (1)*]	2.67	2.33
Use		4.50	3.17

The mean value for the objectivity of the standard rubrics ($\overline{X}$ =3.00) was lower than the one for the objectivity of the rubrics based on the SOLO taxonomy ($\overline{X}$ =4.33) (Table 2). The finding suggested that the raters considered the rubrics based on the SOLO taxonomy more objective when compared to the standard rubrics. In fact, the raters' responses to the open-ended question "What do you think about the objectivity of standard rubrics?" indicated that they thought the standard rubrics were not satisfactorily objective. On the other hand, the raters' responses to the question "What do you think about the objectivity of rubrics based on the SOLO taxonomy?" suggested that they thought such rubrics could enable student responses to be rated independently of the rater and they were more objective compared to the standard rubrics. Below are some quotations from the raters regarding their opinions about the objectivity of the standard rubrics and those based on the SOLO taxonomy.

…I think the standard rubrics are not satisfactorily objective. As for those rubrics based on the SOLO taxonomy, I consider them objective. I believe that most raters assign the same score to a student response when they rate using rubrics based on the SOLO taxonomy…[R7]

…although the standard rubrics might be objective for students that give a full answer to a question, they are not that objective for those who partially answer a question…[R1].

Those rubrics based on the SOLO taxonomy were better ($\overline{X}$ =3.83) than standard rubrics ($\overline{X}$ =3.00) at distinguishing among students of varying levels of competence in a given subject (Table 2). The raters reported that those rubrics based on the SOLO taxonomy were good at distinguishing among students of varying levels. In contrast, they asserted that the standard rubrics could not satisfactorily distinguish among students of varying levels. Some views of the raters are presented below.

…The standard rubrics are able to distinguish between low-level and high-level students, but they cannot distinguish intermediate-level students from others in a satisfactory manner…[R4]

…I think the standard rubrics will fail to distinguish among students of varying levels of competence in a given subject…[R2]

…Those rubrics based on the SOLO taxonomy play a pivotal role in disclosing the difference among students…[R1]

…I believe the SOLO taxonomy can distinguish students from one another by their levels…[R5]

The raters viewed those rubrics based on the SOLO taxonomy ($\overline{X}$ =3.83) as more successful than the standard rubrics ($\overline{X}$ =3.00) in providing feedback on students' strengths and weaknesses (Table 2). The raters reported that it was not clear in the standard rubrics what score to assign to a particular student, which made it difficult to provide meaningful feedback for students. Below is the explanation of one of the raters as to why the SOLO taxonomy was more successful in providing feedback on students' strengths and weaknesses.

…Making a comparison between those rubrics based on the SOLO taxonomy and the standard rubrics, I think the former is more useful. The reason is that those rubrics based on the SOLO taxonomy provide pinpoint clues as to what subjects students have problems with…[R1]

Although the raters reported that neither the rubrics based on the SOLO taxonomy nor the standard rubrics were easy to prepare, they stated that the former ($\overline{X}$ =2.67) was still easier to prepare than the other ($\overline{X}$ =2.33) (Table 2). One of the raters explained why the rubrics based on the SOLO taxonomy were easier to prepare than the standard ones as follows.

…Even though it is hard and time-consuming to prepare those rubrics based on the SOLO taxonomy, I think they can be prepared in an easier way when compared to the standard rubrics…[R1]

The mean value for the ease of use for those rubrics based on the SOLO taxonomy ($\overline{X}$ =4.50) was higher than the one for the standard rubrics ($\overline{X}$ =3.17) (Table 2). The finding suggested that the raters considered the rubrics based on the SOLO taxonomy easier to use when compared to the standard ones. This can also be concluded from the raters' responses to the open-ended questions as to the ease of use for the standard rubrics and those based on the SOLO taxonomy. Some quotations in this respect are presented below.

…It is easier to rate responses when using the rubrics based on the SOLO taxonomy. Compared to the standard rubrics, they do not make things complicated…[R4]

…The rubrics based on the SOLO taxonomy have clearer criteria for responses, which makes it easier to use such rubrics…[R7]

…What I like most about the rubrics based on the SOLO taxonomy is that the rating process was clear and easy. The reason is it was clear to determine what score should be assigned to a particular score…[R5]

The other question was as to their views on the necessity of organizing training sessions on the standard rubrics/rubrics based on the SOLO taxonomy before they were administered. The raters reported that it was necessary to provide training sessions on the rubrics, whether they were standard or based on the SOLO taxonomy.

