

Motivation Theories and Implications for Teaching and Learning in the Biosciences

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Introduction

Learning is fundamental throughout the development of human life. It is also known that motivation is a key factor to successful learning. The pre-entry attributes of the student (Terenzini & Pascarella, 1980) including their own internal attitudes and motivations, are considered important for successful integration into a university system. In addition, Tinto (1975) has maintained that pre-university schooling is important for academic and social integration of students and hence their learning and motivation as deduced from successful completion rates.

A pivotal goal of higher education is for students 'to learn how to learn.' A variety of teaching approaches encourage students to adopt a deep approach to learning by seeking a personal understanding. One important aspect of the learning environment identified by Biggs (1999) that encourages deep learning is the motivational context. This depends on students taking 'ownership' of course content and establishing a positive emotional climate associated with their learning. Furthermore, implicit in the idea of 'lifelong learning' is the notion that students should depart from higher education with the ability and motivation to continue learning throughout life's journey from sources other than university.

There is increasing research interest with respect to integrating motivation into teaching and learning processes in order to foster in students the disposition and capacity for lifelong learning. However the study of motivation is complex. Definitions vary widely and theories are diverse, influencing the indicators used to assess motivation and even the interpretation of the data obtained (Schunk, 2000). Added to this, the motivation of learners may vary in different domains, different contexts, with different teaching and learning strategies, and at different stages of a learning interaction.

Within the science domain, the recent Science and Innovation White Paper (HEFCE 2008) highlighted 'the critical role that higher education plays in the competitiveness of the nation and the productivity of its public services'. A good supply of well-

trained, talented and motivated researchers is essential for research excellence and innovation. The challenge therefore, for higher education, is to skill and motivate science students to become creative and entrepreneurial 'lifelong learners' in a fast changing work environment that provides better health care, ensures a cleaner, safer environment, and builds on the existing science base to ensure excellence.

For the Biosciences disciplines, QAA Benchmark statements specify motivating and challenging the student with the use of a 'skilled and balanced selection of teaching and learning techniques' (QAA website). Blended learning is recommended through a wide range of teaching methods - including laboratory sessions, self-directed study, computer-aided learning, case studies and problem-based learning, demonstrations, active learning sets, work-based learning and/or placements, reflective practice, research project work - and assessment strategies. Clearly this calls for a commitment to developing curricula to encourage motivation and foster 'deep learning' that goes beyond formal education. In so doing, teachers need to better understand how learners learn so that instruments can be used to identify the different learning styles and motivations. They also need to structure activities that take into account these various learning styles, multiple intelligences of learners and creating the context that provides the extrinsic motivation to complement the learner's own intrinsic motives.

This paper provides an overview of theories of motivation based on the work of some motivation theorists. Some key principles are identified from the literature that link cognition, motivation and learning and which could have application in the teaching of Biosciences towards the goal of lifelong learning.

Motivation and Learning

It is well recognised that motivation can provide the impetus that facilitates learning. In fact, learning models do subsume a theory of motivation either directly or indirectly.

Many definitions of motivation exist in the large volume of literature on the subject. The term motivation derives from the Latin word for movement. Building on this concept, Lewin (1938) posits that motivation is the result of tensions or energy created in response to particular needs or goals. This implies that behaviour is necessary to fulfil needs or achieve goals. As defined by Weiner (1992), 'Motivation is the study of the determinants of thought and action – it addresses why behaviour is initiated, persists, and stops, as well as what choices are made' (p.17).

As with the definitions, there is extensive proliferation of theories on motivation. Initial perspectives emphasised motivation in terms of mechanistic theories or those based on the cognitive approach (Weiner, 1992). In mechanistic theories, motivation is described in terms of the 'machine metaphor' where human behaviour

is paralleled to machines with their motivation being based on needs, drives and instincts. In cognitive theories, motivational behaviour is predicated on thoughts, beliefs and choices. However, this classification is questionable as some theories have ideas common to both categories.

