

Intrinsic versus extrinsic motivation: A study of undergraduate student motivation in science

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Abstract

Many individuals who enter into science programs do so because study in this area is a requirement rather than because of a genuine interest in the subject matter. As a result, science educators need to find new ways of motivating today's learners. One approach is to modify the educational process so that students no longer find themselves in the roles of traditional learners, where the instructor directs them to the information. Instead, they need to become active learners, who take responsibility for their own learning both in and out of the classroom. This study examined the effects of an external motivation approach that utilized a token system known as Microbucks. Qualitative examination of the data showed that students responded favourably and quantitative analysis showed up to a 9.39 percent increase in final grades.

Introduction

For many learners, science is the furthest topic or subject area on their minds, and can even be seen as a dreaded or even vile class. But science courses are requirements; they are required for graduation, they are required for entrance into certain fields, they are required for acceptance into a number of professional programs. With many individuals entering into sciences with this low level of interest and motivation, it would appear to be an uphill battle for the teacher to motivate learners. To add to this conundrum or situation, the pace of new information is increasing at such a rate that one's understanding of content in the subject area becomes obsolete very rapidly. Therefore, it is very important to find ways to modify the educational process, so that individuals no longer find themselves in the roles of the traditional students, where the instructor directs them to the information. Instead, they need to undertake the role of active learner, able to take responsibility for their own learning, both in and out of the classroom (Vygotsky, 1987). Thus, it becomes the role of educators to instill in their students the strategies necessary to optimize learning. Students must be able to find relevant and pertinent

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information. They must be able to make connections; they must be able to recognize and solve problems; they must be able to demonstrate higher level thinking. But how do we, as educators, not only recognize, but evaluate and measure, these achievements? Although it seems obvious that we should encourage these behaviors, there still exists much debate about whether or not we should reward them.

Authentic assessment of student skills and abilities, which some believe will lead to a greater accountability of educational systems, have been embraced by a number of schools from K-12 through university (King, 1993; Layton & Locke 2007). One of the results of these shifts is a change in the way that we operate our university classes (McDaniel, 1994). Some educators have most recently moved away from didactic delivery of material followed by formal examinations, toward the use of other assessment strategies such as portfolios (Kuisma, 2007). For this study, the methods that were implemented emanated from a constructivist paradigm, which places the emphasis for learning on the student, rather than residing with the teacher. For example, students were given the opportunity to interpret topical research related to course content, which was then associated with a token economy system known as Microbucks.

Assessment can and should be an important and integral part of the learning process and it can take many forms. An educator can assess the students prior to the beginning of a lesson to recognize their background skills and knowledge, which is an important part of formative assessment. From here, one can assess student progress during the instruction, to recognize the places where they have become proficient, and those areas where they need additional help. Finally, there is summative assessment or evaluation, which is used after the completion of instruction. Effective assessment requires educators to analyze each activity and provide feedback to students in a timely manner, but how does one provide such formative assessment in a classroom environment setting? The focus of this study was on the implementation of a token economy known as "Microbucks," which was used as an assessment tool and motivator for students.

Motivation

It is important to note that learning is not synonymous with the acquisition of information. A basic requirement of learning is motivation and as such, it requires effort; however, all students do not apply the same amount of energy to the task. Microbiological

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knowledge would appear at first glance to be a significant motivator for individuals interested in a career in the health sciences. One might even go so far as to say that many students with such aspirations may even be intrinsically motivated to learn. It is easy to argue that the application of this knowledge is crucial for the health practitioner, and yet educators are faced with individuals who are not intellectually engaged in the study of microbiology. The focus of this self-study was to determine whether motivating factors can be used to stimulate active engagement that will result in measurable learning. In other words, "what can educators do to foster in their students an interest for subject matter?" If we, as educators, recognize materials that work as motivators, can we use these resources to turn our students into confident, competent individuals? Are we capable of producing and providing appropriate stimuli that will lead to the development of internal cognitive motivation? Can we get our students interested in learning microbiology, for life? In short, do extrinsic incentives lead to an enthusiasm towards the subject material that will over time result in intrinsic motivation?

