

The Influence of External Feedback on Skill Learning

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Abstract: External feedback is an important component of the interaction between coach or teacher and athlete or student in motor skill learning. Based on literature review, the explanation is made that the effective use of external feedback depends on understanding the various effects of external feedback on motor skill learning and the conditions characterizing the occurrence of each effect. Four distinct relationships between external feedback and motor skill learning are presented: External feedback is important for motor skills learning; it is not needed to learn some skills; for some skills it enables the learner to acquire the skill faster or achieve a higher level of performance than would be possible without it; it can be provided in such a way that it hinders skill learning.

1 INTRODUCTION

It seems that practitioners do not fully understand that external feedback can have a variety of influences on skill learning, positive or negative (Magill et al., 1991). In fact, external feedback has traditionally been given a two-part role in skill learning. One part is that external feedback is necessary for effective skill learning to occur. The second is that external feedback is beneficial for skill learning (Magill, 1993). The impact of the view projected from motor skill learning theories and research that external feedback is necessary and beneficial for skill learning can be seen in the pedagogical literature. For example, in a highly regarded teaching methods textbook for physical education teachers, Siedentop et al. (1984), stated that "it has been known for some time that feedback is necessary for learning.... Physical educators must learn to be expert deliverers of feedback". In another well-respected textbook, Rink (1985) told prospective physical education teachers that "feedback is an absolutely essential ingredient for learning". The point to be made in this paper is that the statements are incorrect and that the statements made by the textbook authors cited are at worst incorrect and at best incomplete. To make this point, research literature will be reviewed to describe the specific effects of external feedback on skill learning. What will be seen is that feedback is not always necessary and beneficial for skill learning. In

fact, four different relationships between external feedback and skill learning exist (Magill, 1993). Fortunately, these different relationships can be related to specific characteristics of the skills being learned and, in some cases, to the characteristics of the learners to whom the feedback is directed. From a motor skill learning perspective, this categorization of relationships provides a more appropriate base on which to develop theory and research. From a pedagogical perspective, viewing external feedback in this way provides direction for determining the appropriate use of external feedback to help establish optimal learning conditions (Tan et al., 1994).

Before looking at the specific relationships between external feedback and skill learning, it will be instructive to consider some bases for questioning the traditional role given external feedback. While the discussion about the different types of influences of external feedback on skill learning will reveal empirical evidence arguing against the traditional role, there are additional reasons for expecting that external feedback may not always be necessary and beneficial for skill learning. These reasons are revealed in both motor learning and physical education pedagogy literature. The first reason comes from an influential review of the KR literature by Salmoni et al. (1984). This review sets the stage for the present discussion because it established that the commonly referred to principles of KR "are at best in need of some conceptual

rearrangement and at worst largely incorrect". They demonstrated that different conclusions about these KR principles could be derived when the research literature was examined in terms of whether the KR effects were on performance during practice or on performance during retention or transfer tests. While this important review did not suggest altering the view that external feedback is necessary and beneficial for skill learning, it did open the door for concern about all traditionally held views related to the influence of external feedback on skill learning.

A second cause for questioning came from a theoretical perspective of skill learning and control that is an alternative to the theories of Adams and Schmidt. Known as *action theory* or *dynamic systems theory* (Meijer and Roth, 1988), this view of skill control argues that the theories of Adams and Schmidt have ignored both the wealth of environmental information available to people who are performing skills and how that information influences skill learning and control. As a result, this view downplays the role of external feedback in skill learning and emphasizes the positive role played by environmental information in the interaction between the sensory-perceptual system and the motor-control system (Buekers et al., 1992). Because individuals use this environmental information to guide their actions, the need for external information takes a secondary role in skill learning (Fishman and Tobey, 1978). Hence, the traditional role given external feedback is dismissed and a lesser role is proposed.

Finally, the belief that external feedback is necessary and beneficial for skill learning can be questioned by considering what occurs within a physical education class environment. According to teacher behavior research in physical education, a teacher gives only about one or two feedback statements per minute in a class, and these statements are not equally distributed among all students in the class (Lee et al., 1993). Some students receive no feedback from the teacher while others may get many feedback statements during a class period. Yet, when improvement in performance or achievement are correlated with the amount of feedback received, the result is that there is no strong relationship between these variables (Tan et al., 1993). This means that in physical education teaching situations, there is no conclusive evidence indicating that the degree of skill learning by students depends on the amount of or type of teacher feedback the students received. These three different but related pieces of evidence call into question the view that external feedback is necessary

and beneficial for skill learning. If this view inappropriately describes the role of external feedback in skill learning, then the question becomes, what is the appropriate view of that role? The following sections will address this question by showing that rather having one role, external feedback can actually play four different roles in skill learning. The role it plays depends largely on certain characteristics of the skill being learned and of the person learning the skill (Magill, 1993).