Motivation theories

Motivation theories may also be broadly differentiated into behaviourist, humanist, cognitive and social learning theories (Table I). Again, this is not an absolute categorisation as theories may overlap e.g. cognitive social theories; expectancy-value theories explain motivation in the aspect of cognitive processes but the theories are still similar to the mechanistic/behavioural theories (de Vicente, 2003). The source of motivation is also included in Table I and is differentiated as either intrinsic (doing something for its own sake) or extrinsic (doing something for some other reason). The underlying idea in these theories is that activities will be performed based on the reasons for the action or on the beliefs of the person doing those activities.

Table I: Typology of Motivation theories

	Behavioural	Humanistic	Cognitive	Social Learning
Source of Motivation	Extrinsic reinforcement	Intrinsic reinforcement	Intrinsic reinforcement	Extrinsic & Intrinsic reinforcement
Important influences	Operant behaviour reinforced by rewards, incentives; punishers	Need for self-esteem, self-fulfilment and self-determination	Beliefs, attributions for success and failure, expectations	Value of goals, expectancy of reaching goals

One of the earliest behavioural theories by Skinner maintained that all behaviours are motivated by rewards which hence reinforce learning. According to Skinner, having the correct answer will motivate the student to go on to the next level, working through all levels until the desired behaviour is achieved; and as the student works through the task, the desired final behaviour is progressively shaped.

Key theorists in the Humanistic paradigm are Maslow, Herzberg and Deci (see Deci & Ryan 1985; Deci *et al.* 1991). Maslow's Hierarchy of needs emphasizes growth and development of the individual in satisfying needs in a hierarchical fashion. This may account for differences in behavior of students. He regarded 'the single, holistic principle that binds together the multiplicity of human motives is the tendency for a

new and higher need to emerge as the lower need fulfils itself by being sufficiently gratified' (Maslow, 1968, p.55). From a learning point of view, this means that as one becomes more self-actualised, the ensuing development of wisdom will enable appropriate behaviour in a wide variety of situations.

Norwood (1999) proposes that Maslow's hierarchy theory can be used to describe e.g. the kinds of information that individual's seek at different levels. For the student, this could be translated into seeking coping information (basic needs); helping information (safety needs); enlightening information (social needs); empowering information (self-esteem needs) and lastly edifying information (self-actualization needs). In faculties and in the wider university community, social needs in particular, may explain why students experience social motivation among their peers in, for example, group tasks. Also, as raised by Tinto (1975), the satisfaction of social needs was important for social integration into the university system and hence successful learning and completion. However, much criticism has been levelled against the assumption that initial satisfaction of the lower needs is required before proceeding to the next need level, as individuals are likely to be faced with more than one need simultaneously.

Herzberg's 'motivational hygiene' theory (1966) although proposed in the work environment has application to motivation in student learning. The reduction of demotivators (or attending to 'hygiene factors') - such as bureaucracy, poor administrative procedures, poor communication, poor access to the VLE, inadequate teaching tools/facilities, use of grades etc. - and an increase in motivators (or incentives) - such as stimulating, well-designed teaching, interesting activities according to learning styles and multiple intelligences, appropriate assessments - can enhance positive motivation in students.

The cognitive view is based on Jean Piaget's principles of equilibration, assimilation, accommodation, and schema formation, hence motivational behaviour is construed as being based on thoughts, beliefs and choices. The 'expectancy' theory (Vroom 1964) is based on the premise that people are motivated by the likelihood of success at a task (expectancy). The construct is one of the most important mediators of achievement behaviour. The expectancy-value theory (Eccles & Wigfield, 2002) additionally stresses a second cognitive influence which is the reason for engaging in the task (value). This theory led the way in explaining motivation in cognitive terms. Current research on the expectancy-value construct continues to emphasise the two beliefs of the individual but contextual influences are included in the later models.

