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Investigating Formative Assessment

Bilgilendirici Değerlendirmenin İncelenmesi

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Abstract

There are different kinds of assessment. The purpose of this article is to investigate formative assessment and the link between formative assessment and learning in great depth. Formative assessment can be used to determine children's knowledge or understanding in order to give feedback and to help to plan the appropriate next steps for pupils' learning. Therefore, it can be stated that formative assessment is vital for the enhancement of students' learning. Although it seems difficult to apply formative assessment in classrooms, questions teachers ask and some open-ended tests can still give an idea of what pupils think and help teachers plan the next steps for their teaching.
Keywords: Formative assessment, learning.

Öz

Değişik değerlendirme teknikleri vardır. Bu makalenin amacı, bilgilendirici değerlendirmeyi ve bu tip değerlendirmenin öğrenmeyle olan ilişkisini detaylı bir şekilde incelemektir. Bilgilendirici değerlendirme, öğrencilerin bilgilerini ve anlamalarını tespit etmede kullanılabilir. Bu da öğrencilere dönüt vermede ve öğrencilerin öğrenmeleri için gerekli olan sonraki basamakların planlanmasında faydalı olacaktır. Bu yüzden, bilgilendirici değerlendirmenin öğrencilerin öğrenmelerine olumlu yönde katkıda bulunması beklenmektedir. Bilgilendirici değerlendirme sınıf ortamında zor olmasına rağmen, öğretmenlerin sorduğu sorular ve derslerde uygulanan bazı açık uçlu testler yoluyla öğretmenler, öğrencilerin anlamaları ile ilgili fikir sahibi olabilirler. Bu da öğretmenlerin, öğretmek için bir sonraki basamakların ne olacağını planlamalarını sağlamalarına yardımcı olur.
Anahtar Sözcükler: Bilgilendirici değerlendirme, öğrenme.

Introduction

It has recently been realised that there is a link between assessment and classroom learning. Therefore, studies on assessment have moved away from exploring restricted types of test, which can make very little contribution to pupils` learning, to other techniques, which can have an impact on pupils` learning. Since assessment and classroom learning are closely related to each other, the consideration of effective assessment strategies would be beneficial for both pupils and teachers. The purpose of this essay is to investigate formative assessment in mathematics classes. There are three parts to this investigation. Firstly, what formative assessment means will be discussed. Secondly, the link between the formative assessment and two of the theories of learning, behaviourism and constructivism will be discussed. Finally, potential difficulties of using formative assessments in mathematics classrooms in constructivist teaching approach will be mentioned.

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Definition of Formative Assessment

There is no widely accepted definition of the formative assessment (Black and Wiliam, 1998). Some

of the definitions give emphasise on the role of the teacher in formative assessment, some of them also consider the role of the learner. The other interesting thing in definitions is that some of them are giving the definition of formative assessment by contrasting summative assessment. This might be due to the fact that although formative and summative assessments are very different tools, they are easily confused in practice. However, the common point of the definitions is that, in a broad sense, formative assessment serves to maximise students' future learning. In contrast summative assessment is defined as what learners already have achieved, usually for purpose of either evaluation or selection. Harlen and James (1997) claim that the Task Group on Assessment and Learning, (hereafter TGAT), puts the terms *formative*, *summative*, *evaluative*, and *diagnostic* into common circulation, and this results in the confusion of formative assessment with summative in practice. TGAT (1988) makes the distinction between formative and summative assessments in terms of purpose and timing with formative assessment being used to recognise the positive achievements of a pupil and discuss the appropriate next steps and summative assessment being used for the recording of the overall achievement of a pupil in a systematic way.

Capel, Leask and Turner (1995) claim that the TGAT report is more to combine than to distinguish the different purposes of assessments. They support their claims by stating that some purpose may, however, be served by combining in various ways the findings of assessments designed primarily for different purpose.

Many authors agree that summative and formative assessments are two different types of assessment in terms of the purposes they serve. For instance, Capel et al. (1995) see formative and summative assessments as the opposite poles on a continuum and identify formative assessment with professional purpose supporting the learners' future learning and summative assessment with bureaucratic purpose serving the needs of the system, the administration and politicians. However, Bowers's (1989, 1-2) following distinction says much more than the above distinction does: 'An American educator who was examining the British educational system once asked a headmaster why so little standardised testing took place in British schools. "My dear fellow," came the reply, "In Britain we are of the belief that, when a child is hungry, he should be fed, not weighed".