2 DISCUSSIONS

2.1 Four Relationships of External Feedback to Skill Learning

2.1.1 Necessary for Skill Learning

Although the proposal that the view of external feedback as necessary and beneficial for skill learning is not appropriate, there are certain skills for which external feedback is essential for learning. For these skills, no learning occurs without external feedback. This influence of external feedback is illustrated by the following two examples of experimental evidence. These examples also demonstrate the types of skill characteristics that indicate when learning a skill requires external feedback. Both examples involve laboratory tasks, and both follow a similar procedure to demonstrate the need for external feedback, which is KR in both cases. This procedure is to withdraw KR after different amounts of practice. If KR is necessary for learning these skills, then withdrawing KR too early in the learning process should lead to not learning the skill. The second situation involves an important characteristic of the person learning the skill. External feedback becomes essential for learning when the learner lacks prior knowledge about the relationship between the goal of an action and the movements required. Examples of this situation include learning to throw a ball at a particular speed, or learning to run at a specific pace. In these types of situations, the critical learner characteristic is not whether the person is a beginner or is skilled, it is whether the person has the appropriate prior knowledge necessary to produce the action that will lead to the desired goal.

2.1.2 Not Necessary for Skill Learning

There are skills for which the environment or some non-feedback-related source provides sufficient

information to learn the skill. Two examples of research investigations demonstrating these situations illustrate how it is possible to learn certain types of motor skills *without* external feedback. For these two investigations, one skill was a laboratory task, and the other was a real-world skill. The benefit of considering both types of skills is that generalizing experimental results to learning sport skills becomes a less venture some leap and gains more ecological validity, especially given that some practitioners and pedagogy researchers have come to demand relationships between skills used in experiments and those learned in the "real-world" before having confidence in such generalizations. The experimental design was based on one by Newell (1974) in which KR either was available on all 75 practice trials or was withdrawn after specific amounts of practice. The results of all four experiments were consistent in showing that regardless of the number of trackway speeds practiced or the type of test experienced, KR was not essential for learning the skill. Regardless of when KR was withdrawn, there were no statistical differences between KR- withdrawal conditions for any of the retention or novel transfer tests. Another experiment that demonstrates that learning a complex motor skill can occur without the aid of external feedback was reported by Magill (1993). These results indicate that the rhythmic gymnastics rope skill could be learned in the absence of external feedback if the subjects observed a skilled model perform the skill. When the model could not be observed, external feedback was required to supplement the verbal instructions.

The two research investigations described here reflect two very different situations, although both demonstrate learning without the need for external feedback. In the experiments by Magill et al. (1991), the task itself provided the feedback needed to learn the skill, even though subjects picked up that information in a nonconscious (i.e., implicit) manner. The evidence from these two studies indicates that there are indeed situations in which people can learn skills without the aid of external feedback. One of these situations occurs when the skill itself provides sufficient task intrinsic feedback to enable learning to occur. Another situation occurs when a demonstration is provided that shows the learner how the skill is performed correctly. It is very likely that external feedback will not be needed to learn skills in situations such as these. What is common to each situation is that some form of external referent is available that enables the performer to determine the correctness of an action.

In the case of learning the rhythmic gymnastics rope skill, the external referent was not the task itself but a skilled model performing the skill. The modelled performance became the reference against which the learner could compare a practice attempt and then base corrections to be attempted on the next trial.