Students begin their university careers with a vague set of beliefs and ideas about how knowledge is acquired and learned. Learning, unfortunately, to many of our students, means memorizing a large number of "factoids," small bits of content related to the subject. School is the place to learn, to receive grades as evidence of one's learning, and a place to finish learning, so that one can move on in life to important things, like a job. Let's face it – students are in school for the big pay-off. They recognize the value of good grades and invest more in the grade itself, than in the learning that the grade should represent. In fact, to a high degree, we encourage this behavior. We propagate this belief through the educational system which requires that students have a high Grade Point Average (G.P.A.), in order to be considered for admission to graduate and professional schools and to successfully land high-paying jobs.

Extrinsic motivation is often tied to economy inclusive of time; if one can accomplish the same end in less time, he or she will. The pursuit of a diploma or degree is one area where there appears to be a number of individuals who seem content if they receive less for their money. Let these students out of class early and they are happy, cancel a class and they are overjoyed, scratch a week of coursework and they are ecstatic, as long as this does not negatively impact their grade. Lest we feel a tad bit self-righteous, we must recognize that extrinsic motivation is a very powerful force in our lives as well. Even though we love our occupation, very few of us would be in the classroom tomorrow if our administrator came in and stated that the school was

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not going to pay us any longer. Although we are intrinsically motivated, this alone appears to be insufficient to keep us there.

The favorite refrain of students "She's really smart, but she can't explain it to me," is as exasperating to us as "They don't seem to get it, they're so lazy they won't get anything, except an F," must sound to them. The typical classroom pits us against them, with us possessing the external factors to control the class, and them obeying if they wish to succeed. However, these behaviors are predictable, and possibly avoidable if both sides are willing to recognize why we behave as we do.

It has been suggested that the stimuli that lead to the motivation to achieve are established early in childhood and carry on into adulthood (McClelland, 1978; Nunner-Winkler, 2007). The alternative viewpoint would hold that individuals are influenced by their present circumstances and achievements, which implies that motivation is modifiable (Stipek, 1988). It is this second viewpoint that gives educators hope that their efforts and energies can pay out rich dividends, in relation to student learning.

Stipek (1988) described five hypothetical students who illustrated some of the common motivational problems that are encountered in the classroom. She emphasized that there are ways to address motivational issues, and that it may be possible to affect an individual in a way such that he or she becomes interested in lifelong learning. There are many psychological factors that have been recognized as important for our behaviors (Steers & Porter, 1987; Chatzisarantis, Hagger, Martin, Smith, & Sage, 2006). Most individuals break down motivation as being influenced by intrinsic (internal) and extrinsic (external) factors.

Intrinsic motivation is generally considered more desirable, yet it is difficult to encourage intrinsic satisfactions without the use of extrinsic motivators, as the two seem related to each other and to the learning process in undefined ways. It is also arguable whether it is possible to separate the two, since in nearly every situation both appear to be operating (Lowman, 1990; Bye, Pushker, & Conway, 2007). In many circumstances, the external persuasion, known as a grade, weighs heavily on the learner, and unfortunately, supersedes intrinsic motivation. The threat of a poor grade can be used as a powerful motivator, and extrinsic inducements often produce rapid results.

A number of studies suggest ways to encourage intrinsic motivation (Deci & Ryan, 1985). Reinforcement theory recognizes that the frequency of a behavior can be increased if the

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individual is rewarded for a behavior. Correspondingly, the frequency of a behavior can be decreased if the individual is punished for a particular behavior. Such operant conditioning was popularized by the work of B. F. Skinner (1971). One way an educator has to show approval of certain behaviors is through the use of extrinsic rewards. There are a number of examples of the successes of token economies in the classroom. In one program developed by Cohen (1973), a reward system was implemented for adolescent boys who had been placed in a residential home, because of prior trouble in school or with the law. Academic excellence was rewarded with points, which could be used for a number of material items or special privileges. It was reported that this technique worked very well with these individuals. Another example is illustrated by Alschuler (1968), who set up performance contracts with the students. The students decided their personal performance goals, those who set high goals and achieved that level of success were rewarded the highest payoff, those who set low goals received the least. Teachers need not fear using extrinsic rewards, as long as they are used to reinforcing valuable behaviors (Workman & Williams, 1980).