...I think that could be useful, for rating through standard rubrics is not common. I am sure that the number of teachers who know about and use them is few…[R2]

...I believe that training sessions should be provided for anything that presents something new. For instance, I have been a teacher for two years, but I have been rating student responses in accordance with my own answer key. To be honest, I had difficulty in rating these 8 questions. Therefore, I am for the provision of training sessions on rubrics…[R5]

...I think training sessions are necessary. Otherwise, we might have had wrong results if we had used or applied the SOLO taxonomy to the rubrics without knowing anything about it…[R7]

The raters' responses to the close-ended and open-ended questions in *the Survey of the Views on Standard Rubrics* and *the Survey of the Views on Rubrics*

Based on the SOLO Taxonomy indicated that they considered the rubrics based on the SOLO taxonomy more efficient than the standard rubrics in terms of objectivity, the ability to distinguish, the ability to provide effective feedback, and ease of preparation and use. This was strongly suggested in the raters' responses to the following open-ended question: "Do you prefer to use standard rubrics or rubrics based on the SOLO taxonomy for rating open-ended mathematics questions? Why?" Some responses to the question are presented below.

...I definitely prefer to use the rubric based on the SOLO taxonomy, since it is easier to rate and more objective...[R4]

...I prefer to use those rubrics based on the SOLO taxonomy, since I believe they are more useful and objective...[R5]

...I prefer to use those rubrics based on the SOLO taxonomy. The reasons are they are more suitable for distinguishing between who knows and who does not, they are more useful in terms of planning, and they are more successful in distinguishing among varying levels of abilities...[R7]

DISCUSSION AND CONCLUSION

The present study attempted to comparatively explore the views of raters on standard rubrics that are not based on a particular taxonomy and those rubrics that are based on the SOLO taxonomy. According to the findings, the raters considered those rubrics based on the SOLO taxonomy more objective than the standard rubrics. One of the main aim of using rubrics in the scoring process is to reduce the rater effects and to increasre the rating's objectivity (Guler, 2012). Considering the raters' views on standard rubrics and rubrics based on the SOLO taxonomy, it could be argued that compared to standard rubric, SOLO based rubrics is a rating scale more serves to that purpose. This is supported by the theoretical idea that those rubrics based on the SOLO taxonomy provide objective criteria to be used in the evaluation process (Maddrell, 2011). The finding is also confirmed by empirical research. In the research conducted by Yazici (2013), three raters rate the responses of high school students to open-ended physics questions. First, the raters used their own rating scale. Next, they rated the same student responses using rubrics based on the SOLO taxonomy. Afterwards, they were asked to comment on these rubrics. All the three raters admitted that the rubrics based on the SOLO taxonomy were more objective than their own rating scales.

While expressing their opinions of the rubrics based on the SOLO taxonomy, the raters reported that such rubrics were easier to prepare and use than the standard rubrics. According to this, it can be said that the SOLO based rubrics are more practical than standard rubrics. The finding is consistent with what Yazici (2013) discovered. In that study, the participant raters viewed rubrics based on the SOLO taxonomy as easier to prepare and use than their own rating scales. In other words, there are parallels between the findings of the study conducted by Yazici (2013) and

the findings of the present study regarding the objectivity of rubrics based on the SOLO taxonomy and their ease of preparation and use. Even so, it should not be neglected that rubrics based on the SOLO taxonomy were compared with standard rubrics in the present study but with the rating scales of the participating raters in the study by Yazici (2013).

Finally, the raters in the present study reported that the rubrics based on the SOLO taxonomy were better than the standard rubrics at distinguishing students of varying levels of competence in a given subject and at providing feedback on students' strengths and weaknesses. In other words, SOLO based rubrics provides more diagnostic information than standard rubrics about student's achievement level and aspects of his/her performance that need to be correct. According to Hall and Salmon (2003), it is one of the main objectives of using a rubric in the evaluation process to provide feedback on students' strengths and weaknesses. According to the raters' responses, it can be said that rubrics based on the SOLO taxonomy can serve the purpose in a better way than standard rubrics.