2.1.3 Enhancing Skill Learning

There are motor skills that, although they can be learned without external feedback, can be learned more quickly or to a higher level of performance if external feedback is provided. If the full range of sport skills were assessed, most would likely fall into this category. Some form of external feedback is beneficial for learning these skills. Two research examples, one involving a laboratory task and the other a sport skill, illustrate the types of skills that can be placed into this category. Each of these skills includes characteristics that make it possible to establish criteria that indicate when external feedback should be presented to improve learning. For the two skills used in these two experiments, there was sufficient task intrinsic feedback available to enable the subjects to discover how to improve their performance during practice. But the availability of external feedback, especially in a form that provided information that allowed specific skill improvement to occur, enabled subjects to perform beyond that level. And, in the case of the movement time task in the Stelmach (1970) experiment, subjects who received external feedback made this improvement at a faster rate. There appear to be two messages here. First, there are skills that can be learned to a certain level without the aid of external feedback. These skills provide sufficient task-intrinsic feedback to enable learners to improve performance. But, there is an upper limit for this improvement. To achieve a higher level of performance, external feedback must be provided. Second, all types of external feedback will not have the same enhancing effect on skill learning.

2.1.4 Hindering Skill Learning

A frequently forgotten characteristic of external feedback is that it can hinder skill learning. In some cases, people would learn the skill better if they had not received the external feedback, and in other cases they would learn the skill better if they had received a different type of or schedule of external feedback. Here again is an example in which the type of external feedback becomes a critical concern. Because there are several different types of situations in which external feedback can hinder

learning, three examples of research evidence will be described here to illustrate this effect. Two conclusions can be derived from the results from these three experiments. First, there are forms of external feedback that can hinder learning. This situation seems to occur when task-intrinsic feedback is not readily apparent to the learner. As a result, the learner develops a dependency on the external feedback. The problem with this dependency becomes apparent when the task must be performed at some later time without the external information available. Performance suffers greatly in this situation. Dependency on external feedback can account for the results in all three experiments. What becomes especially remarkable about the development of this dependency is that it occurred while learning the coincident-anticipation timing task, even though the task could be learned as effectively without external feedback as with it. But, because the use of task-intrinsic feedback was not consciously evident to subjects, they were easily misled by erroneous external feedback.

Second, it is possible to encourage learners to develop a dependency on external feedback by providing this information too often. Because the augmented feedback is easier to use, and typically more meaningful to the learner, the external feedback becomes the focus of attention, and important task- intrinsic sensory feedback is ignored. In effect, learners learn the external feedback rather than the skill itself.

2.2 Implications for Skill Instruction

The four different relationships between external feedback and motor skill learning indicate that there is more to providing external feedback than simply taking a "some is needed" or a "more is better" approach. What we know is that there are skills for which no external feedback is needed because it is redundant information. Also, there are skills for which less external feedback is actually better than more. What is important in an instructional situation, then, is to determine *what* external feedback to provide and *when* to provide it. The preceding discussion of the various relationships between external feedback and skill learning provides some direction for making these critical determinations. Three suggestions in order to give external feedback effectively are presented here.

2.2.1 Evaluate the Skill

It is important in any instructional situation to evaluate the external feedback needs of the situation as determined by specific characteristics of the skill being taught. Insights into evaluating skill characteristics have been suggested based on those features of skills that have characterized the various effects of external feedback on skill learning. At least four features of skills have been described that can be related to the need for or type of external feedback for learning the skill. *First*, if the skill being learned does not allow the learner to detect critical sensory feedback information, such as when a limb's spatial position cannot be seen, then external feedback is required. *Second*, if the skill being learned involves acquiring a new concept that is essential for successful performance, such as understanding a unit of measurement, then again, external feedback is required. *Third*, if the skill provides the learner with all the essential feedback information needed to learn the skill, then external feedback may not be needed. These situations are indeed rare, but they do occur. *Fourth*, skills for which the outcome is easy to determine but the limb coordination requirements to produce high-level performance are difficult to develop require knowledge of performance about limb movement characteristics. Without this type of external feedback, the skill can be learned to a limited degree; however, the availability of external feedback based on limb movement characteristics enhances the level of performance achieved. In these situations, what becomes critical to facilitate learning is determining what information to give as external feedback and how to give it.

