ENHANCING STUDENTS SELF-DIRECTED LEARNING AND MOTIVATION

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ABSTRACT

While mastery of knowledge and technical skills are essential, students must also be motivated and self-directed in order for purposeful engineering applications and innovation to take place. This paper describes an initiative adopted at Singapore Polytechnic (SP) to enhance the motivation of engineering students to be self-directed learners. Using a framework based on the principles of Self Determination Theory (Deci, 1995; Ryan and Deci, 2000) and Tony Wagner's (2012) Creating Innovators, innovative curriculum changes were implemented to enhance the intrinsic motivation and self-determination of learners in the Diploma in Mechatronics and Robotics. .

The curriculum changes, adopted since 2012, were aimed at enhancing the students' intrinsic motivation through meeting their psychological needs of mastery, autonomy, purpose and relatedness (Ryan and Deci, 2000). Implemented into all 3 years of study, the changes focussed on play in the first year, passion in second year and purpose in the third year.

The paper will also share a study conducted to ascertain the impact of the changes in the programme on students' motivation. While qualitative results showed improved students' motivation and engagement in learning, more needs to be done to develop the students' skills for self-directedness and self-determination. The paper will also reflect on the strategies used and suggest improvements for future implementation.

KEYWORDS

Intrinsic Motivation, Self-Determination, Competence, Autonomy

INTRODUCTION

Singapore Polytechnic (SP) recognises that we have a diverse student population with a wide range of interests and abilities. Given this backdrop, SP has developed and put in place a range of initiatives to meet the different learning needs of our students. The Intrinsic Motivation initiative was adopted in 2012 to **level up less motivated learners** and to prepare our students better for the Innovation economy.

The definition of *less motivated learners* varies from programme to programme. For example, in some programmes, *less motivated learners* refer to those who lack interest and drive as they do not feel competent in the subjects they are learning. For other programmes, students felt that they were in an unglamorous, sunset industry and hence lacked the motivation to study and underachieved.

To tackle this challenge, SP adapted and piloted an Intrinsic Motivation (IM) framework, based on the works of Edward Deci and Richard Ryan (1995, 2000) and Tony Wagner (2012). The key focus of the framework is to incorporate curriculum activities that encourage competence, relatedness, autonomy, purpose, and the cultivation of a growth mindset (Dweck, 2006).

As learner motivation comes in various shapes and sizes ie not all motivation is the same, lecturers must understand and take into account the nature of student motivation, and not simply the magnitude of motivation, to design effective and engaging learning experiences (Reeve, 1996). Lecturers, hence, must consider the ways in which motivation interacts with and is affected by a wide range of classroom characteristics, such as pedagogical approach, physical environment, teaming and collaboration, and student autonomy.

Together with CDIO and Design Thinking, the Intrinsic Motivation initiative aim to develop the Creative Confidence in students where they have the spirit to *Dare to Do* and *Dare to Think* to be innovative and try new ideas and challenges.

LITERATURE REVIEW

Developing Self-Directed Learners

The main idea in self-determination theory is that of goal internalization, a process whereby individuals actively integrate extrinsic, or externally motivated goals and behavior into intrinsic, or internally motivated goals and behavior. Levels of internalization are described on a continuum with different motivational orientations.

- amotivation, a condition that occurs when learners feel no competence or autonomy, find no value in the learning activity, and expect no desired outcomes.
- intrinsic motivation, a state described by interest, enjoyment, inherent satisfaction, and internalized goals.
- extrinsic motivation, which is initiative and regulation of action that may be prompted by a range of inputs, from external rewards and punishments to an identification of value in the learning activity.

According to the theory, individuals will fully engage in learning when three basic needs are satisfied:
- autonomy, which is the feeling of choice and control;
- relatedness, or the building of social connections; and
- competence, which is the development of a sense of mastery or self-efficacy

Besides, meeting the learners' psychological needs, it is also important that students understand and apply positive beliefs in how they go about their learning.