The above statement explains the difference between the formative and summative assessment. Tunstall and Gipps (1996) give one of the definitions which do not contrast summative assessment with formative assessment:

> Formative assessment ...means teachers using their judgements of children's knowledge or understanding to feedback into the teaching process and to determine for individual children whether to re-explain the task/ concept, to give further practice on it, or move on to the next stage (389).

The Link between Formative Assessment and Learning

Black (1999, 7-8) gives importance to the role of the learner in his definition of formative assessment and defines formative assessment as "...encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged." Therefore, there is not a specific tool to perform formative assessments, it can be any kind of tool, and the important thing is to be able to use the results to discover students learning needs to enhance learning. Secondly, both students and teachers must be involved in the process of formative assessment. In other words, students must also be involved in their own assessment to recognise their own learning needs to move forward. However, to be able to this, students must know what their learning goals are. To assess whether they themselves achieve those goals, they also need to develop an ability to criticize their own learning. And this development can started from the primary school years, for example, as Harlen and James (1997) point out, by asking primary school pupils to select their best pieces of work and discussing why the particular ones were chosen. Once above aims are achieved, and then formative assessment might be a really good thing to enhance learning. There are some research findings that show formative assessment enhance learning; for example, research done by Black and Wiliam (1998) indicates that teacher assessment, which diagnoses pupils' difficulties and provides constructive feedback

leads to significant learning gains. Similarly, another study, in which 11-year-olds were given either written feedback on their tests, a graded mark, or both, shows that the performance of the group who received only comments increased by one third, while that of the other two groups declined. (Houssart, 6 February 1998). Fontana and Fernandes (1994) carried out a research project to test the effects upon student's mathematical performance of the regular use of pupil self-assessment techniques with 45 Portuguese teachers. 246 students of ages 8 and 9 with 108 older students with ages between 10 and 14 constituted the experimental group, and the teachers of these students were trained in self-assessment methods on a 20-week part-time course. A further 20 Portuguese teachers of control group students were not trained in self-assessment methods rather they took another course in education. Results of this research showed that the students (n=354) experimental group manifested significant improvements in scores on a purpose-built mathematics test when compared to a control group of students (n=313) in classes where pupil self-assessment was not used. These results show that formative assessment enhances students learning, however, the meaning of learning and how it is satisfied differs from one theory of learning to another, and this also changes the roles of assessment, learner, and teacher. For example, the behaviourism theory with its emphasis on purely procedural knowledge assumes that complex knowledge can be separated into parts and these parts can be transmitted from teacher to students one by one in a hierarchical way from simplest to hardest. And whether the learner receives the knowledge or not, can be assessed by means of tests. Black (1999) points out this, and adds that behaviourist psychology lays emphasis on stimulus-response theory, and states that the test item is the stimulus, the answer the response, and a learner has to be 'conditioned' to produce an appropriate response to any given stimulus. Such an approach to teaching and learning may be called traditional, and has been influential for many years. In fact, Davis (1992) uses the term "*traditional view of mathematics*" to describe this approach without using the term behaviourism. The corollary of such an approach can be seen in the following comments by Bloom (1971):

> We have...[analysed] each unit into its constituent elements. These ranged from specific terms or facts to more complex and abstract ideas, such as concepts and principles...We have considered these elements forming a hierarchy of learning tasks... we have then constructed brief diagnostic-progress tests to determine which of the unit's tasks the students has or has not mastered and what he or she must do to complete his or her unit learning (cited in Shepard, 1991).

Therefore, those who hold a behaviourist view of learning, as Denvir (1989, 287) points out, "...will, in any case adopt a strongly didactic, instructional teaching approach." and as a result formative assessment becomes nothing but just finding out whether the learner, (who are seen as empty vessels to be filled), acquires the rote skills and knows the facts by means of unit tests which consists of closed, short answered or pseudo-open questions, or by means of tick lists and can do statements, and as a result, formative assessment turns out to be a repeated summative assessment the purpose of which should be very different from formative assessment.