University instructors, most skillful at motivating students to work and to learn, share a number of qualities, which according to Lowman (1984), include recognizing that students vary greatly in academic abilities and in interests and attitudes toward work and authority. Instructors also need to understand that extrinsic motivators are recognized by the students, and that evaluation in the form of grades may be counterproductive in establishing lifelong learning habits. Good teachers de-emphasize grading as much as possible and encourage students to develop their intrinsic motives. So how does the educator prepare a course that encourages self-directed learning? Our typical thoughts run to questions such as: "What do I want them to know; what do I want them to be able to do?" and ultimately, "How do I assess their progress"?

Using Microbucks in the Classroom

The class was comprised of 67 students enrolled in a sophomore level biology class. The institution at which the study was conducted is a mid-sized undergraduate, private institution of approximately 3500 students, located in western New York. The 67 participating students were introduced to the concept of Microbucks through the description included in the course syllabus in the section pertaining to grading. The following passage contains the material from the syllabus.

Microbucks. As an added incentive or inducement for you to become an active learner in Microbiology, Microbucks have been developed. Each Microbuck is worth 1 point. They can be earned in the following ways:

A. 1 Microbuck for each question answered in class

B. 1 Microbuck for an article about microbiology that has been downloaded from the Internet (you must include www address and date and write a one to two paragraph interpretation/opinion of the findings; limit 1 per week).

C. 1 Microbuck for an article about microbiology from either the newspaper, or a publication from a popular or research journal (you must include a reference source and write a one to two paragraph interpretation/opinion of the findings; limit 1 per week).

The number of Microbucks that one may acquire from category A is unlimited. Do not underestimate the power of Microbucks on your grade. Microbucks may only be applied towards your Biology 212 lecture grade...They are not real money.

Students are responsible for annotating the back of their Microbuck with the reason for receiving it and the Microbuck may not be exchanged. A tally sheet is filled out at the end of the semester with a total count and a brief description of the reason for the award.

Upon submission of an article, the student is usually asked a few questions about his or her choice. It is advisable for the instructor to act as if he or she has no prior knowledge of the information in the article. This strategy is important for encouraging students to describe the salient features of the article, and to define what it is about the article that is interesting to them.

Microbucks received during class for answering questions are awarded in the following manner. Concerns about inequities in reward due to differences in student willingness to talk in class are addressed in a number of ways. First, a student must be called upon by the teacher/instructor to answer. Questions are posed, and after a period of time, individuals are asked to raise their hands if they feel that they know the answer. Random criteria are used to determine who has the first chance to answer. For instance, it may be stated that only individuals who have not received a Microbuck in the past week are eligible, or only those whose first name begins with A through M, or those sitting in the back half of the classroom are eligible. More than one answer may be rewarded a Microbuck, so students recognize that they should not turn off just because somebody else has been called upon to answer the question. Follow-up questions that require higher-order thinking skills are also used; this opens up a Socratic discussion on the topic to explore the limits of content and conceptual understanding. Class occasionally starts

with a Microbuck-worthy question that is based on the required reading for that period, or on an extension of a topic that was discussed in a prior class. Microbucks have been awarded after small group discussions of a problem or issue. This avenue suits certain individuals who are afraid to be seen as wrong in front of their classmates. Feedback is given to students regardless of the correctness of the answer. Students were also asked to address specific questions as a way to explore their personal motivating factors.

Student Feedback on Microbucks

Not so surprisingly, there were a large number of factors that affected student motivation. It was recognized that there was probably not going to be a single fix, a panacea that would work effectively to motivate all students. Extra credit is a mantra from students that we tire of hearing; most extra credit assignments mean one thing for the educator, extra work. The idea of using external rewards is not a novel one; however, the thought of tying the reward system to the extra credit appeared to be advantageous, especially if some universal currency could be developed that could be offered for a number of activities.

The thought of a universal currency led to the construction of Microbucks. Students appreciated the use of Microbucks. Student motivation levels rose, participation was high, and students felt that the "bucks" were valuable, perhaps in a disproportionate manner to their real effect on grades. Students rated the concept of Microbucks very favorably on the course evaluation, using a five point Likert scale.