Students' motivation and learning can also be encouraged through curricula designed to provide learning contexts in which students:
1. can make choices during learning activities and experiment in a playful and less formal context;
2. learn how to master key skills, feel a sense of mastery and develop a passion for the subject;
3. find a sense of personal purpose in their future learning.

As the students journey through the different learning contexts, they recognise that creativity is not the domain of only a chosen few but that with confidence and effort, they too can be creative (Wagner, 2012).

Key to meeting students' psychological needs are the interactions between lecturers and students (Reeve and Jang, 2006). Teacher-student interactions can provide the necessary support system to nurture students' interests, develop important skills and social responsibilities.

IMPLEMENTATION OF THE INTRINSIC MOTIVATION FRAMEWORK IN THE DIPLOMA OF MECHATRONICS AND ROBOTICS

The Diploma of Mechatronics and Robotics (DMRO) adopted the Intrinsic Motivation initiative in 2013. The course chair re-designed the curriculum to include engaging learning activities and interactions that promote the sense of satisfaction, achievement and connectedness, and through which students develop passion and purpose for their discipline.

The Intrinsic Motivation Framework is infused in the curriculum as follows:

- *i*nspire through Purposeful Play in Year 1: *i*nspire aims to instil the desire to Be and to Learn in students. Students are given autonomy to learn through play. *Goldilocks tasks* that are neither too easy nor too hard are employed. Activities include experimenting with engineering objects (e.g., building the catapult machine), designing their own products and entering local robotic competitions. The emphasis was on students having both a choice in what they do and experiencing fun in the learning process.

- **Autonomy and Mastery in Year 2**: Students build and develop key skill sets through capstone projects, such as building an autonomous guided vehicle and compete among each other.

- **Possibility and Meaning in Year 3**: Students build upon their foundational knowledge and skills to choose a project of their own interest that has special meaning for them. A learning space is provided within which there are learning spaces for co-creation, facility, play, knowledge and sharing. Relatedness among students, and between staff and students is further strengthened when they work on the final year capstone project.

Feedback from students has been very positive. The students produced very good learning outcomes in the form of several Final Year Projects (FYP) that were selected for public display during the annual SP Engineering Show.

STUDY OF THE INTRINSIC MOTIVATION INITIATIVE IN THE DIPLOMA IN MECHATRONICS AND ROBOTICS

A study of the implementation of the DMRO was embarked in 2015. The aim was to gain a better understanding of the success elements of its implementation and areas that required improvements.

Interview Methodology

We interviewed 16 instructors and students from DMRO. We sought to understand qualitatively what the shared learning experience in DMRO is like for staff and students, and what makes it special. The responses of the interviewees are put together to form a detailed contextual narrative against which the other research results can be interpreted.

Table 1: Details of lecturers and students interviewed.

DMRO Instructors	DMRO Students
• Course chair • Final year (Year 3) level head • Year 2 level head • Lab technician	• 7 Final year students • 3 Year 2 students • 2 Alumni

Going in we knew that DMRO was different from other Engineering courses because of their focus on project work, especially the capstone final year project. The instructors interviewed were selected based on their involvement in the student projects and their high degree of interaction with the students. Likewise, we interviewed mostly final year (Year 3 students) who were going through or had completed their final year projects. They were also in a good position to look back over the past 3 years and comment on the overall experience in DMRO. The students were chosen for a wide range of academic abilities and interest levels in Engineering.

We adopted an ethnographic method to the interviews. The key tool is the use of open-ended prompts to elicit from the participants stories of their prior experiences, which they personally find interesting. This approach is effective at getting respondents to become more receptive to the interview, leading to a richer and more authentic account of what happened than by asking direct, yes or no questions.

We prepared a list of interview questions (Table 2). These acted more as a guide to ensure coverage of issues and would be adjusted in the flow of the conversation.

Table 2: List of interview questions

Questions for staff	Questions for students
• Could you describe the students' journey of growth through your eyes? • How would you describe the students in DMRO? • What was the students' inspiration? • What teaching methods were attempted and how did those work out? • What is important to you as an instructor? • How is it like to teach in DMRO? • What changes do you envisage for the DMRO curriculum in the future?	• What was your life like before SP? • How did you end up in SP, in your course? • Tell us about your experience in your course. • Tell us about the projects that you've done. • Was there something fun or memorable? • What has made you who you are today? • If you could go back in time, what advice would you give yourself?

