

Constructivism and STEAM: working with learners as partners to explore perceptions and attitudes towards innovative pedagogies

To identify, explore, describe, and produce an analysis of the perceptions and attitudes of Scotland Rural College student and staff experiences regarding perceived learning and teaching, and to develop future partnerships.



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SRUC: Leading the way in Agricultural and Rural Research, Education and Consultancy.

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What is the issue?

Recent research has suggested that students' feelings about traditional schooling approaches are mainly negative. Keywords being: 'tired', 'stressed', and 'bored' (Moeler, et al. 2019). Mental health and wellbeing were already in decline prior to the pandemic, with this trend further accelerating since 2020 (gov.Scot, 2022). The arts have overwhelmingly demonstrated to have a positive impact on learning and development while also strengthening mental health (Kaimal et al. 2016; Winsler et al. 2019; Hardiman et al. 2019). In addition, the merging of scientific and artistic perspectives encourages and brings forth fluidity of analytical and empathetic thinking (Burde and Wilhelm, 2020). Therefore, a push towards more holistic and traditional 'right-brained' skills of communication, empathy and seeing bigger pictures should aid in alleviating some mental health stress while also boosting learning and development at SRUC.

By focusing on STEAM (science, technology, engineering, arts, math) and Constructivism (i.e., problem-based learning, cooperative learning, etc), SRUC should be better positioned to the 2020-2025 Learning and Teaching Enhancement Strategy. More specifically, this project has been placed in the context of the following CELT objectives: 'working towards designing curricula informed by the latest research and engaging learners in research-based activities – encourage creative and critical thinking - build learning communities – foster learning environments that are inclusive, active, and blended – and work with our learners as partners'.

What is STEAM and Constructivism?

Students were introduced to STEAM (Science, technology, education, arts, maths) and Constructivism in the initial weeks of the project (see Appendix for more details regarding dates and scope of project). According to Georgette Yakman (2019), the founding researcher of the STEAM educational framework, STEAM integrates the liberal arts, and more specifically 'the "who & why," the reasoning, to the "what & how" of STEM'. Yakman advocates that STEM projects focus on the science topic, but STEAM projects the focus situates on the social studies topics because you are able to apply science to social studies, but it is not always possible to apply social studies into science. Constructivism theory, sometimes referred to as active learning, argues that the goal of teaching is to provide experiences that facilitate the construction of knowledge. It is against more passive forms of learning, and so a whole slew of sub-genres falls under its domain: peer learning,



inquiry based learning, problem based learning, cooperative learning. Meta analysis results show that constructivism-based teaching techniques result in significant academic achievement (Semerci and Batadi, 2015; Dağyar and Demirel, 2015; Habersang and Reihlen, 2018).

Why does this matter in the context of learning and teaching at SRUC?

Transdisciplinary collaboration is needed to create new possibilities and perspectives. The world has a series of challenges that are growing in nature (i.e., climate change, biodiversity, aging population) and may increasingly be left to future generations to deal with. Therefore, a radical system change approach is recommended. Increasingly, students will need to be able to respond to a job market that values creativity, collaboration, social intelligence, and empathy. The teaching pedagogy of constructivism and STEAM are evidence-based methodologies that may offer a higher success rate in meeting existential challenges of climate change, biodiversity, and ageing populations. Creativity and divergent thinking processes that prepare students for the climate and biodiversity emergencies are already being demanded by groups like Teach the Future and Extinction Rebellion. Moreover, a large 'skills gap' is demonstrated by employers across all sectors (Murray, 2022). A 'transdisciplinary' approach to teaching that works to further understand of the impact of the arts on traditional STEM subjects should be encouraged to help address these issues. Recent research from Burde and Wilhelm (2020) indicates that blurring subject matters using the arts (STEAM) results in a plethora of benefits for the learner, some of which will be illuminated throughout this report.

Additionally, automation and artificial intelligence are poised to radically alter labour markets (McKinsey, 2019). And creativity is a key human attribute that is and will be increasingly valuable for future job skills. Further embedding transdisciplinary teaching explicitly in course curriculum (i.e., evidence backed teaching pedagogical methods) should lead to enhanced empathy, openness to new ideas and experiences, and bravery as openness to failure and trust (Burnard et al. 2021).