TABLE1: Student Evaluation of Microbucks

Microbucks are a good idea.	4.85
Microbucks encouraged me to read scientific articles.	4.90
Microbucks encouraged me to participate in class.	4.55
Microbucks encouraged me to come to class more prepared.	4.55

There was almost a universal positive feeling with an approval rating of 4.85 out of a possible 5. One of the most encouraging signs of extrinsic rewards, leading to intrinsic satisfaction, involves the option of collecting outside reading articles related to microbiology. Most students found this to be enjoyable, and they continued to bring in articles even after they had received the maximum number of Microbucks for this exercise. Reading patterns may become established that possess some staying power for lifelong learning and interest in the

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subject area. Even students who did not turn in articles appreciated the fact that they were available, and topical presentations of microbial issues was deemed to be an important component of the course by the students.

Microbucks could have a substantial impact on one's final point accumulation. Students ranged from 0 Microbucks (0% of total points) to 34 Microbucks (9.39% of total points). There is a general trend noted in Figure 1, the high-achievers on written exams tended to accumulate the highest numbers of Microbucks; however, there are some notable exceptions. Several students near the top end of the point scale did not feel the need to acquire articles; one student indicated that she felt that somehow it was cheating to earn points from ways other than exams. This particular student was very driven to perform well on exams, but rarely participated in class discussion, in part because she was too shy to speak in front of others. Other students who admitted to being poor traditional test-takers appreciated the feeling of being in control of their learning.

When students were asked what their main motivators were, some mentioned getting good grades; others described a fear of failure, or disappointing their parents. Several others stated that they did their best because it increased their internal feeling of worth, and they liked the positive feedback they received from their superiors. Present performance was recognized as something that was linked to preparation for the future, and so getting good grades was something that was very important. When asked what it took to do well in class, studying, paying attention in class, doing extra things outside of class, and staying on task, were all deemed as important. Interestingly enough, traditional extra credit was not mentioned, and Microbucks were only mentioned when described as an incentive for class attendance and participation. Another thing to note was that students who became actively engaged in the course would continue to send the instructor emails regarding interesting articles they had found that contained a microbial theme. This is powerful evidence that the reinforcement of the practice of actively finding articles related to a particular subject area, can lead to a situation where the learner continues the practice, even after the reward is removed.

Discussion

External factors have a large influence over our behaviors. Another colleague of mine stated "I don't care why 'bucks' work, all that matters to me is that the class responds in a very positive manner to them, and the level of participation in my classroom is at an all-time high." Students are more apt to be motivated whenever they can see the relevancy of the learning, and how the assessment tool relates to the activity. If instructors model how they acquire new information by using class time to discuss recent news stories, or local issues involving microbiology, and how they contextualize the educational material in their personal and professional lives, then the students will perceive the relevance of the learning, and a higher intrinsic motivation should follow (Perkins & Salomon, 1989). If assessment is focused on the achievement of authentic learning outcomes, then student performance can be measured as a result of some activity or achievement. This performance can be demonstrated at a macro level – the completion of a large project, or at a micro level – answering a question in class.

It is important not to establish a competitive classroom, as studies have shown that this attitude will decrease the participation and intrinsic motivation of some students (Epstein & Harackiewicz, 1992). If students believe that the first person with the "correct" answer will always receive the attention and reward, then individuals with low self-esteem or those fearful of being wrong will concede such victories to others. In such a situation, a number of students stop participating in the class. It should be recognized that this situation can be eliminated through the implementation of some of the suggestions noted in the Methods section. It has also been shown that positive responses to queries can enhance intrinsic motivation (Gottfried, 1983). This can be successfully used even if the student has put forth information that is inaccurate or imprecise. Approval helps the learner feel capable (Brophy, 1983).

The use of operant conditioning has been shown to enhance the intrinsic motivation of individuals (Skinner, Wellborn, & Connell, 1990). One way to empower students in this manner is to allow them to be the ones responsible for discovering information. This is accomplished by rewarding students for finding research articles, websites, or news stories pertaining to microbiology. In this manner, intrinsic motivation is developed as students monitor and reinforce their own progress (Brophy, 1983; Pintrich & DeGroot, 1990). Learning through discovery has been recognized as a powerful intrinsic motivator (Adelman, 1978).