All participants were assured that their responses would only be used for research purposes and would not be personally identifiable. The interviews ranged from 30 minutes to over 2 hours, and were audio recorded and transcribed.

Each interview transcript was reviewed and cross-referenced against other transcripts. We analysed responses for insights and identified broad themes and issues by clustering related quotes. Three themes, which characterise the success of DMRO, emerged: the quality and nature of relationships between the staff and students, the experiences of the final year project; and the learning environment and culture in the lab.

Along these three themes, the shared learning experience in DMRO is described below through a series of mutually supporting quotes with different voices that builds up to a complete picture. The quotes have been edited for clarity and grammar.

THE SHARED LEARNING EXPERIENCE IN DMRO

Nurturing Caring and Trusting Relationships
From the top down, the course chair and his level heads take the lead to engage the students about their well-being.

> *(The course chair) also really comes down and talks to the student, he finds out what is their problem or whatever, and helps them solve it or whatever … In the evening, after his lesson or what, he will come down and then he will check (on) the students. I think that is important, (to have) care for the students.*

> *If you help (the students and) they feel that you are sincere in helping them, then they feel that they also can do their project better.*

The level heads make the effort to be present as often as they can and especially at critical times when the students most desire external guidance.

> *Be prepared to go the extra mile. Definitely much. And one day if (the students) ask you for something and then you say, yeah, I'm going on leave. I'm not contactable. That's it. You lose them.*

> *So in the first four weeks (of the semester-long final year project) we try to catch them. That … is normally the time when they are most dependent. You know, they are lost and don't know what to do. We show them the way. Then from there, we start to bond. Yeah. At the moment that they are dependent, if they don't get help, after four weeks, you'll have lost them already.*

And they foster a spirit of easy conversation with the students.

> *I can dare to say that (the Year 2 and Year 3 level heads) are my friends, I treat them as a friend more than a teacher… That means sometimes I need to treat them as a teacher, I need to respect them. But, you know, sometimes when they are free and they start walking around, then we'll start joking around, yeah ... He'll walk around and tease us and make laughter … So it's quite fun also in the process. – Varian*

As a result, the students feel comfortable approaching the course chair and the level heads with their troubles and their needs.

> *I think the chair, the heads, the teachers, so far have been very good. They guide us … I'm not saying the lecturers, more the heads, the ones that take care of us … So if we got any need, any trouble, we can feedback to them. Then they'll help us … I think (the course chair) took quite good care of everybody over here. That's one of the biggest things.*

This builds a trusting relationship between the instructors and the students, and also sets the foundation for DMRO as a safe and desirable place to learn. Without a degree of interpersonal trust, it will be hard to get through to the students to take on even basic responsibilities.

Master and Apprentice Relationship
To open the students up to learning, the project supervisors seek to first establish their credibility and authority. The project supervisors impress on the students that they have useful skills to be imparted. This sets up a relationship similar to that of a master and apprentice.

> *I'll be there, (guiding them during) fabrication. but we have to show them what can be done. I have to get their trust … If you just talk, you don't show, (the students will say,) "We have to do, but I never see you do right?" (I respond), "Yeah, I can do and I prove that by doing this."*

> *Lead by example. So before you ask (the students) to do it, you must know how to do it. For us, we can and we will.*

With credibility in hand, the project supervisors begin by closely directing what the students do.

Nurturing Mastery
The supervisors match the difficulty level of the project to the team's level of ability, to balance the amount of learning by the student with the risk of not completing the project.

> *We manage their projects. We call it Goldilocks tasks. So for the weaker ones, we advise them to take something simpler. And I think most of them will accept. And the better ones we tell them to pick something more challenging. So (the students) start asking questions, "If I do a challenging project, then is it harder to get A?" So I'll respond to them in this way, "Okay, if you take a simple project, no doubt, you'll get an A. How much do you learn?"… You know, we always ask them to try the more difficult (projects).*

Some students are keen to push themselves beyond what the supervisors expect they can reasonably complete. The supervisors have to rein in this enthusiasm while still supporting the students' sense of autonomy.