Social learning suggests that imitating and observing others are important motivators of behaviour. In the learning environment, students can see, enact, and practice with the help from the tutor and peers in the group. Also, group activities allow participants, with different skills and levels of skills, to practice interacting within a

socially organized unit similar to research teams in the workplace where they learn from the task as well as from each other.

In social cognition theory, the environment, an individual's behaviour and his/her attributes (e.g. knowledge, emotions, cognitive development) influence and are influenced by the other two components. According to Bandura (1987), self-efficacy is a self-judgment of one's ability to perform a task in a specific domain and is therefore situation specific. Zimmerman (1989) pointed out that students can be described as self-regulated in that they establish their goals, develop plans to attain these goals, commit to and implement the plan, reflect on their actions and redirect behaviour. He describes these students as metacognitively, motivationally and behaviorally active participants in their own learning processes. Corno (1994) states that such individuals have 'volition' in that they tend 'to maintain focus and effort toward goals despite potential distractions' (p.229).

The latter motivation theories imply a shift in learning and motivation toward the concept of learner-centeredness. Focus is on active control of the learner and the motivational value of that control (Svinicki, 1999). Associated theories include constructivism, self-regulation in learning, (Pintrich, 1995), and self-determination in motivation (Deci et al, 1991) which depicts a larger shift toward personal responsibility.

Motivation and teaching – the role of research projects

Bioscience disciplines are experimental sciences. Hence a primary instructional method in response to the learner-centred theories is in encouraging an understanding of real-world problems.

An important aspect of this is the research project for which students develop a research proposal outlining the rationale for the study, the research questions, methods they will employ to gather relevant data and how they plan to analyse and interpret the data. Learners, initially guided by the tutors, soon become autonomous researchers, monitoring their own progress over time.

In the self-determination theory, motivation is based on the learner's perceptions of being in control of his or her own destiny. In the context of the research project, the learner makes choices about research goals and develops strategies to achieve them. Tutors encourage learners to make choices about how to learn or what direction to take in fulfilling the aims and objectives of their research. As students develop the 'habit' of reflecting on their learning, they become more competent, progressing to becoming 'deep' learners who become more interested, more focused, more challenged and more motivated. This concept of competence underpins many of the favoured approaches such as attribution, goal orientation and intrinsic motivation theory.

Self-regulation is a variable attribute of learners. The self-regulatory process outlined by Zimmerman (1998) can help learners to develop self-regulation and volition to learn in engaging in their lengthy research project. Exposure to these self-regulation methods is useful in learning but if the learner becomes proficient in their application, these techniques can be used in lifelong learning in informal contexts. In particular, the student encounters many obstacles (e.g. reagents not available on time, difficult techniques, unexpected results, etc.) throughout the course of their research but has to develop the 'volition' to cope with the frustration, overcome the problems and remain motivated to carry the project on to fruition.

Preparing students for lifelong learning involves preparing them to make complex judgements about their own work and for future circumstances. Mok *et al.* (2006) argue that students need to become self-directed learners who are capable of goal-setting, self-monitoring, self-assessment and self-correction in order to gain lifelong learning competence. The research project affords students the opportunity of engaging in all these activities – and thereby to enhance both goal and expectancy motivation and self-efficacy. However, our assessment of the research project needs to emphasize these activities and capabilities of students.

There is also opportunity for learners to collaborate with other students engaging in different arms of the same project or with external individuals from industry. Not only does this mimic work place collaborations but they benefit from learning from peers as well as experts. This ties in with social learning as a form of motivation. Further, the articulation of students' findings in the form of a scientific paper and the verbal defence of their research in an assessed viva voce encourage the development of employability skills.

In employability modules in Biosciences, there is opportunity for students to create their own learning outcomes. One might argue that students may not have sufficient knowledge on how to do this, and time demands may be an impediment. But allowing students to engage in a process where they deliberate on what their goals should be within the boundaries of the module is, in itself, encouraging both motivation and skills development. This is a practice that they will use even in the workplace, hence promoting 'transfer of learning' so that knowledge and skills gained in one context can be applied to another.