IMPLICATIONS

The findings of the study have certain implications for practice and further research. According to the findings, rubrics based on the SOLO taxonomy are more efficient than standard rubrics in terms of objectivity, the ability to distinguish, the ability to provide effective feedback, and ease of preparation and use. Therefore, it could be recommended that rubrics used for rating open-ended questions should be designed on the basis of the SOLO taxonomy. Even so, it is essential that standard rubrics and those based on the SOLO taxonomy should be compared and contrasted in reference to certain rater effects such as rater severity and leniency, the halo effect, range limitation, and center-orientation before rubrics based on the SOLO taxonomy can be decisively proved to be more efficient than standard rubrics.

REFERENCES

Biggs, J.B., & Collis, K.F. (1982). *Evaluating the quality of learning: The SOLO taxonomy*. Academic Press.

Brabrand, C., & Dahl, B. (2009). Using the SOLO taxonomy to analyze competence progression of university science curricula. *Higher Education*, 58(4), 531-549.

Burnett, P.C. (1999). Assessing the structure of learning outcomes from counselling using the SOLO taxonomy: An exploratory study. *British Journal of Guidance & Counselling*, 27(4), 567-580.

Buyukozturk, S., Cakmak, E.K., Akgun, O.E., Karadeniz, S., & Demirel, F. (2010). *Scientific research methods*. Ankara: Pegem Akademi Publishing.

Chan, C.C., Tsui, M.S., Mandy, Y.C., & Hong, J.H. (2002). Applying the structure of the observed learning outcomes (SOLO) taxonomy on student's learning outcomes: An empirical study. *Assessment and Evaluation in Higher Education*, 27(6), 511-527.

Congdon, P., & McQueen, J. (2000). The stability of rater severity in large-scale assessment programs. *Journal of Educational Measurement*, 37(2), 163-178.

Dogan, N. (2013). Effort for classification of measurement tools. In H. Atılgan (Eds.), *Measurement and evaluation in education* (pp. 119-144). Ankara: Anı Publishing.

Ebel, R.L. (1951). Estimation of the reliability of ratings. *Psychometrika*, 16(4), 407-424.

Gronlund, N.E. (1998). *Assessment of student achievement*. Boston: Allyn and Bacon.

Guler, N. (2012). *Measurement and evaluation in education.* Ankara: Pegem Academy Publishing.

Hall, E.K., & Salmon, S.J. (2003). Chocolate chip cookies and rubrics helping students understand rubrics in inclusive settings. *Teaching Exceptional Children*, *35*(4), 8-11.

Hall, E.K., & Salmon, S.J. (2003). Chocolate chip cookies and rubrics helping students understand rubrics in inclusive settings. *Teaching Exceptional Children*, *35*(4), 8-11.

Hattie, J.A., & Purdie, N. (1998). The SOLO method and item construction. In G. Boulton-Lewis & B. Dart (Eds.), *Learning in Higher Education*. Hawthorn, Australia: ACER.

Ireson, J. (2008). *Learners, learning and educational activity*. New York: Routledge.

Kan, A. (2007). An alternative method in the new educational program from the point of performance-based assessment: Rubric scoring scales. *Educational Sciences: Theory & Practice*, 7(1), 129-152.

Kanuka, H. (2005). An exploration into facilitating higher levels of learning in a text-based internet learning environment using diverse ınstructional strategies. *Journal of Computer-Mediated Communication*, 10(3). 09 Ekim 2013 tarihinde http://onlinelibrary.wiley.com/doi/10.1111/j.1083-6101.2005.tb00256.x/full adresinden alınmıştır.

Lake, D. (1999). Helping Students to go SOLO: Teaching critical numeracy in the biological sciences. *Journal of Biological Education*, 33(4), 191-198.

Leung, C.F. (2000). Assessment for learning: Using SOLO taxonomy to measure design performance of design & technology students. *International Journal of Technology and Design Education*, 10(2), 149-161.

Lucas, U., & Mladenovic, R. (2008). The identification of variation in students' understandings of disciplinary concepts: The application of the SOLO taxonomy within introductory accounting. *Higher Education*, 58(2), 257-283.

Maddrell, J.A. (2011). *Community of inquiry framework and learnıng outcomes*. Unpublished Doctoral Dissertation. Old Dominion University, Norfolk, Virginia, ABD.

Mohd Nor, N., & Idris, N. (2010). Assessing students' informal inferential reasoning using SOLO taxonomy based framework. *Procedia Social and Behavioral Sciences*, 2(2), 4805-4809.

Moskal, B.M. & Leydens, J.A. (2000). Scoring rubric development: validity and reliability. *Practical Assessment, Research & Evaluation*, 7(10). 14 Ağustos 2013 tarihinde http://pareonline.net/getvn.asp?v=7&n=10 adresinden alınmıştır.