> *So this (project) is done by the … very high GPA students. This group actually wanted a more challenging (project) … They want (it to move in the) air, they want land, they want water. So I ask them, "Are you sure?" Because we know what it takes to get there, and we know it cannot be done in 15 weeks. So I said take out the water first, so you do the land … If you finish this, I let you try the water. So they go and try, after 12 weeks they realized cannot be done.*

It's important to DMRO that all students finish the projects, to ensure that they gain a sense of accomplishment. To set the projects up for success, the supervisor repeatedly engages each group at the start of the project to level everyone up.

> *Some of them ask me which group to help. I say, "Whichever group needs the most help." … If this group is struggling, then I will spend more time here. Then after this round, I will see which group is the lowest … In (the case of) project*

(work), it's always like that. Some have progressed more, some not. So we always identify the lowest one first. After this one goes up, then the next one becomes lowest.

We put it very clearly: we don't show favoritism. We don't want to spend all our time on the good ones. The objective is for everyone to finish together

The supervisors ensure that what the students learn during a project is relevant to its success. Students will appreciate the usefulness and purpose of what they're doing.

So all these things are given on a need basis. (The students) need the skill. It's not like during lessons: I'm going to teach you this complex theory and in the future five years down the road, you are going to apply this. But what (the students) see is immediate, that means they need to get these parts, or they need to do this design; immediately, we show. So whatever they learn, they can see the outcome straightaway. So it's like just-in-time training.

Nurturing Independence and Confidence

The supervisors begin to wean the students off their dependence on direct instruction, by not simply giving them the answers each time they ask.

(If) you come to me with a question, I'll give you something back. But don't come to me empty-handed. That means don't come (saying), "how to do this, I don't know how to do this." … That means (the students) must try first. Don't expect people to feed you.

When we need advice for something that we don't really know, we'll ask the lecturer for more knowledge. He'll usually help us to think of the idea, then the rest we'll have to figure it out ourselves to solve the problem.

By giving timely praise in response to good work done, no matter how small, one can increase the students' perception of their competence.

Of course, some encouragement given. Don't undermine this little encouragement, it helps. It helps them a great deal. (No matter) how small the success is. The moment you encourage them, they feel "Oh, actually I can take this up" … You must really mean it and they really have done it. So when they do it, you feel it, you give it to them. It strengthens their (sense of) assurance.

It's common for students to feel uncertain and unsure of themselves and their course of action, when faced with the inherent openness of project work. The students will benefit from continued reassurance.

I say (to the students), "If I don't come and disturb you, or if I don't ask then generally it's okay. Just have more confidence, that's all."

I feel that it cannot work, as in the project won't be out in time. When we first came in, there's only the empty shell there. But (my supervisor) told me, "You don't worry, you take it a step at a time." Then slowly – do, do, do –the whole thing came out. So we must thank him.

Eventually, the students should be able to attain a level of independence as the project work comes to a conclusion.

I (as a project supervisor) really learned how to detach (myself) … We will not touch, only at certain unique situations we'll touch. But in most cases we will let them (try to figure things out), even to a point we have to wait for them to come.

(In the) final year project, you have to be more independent. You have to ask. And then most of the time the teacher will say it's your call, your decision, should you make this longer or shorter.

Building a Culture of Cooperation and Mutual Support
The supervisors don't put all of the responsibility of teaching on themselves; they get help from the students to disseminate knowledge and skills throughout the cohort.

We also use a lot of peer influence, because I cannot handle 40 students at once. So we have this method called cascading influence to a few selected ones. We know that these people can do it more …You won't see it. It's invisible. We are doing it along the way. There won't be meetings …It's like when your parents give you the key, you know, that kind of thing. It can happen anytime.