In work placement modules, they are also motivated by participating in a community of practice, exposed to the active practice of the discipline and learning from individuals already involved in professional applications. Again, the skills development in these activities underpins many of the current learner-centred motivation theories.

Conclusion

Clearly, the various motivational constructs inform instructional methods and influence teaching and learning. However, not all students are motivated to learn and complete. Contributing factors such as increasing student numbers, high teaching loads, lack of investment in teaching innovations, constraints in identification of learning styles and intelligences of students, deny teachers the opportunity of fully motivating their students.

Nevertheless, there is growing interest in how tutors can use motivation constructs to facilitate student learning, especially in instances where students lack motivation. Motivation theories can be used by tutors to assist students to overturn negative feedback and motivate them to succeed in their learning goals. These theories, brief descriptions of them and possible tutor interventions are tabulated in the appendix. We can expose students to a wide range of stimulating teaching strategies and experiences and help them towards self-regulation to a point where they can go on to become lifelong learners.

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APPENDIX: Motivation theories that that inform intervention (Table prepared using info from Svinicki (1999).

Theory	Description	Authors	Tutor intervention
Self-worth theory	Maintains that individuals respond in a way that will maintain their image of self-worth	Covington, 1984	Tutor to assist learner in finding out what went wrong. Emphasize internal reinforcers and motivation
Expectancy value	Learner's motivation is a function of how likely success at a task is(expectancy) and the value that the learner places on that task (value). Both components must be present in some degree for the learner to be motivated	Atkinson and Birch, 1978; Eccles, 1983.	Instructors can intervene to help raise student expectancy for success or to increase the perceived value of the task for that learner
Self-efficacy	Concept of self-efficacy is a belief in one's own ability with regard to a specific task	Bandura, 1989	Convince the learner to link their behavior and consequences; that they can succeed and increase their self-efficacy
Cognitive motivational concept	Student motivation is tied to progress toward a goal by narrowing the gap between current level of performance and the goal	Schunk & Zimmerman, 1994	Tutor can help learner to focus on goal and draw attention to peers who have reached the goal and received positive benefits.
Attribution theory	Learners' motivation is based on what they believe causes their success or failure	Weiner, 1980; Peterson & Seligman, 1984	Tutor can change learner beliefs and attitudes about learning
Goal orientation theory	Learner's behavior is determined to a great degree by the type of goal for learning: mastery goal orientation or performance goal orientation.	Ames, 1992; Dweck, 1986	Tutors to work with students and their goals; encourage mastery goal orientation and hence, desire to learn something new.

Theory	Description	Authors	Tutor intervention
Self-determination theory	Motivation is based on the learner's perceptions of being in control of his or her own destiny.	Deci, Vallerand, Pelletier & Ryan, 1991.	Give the learner choices about goals and strategies for achieving them. Encourage them to make choices about how to learn or what direction to take.
Attributional concept of belief	Is an internal control over outcomes, known as locus of control	Weiner, 1986	Encourage learners to have choices and believe that their success depends on those choices.
Intrinsic versus extrinsic sources of motivation.	Intrinsic motivation comes from having choices, from choosing challenging yet attainable goals, from feelings of being in control, and from self-efficacy for the task at hand.	Deci, Vallerand, Pelletier & Ryan, 1991; Ames & Ames, 1991; Csikszentmihalyi, 1975	Set challenging yet attainable goals for learning, and provide feedback on progress. Emphasize internal reinforcers and motivation.
Concept of volition	Is the force that keeps motivation going in the face of obstacles. Involves using strategies that help learners overcome obstacles, cope with frustration, and carry the task through to completion	Corno, 1993	Teach students how to carry through as well as how to get started. Encourage students not to give up if they cannot solve a problem immediately.