However, as Selden and Selden (1997) mention, contemporary learning theories have moved away from the sway of behaviourism, which valued mainly directly observable phenomena, and thus disparaged any mention of the mind or its contents as unscientific. Following Piaget, studying the processes inside the learner's mind has become more interesting. Hence, as Ginsburg (1981) writes that the investigation of mere behaviour or the results of achievement tests are disparaged by constructivists. The main theme of the classical constructivist theory involves that learner is active in the learning process, he/she does not passively receive knowledge from the environment, and learners construct new concepts through reflecting on their physical and mental actions by modifying them. As opposed to behaviourism, this theory gives more emphasize on conceptual understanding, thus the aim of the assessment is to test this understanding. This can be seen in Jaworski's (1988) comments:

> When mathematics is presented formally with strict procedures, rules, theorems and results, it is possible to test pupils' ability to reproduce it. Pupils can be seen to quote theorems, apply rules and follow procedures. However, such testing probably says little about the pupils' overall mathematical

> understanding. Some form of diagnostic testing is necessary to find out what mathematical meanings pupils have made and what construction they have put on various rules and procedures in trying to reach some overall coherence. (p. 290).

Hence, Jaworski (*ibid.*) writes that assessment of learners' mathematical understanding should provide feedback to the teacher for the creation of appropriate activities or tasks. A related theory of classical constructivism is called social constructivism. The major theme of the social constructivist theoretical framework is that social interaction plays a fundamental role in the learning process. According to this theory, learning reflects a social process in which learners interact, discuss, and even argue their ideas with teachers and peers, in the process of understanding a concept. Vygotsky (1978), who makes invaluable contributions to this theory states that every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological).

A second aspect of Vygotsky's theory is the idea that the potential for learning is limited to a certain area of appropriate and productive challenge, which he calls the "zone of proximal development" (ZPD). Moreover, full development during the ZPD depends upon full social interaction. The range of skill that can be developed with adult guidance or peer collaboration exceeds what can be attained alone. Thus, the role of formative assessment should be to identify this zone accurately and to explore progress within it. For example, group work which involves activities that provide students with the chance to assess themselves could be quite good for students` learning since they can learn from the assessments of their peers.

Therefore, those who hold a social constructivist view of learning place more emphasis on the factor of the individual's prior experience of learning, see learning as a more interactive process, and take account of the role of teacher-learner and learner-learner interaction. Wood (1976, cited in Black, 1999) asserts that learning should be 'scaffolded' by the learner who is being set an appropriate task with an appropriate support, and thus the purpose of the assessment should be to identify what learner could achieve next. Ausubel (1968, 4) whose views have similarities with Wood's above comment asserts: "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly." Therefore, for social constructivists, 'readiness' of the learner to be taught accordingly is very important. Wood (1987) argues in a discussion of what an educational formative assessment must identify the level of task that a child is ready to undertake on the basis of what he can already do, as long as she/he receives the best possible help from an adult. This should be done, as Harlen and James (1997) point out, by gathering information through observing pupils, listening to them discussing informally with their peers as well as when talking to the teacher, reviewing written work and other products, and using their self assessments. Therefore, the role of the teacher in the process of formative assessment is to find out whether the learner is ready to be taught new concepts. Thus, this theory of learning demands more one to one interaction between the learner and the teacher and also among the learners.

Difficulties of Using Formative Assessment in the Context of Constructivism

Torrance and Pryor (1998) point out that the claims of constructivists seem very ambitious, and in practice, it is very difficult to accomplish them since in real classroom situations it might be difficult to assess all students individually, and it might be difficult for teachers to balance formative purposes of assessment with that of summative assessment:

> For the constructivist teacher two purposes of assessment are in direct conflict. An emphasis on summative assessment demands that children be prepared to perform well in assessment tasks, whether or not they have grasped the underlying ideas. Thus teaching would aim to cover up any lack of understanding of concepts by learning set rules and procedures. In contrast, an emphasis on formative assessment demands a teaching approach in which children's conceptions are clearly exposed, enabling the teacher to plan activities which address the real issues which confront the learner. (Denvir, 1989, 288).

Harlen and James (1997) also argue that teachers often cannot balance formative purposes with summative purposes of assessment and as a consequence assessment fails to have a truly formative role in learning. Black (1999) gives three main reasons, some of which are similar to above reasons, that may cause problems for everyday practice of assessment in classrooms: first one is related to learning with understanding ("relational learning", Skemp, 1976) that is it is hard to assess conceptual understanding thus teachers tend to teach and assess "instrumental mathematics". As Schoenfeld (1982) points out, usually a narrow collection of well-defined tasks were focused on and students were trained to execute the tasks that are very close to the ones they have been taught. If they succeed on those problems, they were congratulated. He (ibid) states that it would be deceptive to allow them and ourselves to believe that they 'understand' mathematics.