There's a lot of cross-interaction. So I got this student … when he first started he said he couldn't do something. So he asked, "Hey Ben, come help me do this." … After it finished, now he knows how. He says, "Hey teacher, I need to help this other guy." So it ends up, he is helping another person. This is the way it cascades.

The experience of teaching others raises the students' confidence and begins to build a culture of cooperation and mutual support amongst them.

(The students) are not calculative; (they don't think), "Why must I help them?" They will help each other because they know I will help them. And it's right for them to help others. That's the culture. A lot of the time (they receive help), not from (students) within their group, but from (students from) other groups.

DMRO has a common lab where all students work on their third-year projects. The staff encourage the students – across all three levels – to spend time in the lab, by giving them greater ownership over the space.

So we can leave our stuff here, it's quite convenient. We can leave our bags, like our laptops. We have lockers. So, yeah, it's very convenient, it's very nice. Then it's more homely in a sense when we do our final year projects 'cause we get to see the two classes together in the same course. So we actually see each other, then we can have lunch together.

But let's say maybe (the staff) are not around, we'll ask the students if one of them can stay and check on the lock, to make sure there must be somebody in the lab. It cannot be empty, because there are so many things inside here … So I think making the students responsible also, it feels that they are taking charge of something.

Once students spend a lot of time working alongside each other, the culture of collaboration and sharing spreads easily. The common space creates many opportunities for students to interact with each other and fosters a spirit of progress and momentum for all projects.

Because of this lab, I think almost everyone knows who is who. Then we learn to share, learn to help each other in this whole lab. That's why I say the biggest

part is the lab. It was the lab that brought together all of the three classes in the DMRO, in this lab.

Let's say those who are new to me, when I first met them, I think we started talking when we are doing fabricating, when we are trying to make stuff… Even though we don't know each other. "Hey, you are doing this a bit wrongly, let me help you with this" or "You should use that, not this." We then start to get to know each other.

CONCLUSION

The Diploma of Mechatronics and Robotics (DMRO) embarked on the Intrinsic Motivation initiation and piloted it for 2 years. It involved curriculum reforms to include design build activities and teacher and student interactions that encouraged play to excite and inspire students; built confidence and autonomy; and provided a sense of purpose and connectedness. The initiative was adopted as students joining the programme generally lacked interest as they did not feel competent in the subjects they were learning.

The interview methodology employed in the study has provided a range of insights into aspects of staff and student relationships relating to the implementation of the intrinsic motivation initiative. For example, the interview data clearly highlights the importance of a caring and trusting relationship between lecturers and students. The experiences of the lecturer-student relationship in turn formed the basis of a master and apprenticeship relationship that helped build the students' mastery and confidence in the subject.
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The importance of a learning space conducive for allowing co-operation and mutual support among students was also highlighted. The DMRO integrated project space provided students with a sense of confidence and belonging as they worked alongside their peers, assisted their less able peers and were inspired by their seniors.

Moving forward, a major consideration in the success of the Intrinsic Motivation initiative will be to ensure the necessary competence of the lecturers involved. They must consider not only the level or amount of motivation but also the nature of students' motivation. Faculty need to be aware of the ways in which motivation interacts with and is affected by a wide range of classroom characteristics, such as pedagogical approach, physical environment, student collaboration and autonomy. More opportunities for faculty development, especially in the area of autonomy supporting teacher behaviours and practices (Reeve and Jang, 2006), will help enhance lecturers' competence to facilitate their students' growth from an amotivated to an intrinsically motivated learner.

REFERENCES

Deci, E L (1995). *Why we do what we do: the dynamic of personal autonomy.* New York: Penguin Books

Dweck, C. (2006). Mindset: the new psychology of success. New York: Ballantine Books

Reeve, J. (1996). *Motivating others: Nurturing inner motivational resources.* Boston: Allyn and Bacon.

Reeve J. and Jang, H. (2006). What Teachers Say and Do to Support Students' Autonomy During a Learning Activity. *Journal of Educational Psychology, 98 (1), 209-218.*

Ryan, R & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology,* 25, 54-67

Wagner, T. (2012) Creating Innovators: The making of young people who will change the world. New York: Scibner

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