Conclusion

It can be a generally daunting task to convince students that they can perform well in a science class. Many of the students in Biology 212, Microbiology, are in the Nursing program and have not taken a science class since 10th grade. Some students develop beliefs about their deficiencies compared to Biology majors, and feel that they lack important abilities. It is the job of the teacher to produce an environment where the students feel able to achieve in an area where they may at first feel overwhelmed. It is important for the students to build strong beliefs about their competencies. However, how does one provide such a challenge in a mixed classroom? What would be considered an easy task for some students, and hence not very challenging or rewarding, may be sufficient for other students to feel competent. Small-scale assessment of competencies is important for students, so that they can recognize their progress towards goal mastery. It is important to show students that success comes from practice, diligence, and hard work and that failure can be reversed through these three actions. According to Bandura (1981), small, short-term, proximal goals are useful to establish positive feedback mechanisms in the learner. University students may find that they are not able to assess their level of understanding of the material, and consequently perform very poorly on widely-spaced exams. Bloom (1971) developed such a program, and one of the key components of his program was mastery learning, which was achieved through the dissection of course materials into small, unique skills that could be assessed. These small learning units can be assessed with evaluative feedback in the form of Microbucks.

Research has demonstrated that effective teachers communicate to the class what they want them to learn (Edmonds, 1979; Madaus et al., 1980). The instructor for this course has been recognized for his love of the subject matter, to a degree that many term "infectious." Occasionally, an extrinsic factor can be useful as a "persuasive" device to help establish the intrinsic motivation to become a lifelong learner in a subject, and it appears that for some, Microbucks is one such factor.

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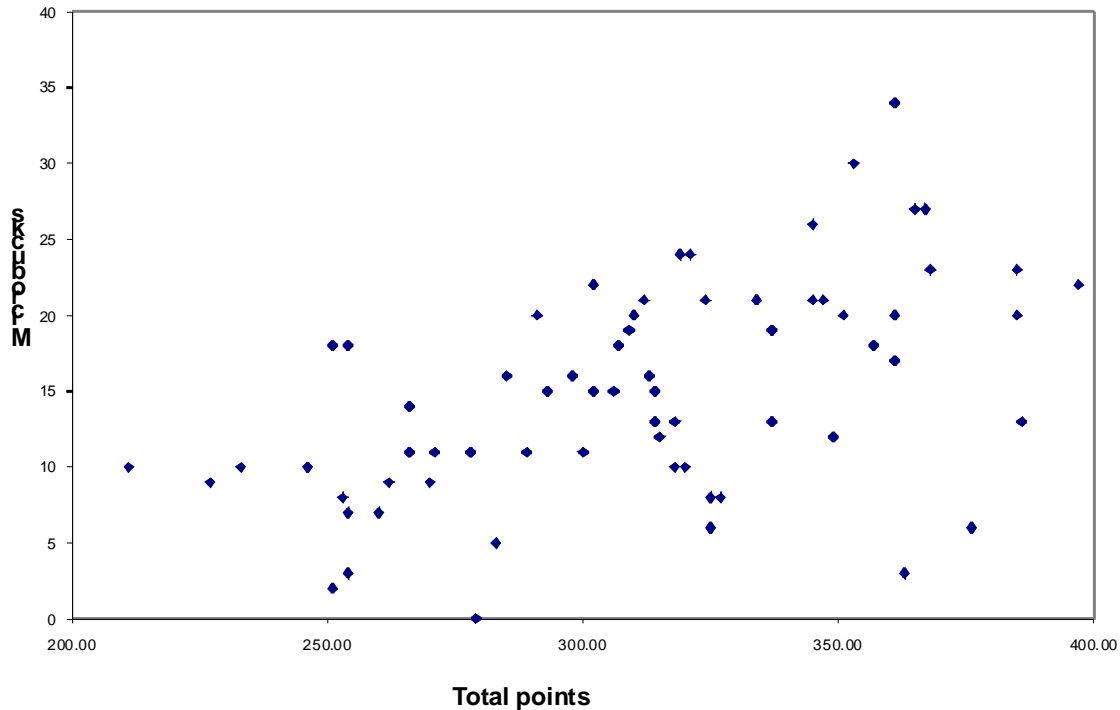
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Appendix

Figure 1. Effect of Microbucks on Point Distribution.



There were 400 points available through examinations. Microbucks were added onto the score to produce the final scores that are plotted above. Student scores below 200 points are not shown.