Black (1999) continues to give possible reasons that may prevent teachers from using formative assessment: the teacher may overemphasise the grading function and they may underemphasize the learning function. Thus, for students getting higher marks become more important than developing a real understanding of mathematics, and they tend to study accordingly. And thirdly, teachers may tend to use norm referencing, which is when a pupil's achievement is judged against those obtained from a defined group of pupils (e.g. a group of the same aged; all those taking mathematics), rather than a criterion-referencing which is based on the quality of the performance of a pupil irrespective of the performance of others. Thus, as Harlen and James (1997) point out, the important point here in the context of formative assessment is that although norm referenced assessments may help teachers to recognise the existence of a problem, it may not help them know what to do about it and may simply have a harmful effect by labelling or pigeon-holing students. Therefore, Harlen and James (1997) assert that to enhance real learning, teachers should use assessments that reveal the specific nature of any problems; and this can only be done by a combination of criterion- and ipsative assessments that is comparing the achievements of a pupil only with that pupil's past performance. The comparison of a pupil's performance with his/her past performance can be done mainly through the portfolio assessment, which is part of formative assessment. In portfolio assessment, a portfolio containing a selection of students' work, experiences, and efforts is created for each student. Portfolio assessment helps to identify the development of students' learning and compare student's performance with his/her past performance. Hence, once the teachers make diagnostic decisions about the pupils' learning needs, they can plan their lessons appropriately to meet these needs, and this may provide invaluable information about the teaching organisation (Desforges, 1989). As mentioned before, constructivism gives emphasis to "relational understanding", and for the constructivist teacher the important thing is to gain access to the ideas and mental frameworks that are constructed in the pupils' minds. However, for a moment if we assume that teachers are not under the effects of above mentioned difficulties, it is still very hard to achieve those aims of constructivism. In other words, even if teachers don't overemphasise grading function of assessments, and they use suitable assessment tools for finding out pupils' understanding of mathematics, we think it is still difficult to find out what goes on in pupils' minds, and to measure mathematical attainment of students.

One way to find out what goes on in pupils' minds might be to observe students' mathematical strategies while tackling problems. However, in this case, there might still be some problems involving validity of judgements based on these observations. Harlen and James (1997) point out that validity is vitally important to formative assessment because it cannot claim to be formative unless it demonstrably leads to action for improved learning. Denvir (1989) sees the difficulties concerning validity may arise from following facts: mathematical thinking depends on context as well as underlying mathematical structure, the mode of presentation and response effects students thinking, and finally mathematical thinking depends on an individual interpretation than of the child's cognitive or intellectual ability. For example, students might perform well while tackling problems that are in familiar or easily recognised mathematical contexts by recalling a standard procedure, or a pragmatic solution. A survey showed that most 13-year-olds could do the following

calculation: 225 ÷ 15 = ? However 50% failed to find out the answer when the following problem is given: 'If a gardener has 225 daffodil bulbs and has to set them in 15 flower beds, how many bulbs will be put in each bed?" (cited in Desforges, 1989). Thus, students may appear to be able to do something in one context but not in another, therefore this may cause problems while making judgements on pupils' mathematical attainments. However, this may also be advantageous, since it gives clues to the conditions which seem to favour a better performance and thus can be a basis planning lessons, and this may provide invaluable information action (Harlen and James, 1997). Therefore, although there are constraints on teachers' practice in terms of developments in assessment, there may also be some opportunities.

Conclusion and Recommendations

This article indicates that formative assessment serves to enhance students' learning. However, the learning depends on what a person understands from learning. The traditional view of mathematics lays emphasis on rote memorisation of facts, procedures, in short "instrumental understanding" of mathematics. Thus, for this approach it seems easier to assess this kind of knowledge by means of tests. On other hand, the modern view of mathematics lays emphasis on real understanding, "relational understanding". The modern view sounds good in theory, but in practice, teaching and assessing with respect to this theory seems much more difficult and demanding. To clarify this, the purpose of assessment should be to understand students` thinking and plan appropriate teaching steps according to this thinking. For this purpose, students need to be involved in their own assessment to recognise their own learning needs in order to move forward. We suggest that teachers should use open-ended questions to understand students` thinking instead of multiple-choice questions. In addition, challenging homework or project works should be given for students to do outside class. However, the crucial point is to give feedback to students` answers to questions or their work since feedback helps students be involved in the assessment process and see their deficiencies in their learning. To give feedback to each student is a quite difficult and time-consuming.