By focusing on STEAM (science, technology, engineering, arts, math) and Constructivism (i.e., problem-based learning, cooperative learning, etc), SRUC should be better positioned to meet aspects of the 2020-2025 Learning and Teaching Enhancement Strategy. More specifically, this project has been placed in the context of the following CELT objectives: 'working towards designing



curricula informed by the latest research and engaging learners in research-based activities – encourage creative and critical thinking - build learning communities – foster learning environments that are inclusive, active, and blended – and work with our learners as partners’.

Therefore, it is argued, a rapid rebalancing of crucial ‘right-brained’ domain specific skills would be best developed through embracing STEAM, Constructivism, and other forms of cooperative and problem-based learning. Transdisciplinary collaboration should be coupled with evidence-based teaching and learning in the classroom to create new possibilities and perspectives for dealing with 21st century challenges. The main aim of this project was to identify, explore, and describe possibilities for building stronger teaching and learning pathways for students and staff, whilst working to identify the most probable pathways to ensuring uptake for evidence-based teaching methodologies across SRUC.

What was done?

The original goal of this project was for students to be instructed on examples of STEAM lessons/assessments by faculty to enable students to create a guide for Year 2 courses with general information and learning strategies that incorporate STEAM/constructivist approaches for individual module's lesson plans and assessments - in Environmental Management and Horticulture at SRUC.

A myriad of evidence-based teaching and learning methods were covered in the 1-hour weekly sessions. Please see the table for information regarding scheduling and information of workshops (Appendix). Constructivism and STEAM principles were embedded in the online Microsoft Teams sessions. More specifically, simulation-based role play, Q&A, team-based presentations, and debate. The following section of the report explains what was done in the weekly 1-hour Microsoft Teams Meetings, as well as ideas and solutions for issues related to STEAM, Constructivism, and associated themes.

Students and Staff were altogether surprised to review research that demonstrated that their intuition towards learning may often be misinformed. For example, a ‘superstar’ lecturer with above average oratory skills may give students’ the impression that their classroom learning experience is superior vs an active learning environment (STEAM, Constructivism). However, empirical evidence indicates higher scores on learning outcomes when the course design implements an active based learning strategy for teaching (Deslauriers et al. 2019). Upon reflective



discussion, the 'team' found that an evidence-based solution to help students limit this bias. More specifically, lecturers should take class time to introduce students to the merits of active-based learning. Deslauriers et al. (2019) explain that taking the time to demonstrate and explain why a certain teaching methodology is being employed will help to alleviate students' concerns regarding their learning in the classroom. Therefore, it is suggested that any lecturer employing STEAM or Constructivism toolkits should intervene prior to any active-based learning to explain concepts and frameworks related to these teaching methods, as this simple adjustment could lead to statistically significant improvements in both student perceptions of 'fluidity of learning' actual tests of learning.

Students and staff takeaways from multidisciplinary teaching were mixed. On the one hand, multidisciplinary teaching with staff and students collaborating on assessment and lesson delivery often leads to higher satisfaction and greater depth and quality of outputs. Students often demonstrate increased soft skills acquisition in terms of indicators relating to leadership, teamwork, time-management, communication, and project-planning (Álvarez and Caratozzolo, 2018). However, finding time to meet and collaborate in teams with staff and students can be difficult and result in inefficiencies in delivery. It is recommended that staff are realistic regarding time constraints and utilise bespoke frameworks to compensate accordingly. In addition, according to the joint student team of Horticulture and Environment students, multidisciplinary assessments can often be overly prescriptive and formulaic – leaving less room for creative autonomy when addressing the assessment prompts. It is advised that Staff work to communicate the possibilities for creative autonomy and spend time articulating opportunities to expand from the assessment prompt so that student's do not 'feel' stuck with their original perceptions of the assessment's requirements.

In subsequent weeks, the team queried the National Centre for Case Study Teaching. The search string that students returned showed 949 related teaching activities that utilise STEAM/Constructivism techniques and other active based learning techniques related to the Environment and Horticulture fields – areas of direct relevance to the students. Main discussion points related to the ease and adaptability many of the case studies could offer as an alternative to lecture style classes. Other in-class teaching methods covered included the Jigsaw classroom and world café method. These active-based learning techniques for facilitating group discussion and cooperative learning were also seen as legitimate tools that could replace some Lecture centric



deliveries while providing an environment for student-led learning and associated cognitive benefits.