Schaefer, E. (2008). Rater bias patterns in an EFL writing assessment. *Language Testing*, 25(4), 465-493.

Stecher, B. (2010). *Performance assessment in an era of standards-based educational accountability.* Stanford, CA: Stanford University, Stanford Center for Opportunity Policy in Education.

Tekin, H. (2009). *Measurement and evaluation in education*. Ankara: Yargı Publishing.

Turgut, M.F., & Baykul, Y. (2012). *Measurement and evaluation in education*. Ankara: Pegem Akademi Publishing.

Yazici, N. (2013). *Comparative investigating of the effect of rubrics used based on SOLO taxonomy on the measurement of success*. Unpublished Master Thesis, Kahramanmaras Sutcu Imam University, Institute of Social Sciences, Kahramanmaraş, Turkey.

Yildirim, A., & Simşek H. (2011). *Qualitative research methods in the social sciences*. Ankara: Seckin Publishing.

Wolf, K., & Stevens, E. (2007). The role of rubrics in advancing and assessing student learning. *The Journal of Effective Teaching*, 7(1), 3-14.

Woehr, D.J., & Huffuct, A.I. (1994). Rater training for performance appraisal. A qantitative review. *Journal of Occupational and Organizational Psychology*, 67(3), 189-205.

APPENDIX

The open-ended math question

Veli, a merchant, sells a product for x TL whose cost is y TL. The relationship between x and y is y= 8x-70. If it is known that Veli sells this product at a profit, what can you say about x, the sale price of the product?

The standard rubric

Grading Criteria	
Level 4 Excellent	The problem is entirely understood and the right answer is given using a proper strategy. -The student knows that the sale price y needs to be greater than the purchase price x if Veli makes a profit. Using the relation y=8x-70, they obtain the inequality 8x-70>x. They solved this inequality without making a mistake and found the correct answer x>10. The operations related to Veli's profit and loss are clear, detailed and serve as a model answer.
Level 3 Good	The problem is understood, but not entirely. -The solution is generally correct, but includes some minor mistakes. They began with a proper strategy and found that y>x for Veli to make a profit, and using the relation y=8x-70 they showed that 8x-70>x. However, while solving the inequality 8x-70>x, they were not able to find the result or found an incorrect result due to a minor mistake or for unknown reasons. -The student found the correct result x>10 for the sale price to be higher than purchase price. However, they did not make sufficient explanation about how they solved the problem.
Level 2 Need to be developed	The problem is partially understood. -The student began with a proper strategy, but was not able to continue. For instance, they can began with a proper strategy and indicate that y>x for Veli to make a profit. However, they were not able to continue to use this strategy, by replacing y with 8x-70 and establishing the inequality 8x-70>x. -The student began with a proper strategy and established the inequality y>x. However, after establishing the inequality of y>x, they did not do the correct operations. There are serious mistakes in their operations.
Level 1 Inadequate	The student did not understand the problem. -They used expressions such as, "There are two unknowns in the problem that are x and y, I do not know what to do." -The student did not do any operation to solve the problem. -The student did not do any operation to find profit and loss. They only repeated the problem with expressions such as, "Veli, a merchant, buys the product for x TL and sells it for y TL." -The students established incorrect inequalities, making it impossible to find the correct answer, or used incorrect expressions and strategies.

The rubric based on the SOLO taxonomy

	Grading Criteria
Relational level	The student determines x=10 TL as a critical value. They find the coherent result that if x is less than 10 TL Veli will make a profit, if x=10 Veli will neither make a profit nor loss, and if x is more than 10 TL Veli will make a profit.
Multistructural level	The student knows that x is a variable. They try to determine profit and loss by giving x more than one value. However, they fail to find the lowest value of x for Veli to make a profit in selling the product. They did not recognize that Veli's profit or loss varies by lower and higher values than x=10.
Unistructural level	The student knows the concept of variable. However, since they only consider a single aspect of the problem they try to solve the problem by giving one value for x. For instance, the student interprets one value of x and responds, "When x=9, y=72-70=2, so Veli sells at a loss."
Prestructural level	The student uses expressions such as, "I do not know," "Merchants sometimes make a profit and sometimes do not," or "Since the number of x in the y=8x-70 is 8, Veli makes a profit." The student does not understand what a variable is and has misconceptions such as "Regardless of the possible values of x, y is always greater than x."