Another aspect of formative assessment is to compare the student's performance with his/her past performance rather than the performance of others. As mentioned above, this can be done through portfolio assessment; preparing portfolios containing the collection of student's works. This is again quite time-consuming and demanding. However, these do not mean that it cannot be accomplished; although the solutions to overcome these difficulties might be very complex.

Even though it is out of the scope of this paper to propose solutions for these difficulties, we think that one of the solutions of these difficulties might be integrating technological innovations into education. For example computers might be used as a tool for carrying out assessments. Computers can give immediate feedback to students and reduce time that needs to be spent by teachers to give feedback. Similarly, electronic portfolios; portfolios published in a digital format via computer, makes portfolios easily accessible, upgraded and cross-reference students' work. In addition, electronic portfolios give immediate feedback to students. All these reduce the amount of job that needs to be done by teachers. Therefore, we assume that the integration of computers into assessment can be quite promising.

References

Ausubel, D. P. (1968). *Educational psychology: A cognitive view.* New York: Holt, Rinehart and Winston.

Black, P. (1999). Assessment, learning theories and testing systems. In P. Murphy (Ed.), *Learners, learning and assessment.* London: Paul Chapman Publishing.

Black, P. & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in education, 5* (1), 7-74.

Bloom, B (1971). *Handbook of formative and summative evaluation of student learning.* New York McGraw-Hill.

Bowers, B. C (1989). *Alternatives to standardised educational assessment.* ERIC Document Reproduction Service No. ED 312 773.

Capel, S., Leask, M. & Turner, T. (1995). *Learning to teach in the secondary school.* London: Routledge.

Davis, R. B. (1992). Understanding "understanding". *Journal of Mathematical Behaviour,* 11, 225- 241.

Denvir, B. (1989). Assessment purposes and learning in mathematics education. In P. Murphy & B. Moon (Eds.), *Development in learning and assessment.* London: Hodder and Stoughton Press.

Desforges, C. (1989). *Testing and assessment.* London: Cassell.

Fontana, D. & Fernandes, M. (1994). Improvements in mathematics performance as a consequence of self-assessment in Portuguese primary school pupils. *British Journal of educational Psychology,* 64, 407-417.

Ginsburg, H. (1981). The clinical interview in psychological research on mathematical thinking: aims, rationales, techniques. *For the Learning of Mathematics, 1* (3), 4-11.

Harlen, W. & James, M. (1997). Assessment and learning: Differences and relationships between formative and summative assessment. *Assessment in Education, 4* (3), 365-379.

Jaworski, B. (1988). 'Is' versus 'seeing as': Constructivism and the mathematics classroom. *Mathematics, Teachers and Children,* 287-296.

Schoenfeld, A (1982). Some thoughts on problem-solving research and mathematics education. In F. K. Lester & J. Garofalo (Eds.), *Mathematical Problem solving: Issues in research.* Philadelphia: Franklin Institute Press.

Selden, A. & Selden, J. (1997, February). Should mathematicians and mathematics educators be listening to cognitive psychologists? *MAA,* Retrieved June 11, 2002 from the World Wide Web: http://www.maa.org/t_and_l/sampler/rs_2.html.

Shepard, L. (1991). Psychometricians' beliefs about learning. *Educational Researcher, 20* (7), 2-16.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching,* 77, 20-26.

Task Group on Assessment and Testing (TGAT), (1988). *A report.* London: DES.

Houssart, J. (6 February 1998). Unlucky number day. *Times Educational Supplement.*

Torrance, H. & Pryor, J. (1998). *Investigating formative assessment.* Buckingham-Philadelphia: Open University Press.

Tunstall, P. & Gipps, C. (1996). How does your teacher help you to make your work better? Children's understanding of formative assessment. *The Curriculum Journal, 7* (2), 185-203.

Vygotsky, L.S. (1978). *Mind in society.* Cambridge, MA: Harvard University Press.

Wood, R. (1987). *Measurement and assessment in education and psychology.* London: Falmer Press.

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