All in all, the prevailing attitude of the students and staff were positive toward the opportunities to scaffold STEAM and Constructivism inspired themes into course design, lesson delivery and assessments. Whilst it seemed exciting, worthwhile, and even fun to redeploy resources towards retrofitting entire SRUC undergraduate programmes with these ideas in mind, a nascent idea took precedent that cast into doubt assumptions of the project.

What interventions are needed?

Students and Staff shared the sentiment that 'we need to further understand the barriers' that teaching staff face. The team were unanimous in solidarity that teacher workload issues, and mental health be fully addressed before recommending learning and teaching tools – otherwise the potential impact of the recommendations would have a higher risk of landing flat and perhaps impacting negatively on SRUC's learning and teaching enhancement strategy 2020-2025. Teachers across higher education were already reporting a high level of burnout prior to the pandemic, but the issue has accelerated during Covid-19 (Gerwin, 2021). Staff at SRUC have also been involved in union led strikes over workload and pay, while staff turnover has been high in recent years. Further amplifying these observations were the results of an internal survey published to SRUC academic staff. SRUC academic staff self-reported that 'addressing workload' would allow them to be more effective in their roles (Lacy, 2021). With this awareness and the situation still evolving (i.e., cost of living crisis), it is recommended that further PTIF related activities should work to further illicit understandings regarding workload. We recommend a targeted survey to gather views of teaching staff on the following criteria:

- 1) inform 'the team' of where teaching staff stand in relation to STEAM/Constructivism
- 2) what existing knowledge academic staff have about active-based learning already
- 3) what their willingness level is to engage with further learning
- 4) what specific barrier(s) they face

After gathering this data and analysing results, SRUC personnel should work to potentially identify a group of lecturers who are interested but either need support or want more information on how it works, that way future iterations of the PTIF can develop outcomes and materials that are more directly addressing the needs of the lecturers as well as the students. A very important caveat



is to further illicit understandings of teacher's perceptions regarding workload before offering guidance and advice on innovative teaching methodologies. In addition, it is recommended to prepare students early by setting expectations around learning and engagement. The goal is for students to be more receptive to evidence-based teaching pedagogical learning methods as the years progress. The Student and Staff PTIF team recommend that efforts are made to engage students at the Year 1 level. As a good example, in the Academic and Professional Applications (iTAPA) module, Team-Based Learning (TBL) was taught to 1st year Environment students, and this allowed for seamless TBL concepts to be scaffolded into Year 2 courses. Students would surely gain confidence and more practice with STEAM and Constructivism techniques through early adoption.

Of course, there are issues with innovation and experimentation that may be high risk. A primary obstacle would be to view STEAM as solely about arts integration. This is problematic since many natural science-based teachers perhaps lack artistic training. Also, there are still gaps in the knowledge regarding on how arts can be integrated meaningfully in STEM. Theory building, best practices, and practical applications are still somewhat sparse. And while STEAM may be somewhat of a higher risk teaching methodology, objections to embedding evidence-based teaching strategies rest on less firm ground. For example, it has been argued that transdisciplinary and 'active-based' learning can only apply to niche subjects or limited types of student learning. However, many years of research provide sound empirical evidence from 'hard science' subjects like physics to soft sciences like 'creative writing', a plethora of examples demonstrating that uptake of these learning and teaching concepts and/or frameworks facilitate advances in learning goals (Burde and Wilhelm, 2020). Furthermore, Finland, a country with a highly regarded educational system, more holistic and integrated approaches in curriculum design have been in place for decades. It could be argued that technological capabilities and understanding in STEM concepts are arguably ahead of humanities' ability to see bigger pictures, build positive social relationships, and implement holistic systems change; These are areas in which STEAM and Constructivism seem positioned to address. In any case, future iterations of the PTIF students and lecturers' collaboration at SRUC should continue to work to address this gap, perhaps by more closely collaborating with CELT and the Knowledge Exchange for Enterprise Network (KEEN).