2.2.2 Evaluate External Feedback Characteristics

It is important to evaluate the external feedback that will be provided in a situation to determine if the feedback may attract the learner's attention to such an extent that it distracts him or her from essential task-intrinsic feedback such that the learner becomes dependent on the external feedback. The instructor must know how different forms of external feedback influence learning a particular skill. Skilled teachers typically use a variety of means to provide external feedback. Some are verbal, and others are visual. Some methods require another person to provide the information, while others include providing external feedback by means of a videotape replay. Some teachers also have students do self-evaluations to

compare their performance against a checklist of skill performance characteristics that the teacher has determined to be critical. The advantage of giving external feedback less frequently is that the learner is able to engage in some critical self-evaluation of his or her performance. This self-evaluation allows the learner to become more attuned to task-intrinsic feedback and how that relates to what he or she is doing (Adams, 1971). One additional point is important to make here. Providing effective external feedback clearly requires knowledge of both the skill and external feedback. The presence of external feedback attracted attention to such an extent that incorrect information was not evaluated as incorrect but was used as the basis for performing the skill. What this means is that instructors must provide appropriate information when giving feedback (Winstein and Schmidt, 1990).

2.2.3 Evaluate the Meaningfulness of External Feedback

External feedback is a form of communication to the learner about his or her performance of the skill being learned (Silverman, 1994). It is therefore important to take into account what information will have the most influence on the learner. This assessment of student needs is critical to facilitate skill learning. In fact, a recent study by Tan et al. (1994) provides evidence supporting the importance of this type of assessment. They showed that competent teachers with 5 years or more of teaching experience based their instructional activities on regular assessments of students' performance. On the other hand, novice teachers do not show this student-needs assessment characteristic. Teachers seem to acquire this characteristic as they gain experience and become more aware of how to determine instructional strategies that best facilitate skill learning. In the experiment by Wallace and Hagler (1979), verbal encouragement was not as meaningful as information about the component movements of the skill. When knowledge of performance about those movements was provided, learning increased beyond what resulted when only verbal encouragement was given. Similarly, in the experiment by Annett (1959), certain types of external feedback were more meaningful than other types. In the case of learning to produce a certain amount of force with a lever, verbal KR about the actual amount of force produced was more meaningful and yielded better learning than seeing a graphic representation of the amount of force being produced while the movement was being produced.

Something alluded to earlier but not discussed is relevant here. The stage of an individual's learning is also an important learner characteristic for determining what external feedback is meaningful (Magill, 1993). In the discussion of the rhythmic gymnastics rope skill experiment by Magill, the type of external feedback used was labelled *prescriptive* knowledge of performance. The information given to subjects prescribed what needed to be done to correct an important performance error. This type of information is different from what is known as *descriptive* knowledge of performance, which simply describes the error that must be corrected. For the beginner, this type of information is of little value. On the other hand, such information can be very useful for the skilled person (Schmidt, 1989). The research was carried out in 2016 to 2017. The data used in this study consisted of primary data and secondary data, include: number of pipeline orders, number of coats required for a pipe, number of coatings required for all pipes, lead time (raw material ordering time), ordering cost and storage cost incurred for the project, organizations and projects structure, data and events from the internet and journals.

This research uses quantitative approach with descriptive research type. Especially descriptive comparative analysis is used to compare three lot sizing techniques in MRP; Lot for Lot, EOQ, and POQ. The analysis starts with MRP step which include: 1) creating a Master Production Schedule, 2) creating a product structure or Bills of Materials, 3) collecting lead time data of raw material ordering, 4) preparing a Gross Requirements Plan, 5) Make a Net Requirements Plan, 6) determine the ordering time of goods (Planned Order Release) with lot sizing method, 7) determine the right lot sizing method.

Determining the right lot sizing method will result in a minimum total inventory cost. Determination of this method is done by comparing total inventory cost based on company calculation with total cost obtained through calculation by lot sizing method. Lot sizing methods used in this research are Lot for Lot, Economic Order Quantity (EOQ), and Periodic Order Quantity. The software for data analysis use Production and Operation (POM) for Windows ver. 3 (build 18).

3 CONCLUSIONS

A critical feature of the communication between instructor and student is the appropriateness of

external feedback. For some situations, it may be appropriate to give no external feedback at all. For other situations, for which external feedback is needed, the critical concern must be to determine three things: what information to give, how to give it, and how often to give it. The answers to these important questions should be based on knowledge of the skill being learned, the effects different types of external feedback will have on learning that skill, and the characteristics of the individuals learning the skill. One final point is important to make here. If providing external feedback is an evaluation component for determining teacher effectiveness, the frequency of providing feedback should never be the sole criterion. Although important, frequency is not one of the most important aspects of determining the effective use of external feedback. This is commonly seen in large classes. The frequency of teacher feedback in these classes is virtually impossible to control.

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