Finally, helping to build more 'personalised learning routes' for students would fit with the Learning and Teaching Enhancement and Enterprising theme. Recent research indicates people



learn SRUC has specialist researchers and consultants whom students could benefit from in terms of on-the-job training. Organisational redeployment may involve work in the short term but enhance productivity and optimise the student and staff learning and teaching experience in the long run. For example, students would still require industry informed foundational courses, but then would be siphoned to SRUC subject matter Specialists. They would then work to learn from experts and related work skills with - real projects with real impact (Shackleton-Jones, 2019). Transferring knowledge into practice in this way could help to unlock some of the estimated '£4.5bn gross valued added (GVA) per annum for Scotland's food and drink industry' (BIGGAR Economics, 2020).

Future iterations of the PTIF staff/student collaborations could work to expand on one or more of these ideas. On a final note, collaboration is key. The students unearthed many 'aha moments' which would surely have not occurred from education staff working individually. It is our understanding that continued integration of industry, staff, and students, into curriculum design will reward the bold in this era of rapid change and upheaval.

Appendix

Dates for Live Sessions STEAM/Constructivism	
1) Introduction – Expectations of Project	Sept 22 nd 2021
2) Constructivism as Pedagogy	Sept 29 th 2021
3) STEAM as alternative to STEM	Oct 6 th 2021
4) Constructivism Lesson design	Oct 13 th 2021
5) STEAM Lessons design	Oct 27 th 2021
6) Constructivism Assessment types	Nov 3 2021
7) STEAM Assessment types	Nov 10 th 2021
8) Class time for project work/Q&A	Nov 17 th 2021
9) <i>Christmas Break/New Years No sessions</i>	Dec 15 th – February 2021
11) Class time for project work/Q&A	Feb 9 th 2022
12) Class time for project work/Q&A	Feb 16 th 2022
13) Class time for project work/Q&A	Feb 23 rd 2022
14) Complete Project work and mock seminar	Mar 2 nd 2022

Table 1 - Workshop/Q&A sessions and dates - beginning of September to last week of February. Two workshops a month over six months - 12 workshops. These are workshops/meetings with staff (Ruth, David, CELT) .5hrs workshop, .5hrs Q&A - 1 hour plus 15 minutes for personal learning logs after each session. *An additional 15 hrs will be allocated to students for outside class time to complete project goals. Total = 30 hrs commitment over 6 months. Students were awarded a £400 stipend for their commitment to the project during the always hectic academic term.

The one thing that would help me be more effective in the next 6 months is

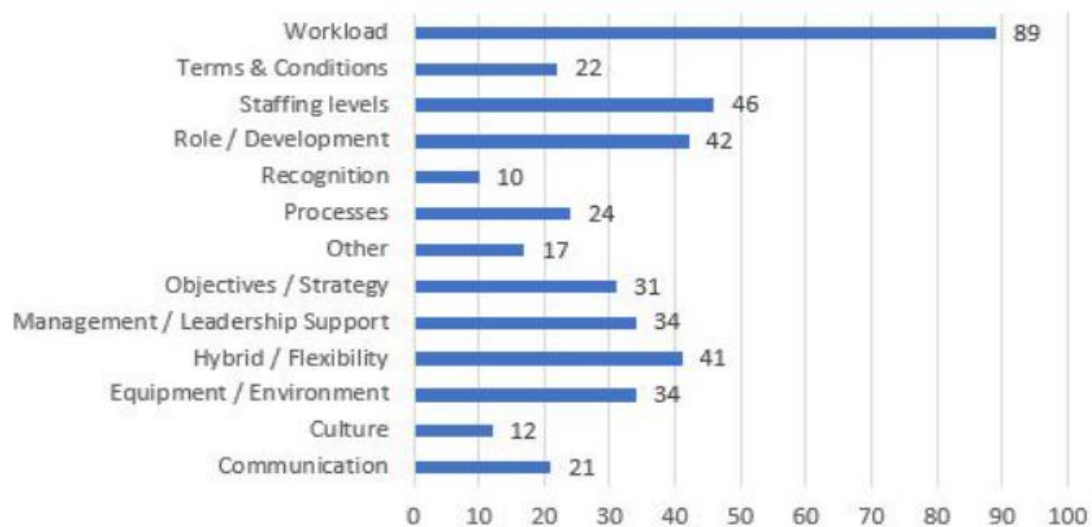


Figure 1. SRUC Academic Staff employee well-being survey (Lacey, 2021)



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